



THEME ISSUE

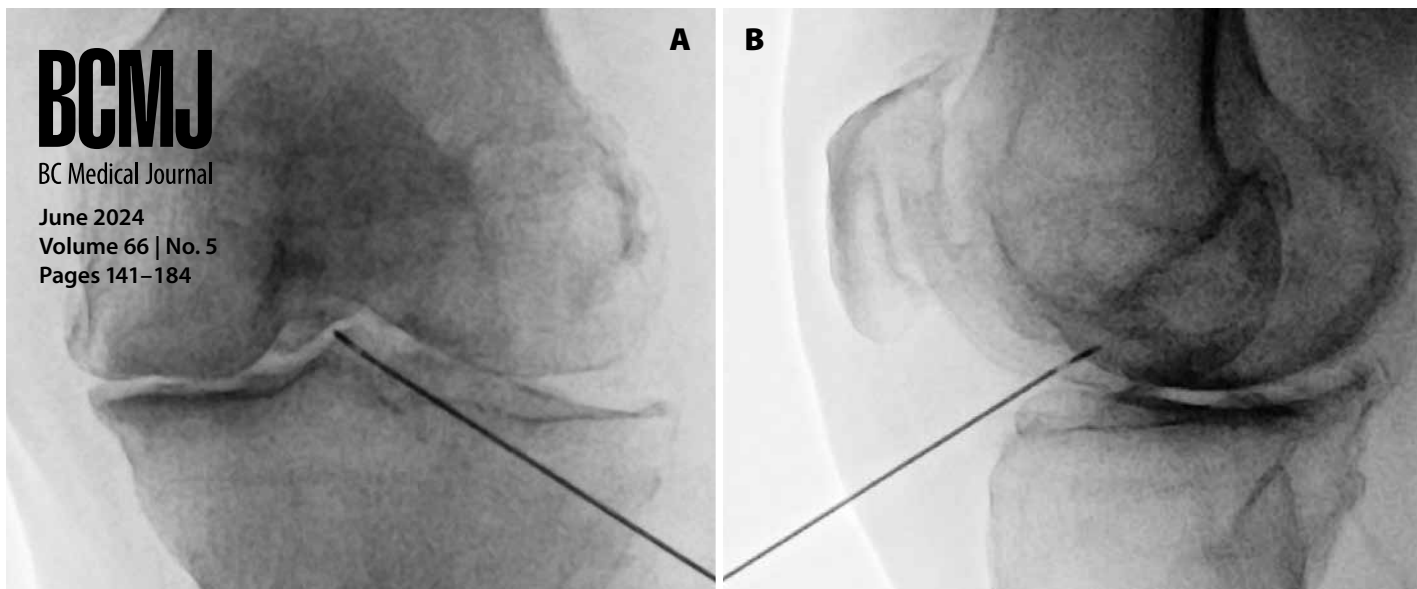
Osteoarthritis, Part 2

Guest editorial: Osteoarthritis, Part 2

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- Osteoarthritis in Indigenous populations in rural British Columbia: Disparities in prevalence and access to care
- Radiologists as clinicians: Radiological interventions for knee osteoarthritis
- Physiotherapy and knee osteoarthritis

Premise: “Lose 70 pounds and you get a new knee”: The current approach to obesity in patients awaiting total joint arthroplasty



AP (A) and lateral (B) fluoroscopic images of the left knee of a patient undergoing neuromodulation. The radiofrequency probe is visualized as a fine needle in the intercondylar notch, inserted via an inferolateral approach. Radiologists can offer a number of image-guided percutaneous therapies in the treatment of knee osteoarthritis, including newer nonpharmacological options such as neuroablation, neuromodulation, and genicular artery embolization. Article begins on page 159.

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Vision: The *BCMj* is an independent and inclusive forum to communicate ideas, inspiring excellent health care in British Columbia.

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ON THE COVER

With a focus on knee osteoarthritis, the authors discuss osteoarthritis in Indigenous populations in rural BC, radiologists as clinicians, physiotherapy, and obesity. Part two of our two-part theme issue begins on page 154.

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For members of Takla Nation, situated 5 hours from Prince George, accessing the health care pathway is complex and multifaceted. See the article, "Osteoarthritis in Indigenous populations in rural BC: Disparities in prevalence and access to care," which begins on page 155.

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The 2024 federal budget: Bad news for medical professional corporations

The 2024 federal budget¹ was released on 16 April 2024. It includes major spending on housing, the Canada Disability Benefit, and a national school food program.² These initiatives will come at a significant cost: Finance Minister Chrystia Freeland projected a \$40 billion deficit this fiscal year. According to the CBC, the government will spend more this year to service the growing \$1.4 trillion national debt than on health care.²

To help pay for some of its commitments, the government increased the taxable portion (aka the “inclusion rate”) of capital gains from 50% to 66.67%. Changes take effect on 25 June 2024³ and are expected to bring in about \$19.3 billion over the next 5 years.⁴

The government’s plan to tax the “very wealthiest” has been criticized by many for failing to account for how middle-class Canadians and small businesses, including medical professional corporations, will be affected. Immediately following the budget announcement, CMA President Dr Kathleen Ross’s remarks were quoted in a *Globe and Mail* article titled “Changes to capital-gains tax may prompt doctors to quit, CMA warns.”⁵

So, what is a capital gain? And why do these changes matter to physicians?

A capital gain is an appreciation in value above what was originally paid to acquire an investment. Capital gains generally apply to the sale of stocks, real estate (except

a principal residence), and assets used in a business. For example, if you buy stocks for \$100 000 and sell them for \$150 000, the capital gain is \$50 000. At an inclusion rate of 50%, that means \$25 000 would be added to your total income and taxed at your applicable tax rate [Table].⁶ Of note, capital gains inclusion rates have varied in recent decades, reaching as high as 75% in the 1990s.⁴

Many Canadians will not be affected by the tax increase, because the new 66.67% inclusion rate applies only to gains over \$250 000 for individuals.⁷ Individual capital gains below \$250 000 that are outside of a sheltered tax account like a TFSA or RRSP will still be taxed at the 50% inclusion rate.

However, the majority⁸ of physicians are incorporated, a structure that enables them to earn professional income that is taxed at a lower tax rate than if that income was earned personally. The corporation’s tax-deferred dollars can then be invested as retirement savings, and physicians can pay themselves income in the form of salary or dividends. Unlike individuals, whose capital gains are taxed at 50% for the first \$250 000, physicians’ medical corporations receive no such exemption and will have *all* of their capital gains subject to the 66.67% inclusion rate.⁶ In other words, the new higher inclusion rate applies to every dollar of capital gains of a corporation. A physician would realize the effects of these changes upon selling property or cashing in investments or shares held by their corporation.⁷

Until now, the integration of corporate and personal taxes would generally make a taxpayer indifferent to realizing a capital gain personally versus corporately. The changes introduced in the 2024 federal budget have thrown the foundational principle

TABLE. Example showing the integration of personal and corporate tax rates assuming a BC individual at the top marginal tax rate.

	Existing rule	New rule
Corporate income tax		
Capital gain	100 000	100 000
Taxable capital gain	50 000	66 667
Corporate tax rate	50.67%	50.67%
Corporation income tax	25 335	33 780
Refundable tax (assumes full refund)	(15 333)	(20 444)
Net corporate tax after dividend refund	10 000	13 300
Amount available for distribution	90 000	86 700
Personal income tax		
Capital dividend (tax-free)	50 000	33 333
Non-eligible dividend	40 000	53 367
Tax rate on non-eligible dividend	48.89%	48.89%
Personal tax	19 556	26 091
Total personal and corporate tax	29 556	39 391
Fully distributed tax rate	29.56%	39.39%
Compare to capital gain individually		
Existing rule		
First \$250 000	26.75%	26.75%
Exceeding \$250 000	26.75%	35.67%

Source: Matthew Baker, CPA.

of integration into disarray, now making it significantly disadvantageous to realize capital gains in a corporation before the net proceeds are distributed.

Dr Ross called the changes “one more hit to an already beleaguered and low-morale profession.” On behalf of the CMA, Dr Ross has asked the government to exclude medical professional corporations from the capital gains changes. At the time this editorial was published, no response to this request had been communicated. Alternatively, I wonder if it might be prudent to ask that individuals be allowed to allocate their annual personal capital gains limit of \$250 000 to their corporation.

What now? Do we feverishly sell off investments prior to 25 June 2024? Invest outside of the corporation going forward? Or continue as is? I will require the careful analysis of an accountant to determine the best financial strategy. The more difficult problem to address for some, however, might be the psychological sting of

once again feeling underappreciated by our government. ■

—Caitlin Dunne, MD, FRCSC

Acknowledgments

I wish to acknowledge Mr Matthew Baker, CPA, for his invaluable contributions and editing of this piece. Mr Baker is a tax partner at Baker Tilly Canada in Vancouver and can be reached at Matthew.Baker@bakertilly.ca, in case anyone else feels as blindsided as I did after these budget changes.

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Driving toward injury-free roadways

In the afternoon of Wednesday, 17 April 2024, a cyclist was struck and killed by a pickup truck in East Vancouver. This tragic event was the 14th death due to a road crash in Metro Vancouver this year, and the province-wide fatality count is higher still. For every road death, there are severalfold more people requiring hospitalization or other health care due to traffic-related crashes, which cause roughly 300 fatalities, 4000 hospitalizations, and 60 000 emergency department visits per year in British Columbia.¹ The overwhelming majority of these harms can be prevented.

The vision-zero approach to road crashes aims to eliminate fatalities and serious injuries due to road crashes by addressing the transportation infrastructure and policy decisions that are the root causes of road crashes. This goal has been endorsed by BC's Office of the Provincial Health Officer, which has called for comprehensive action in the areas of safe speeds, safe roadways, safe vehicles, and safe road users.²

Safe vehicle speeds are crucial to prevent serious injuries due to crashes; higher speeds make crashes both more likely to occur and more severe in their outcomes. A substantial body of evidence indicates that a pedestrian struck by a vehicle moving at 50 km/h may have a 20% chance of survival, while a pedestrian struck at 30 km/h has a greater than 90% chance of survival.³ Action from local governments has been promising: over 60 municipalities in BC have lowered speed limits from the standard 50 km/h to 30 or 40 km/h in specified areas or community-wide.

Posted speed limits are one of many important tools available to improve driving safety. Also important is that the design of roadways promotes safety and is coherent with posted speed limits. Traffic-calming design choices such as narrower lanes, speed

humps, and small roundabouts on residential streets have been shown to decrease vehicle speeds.⁴ Meanwhile, interventions such as raised crosswalks and protected cycling lanes can facilitate safe movement amid roadways.

Strategies to support walking, cycling, and public transit use can decrease injury risk at the population level.

While roadway designs and policies can decrease the harms from crashes, an overall transportation mode shift away from personal vehicles may be most impactful. Strategies to support walking, cycling, and public transit use can decrease injury risk at the population level. Safe and active transportation options can prevent chronic diseases and promote mental health while improving access to work, education, and recreation. Importantly, these more-sustainable modes of transportation can support the imperative of climate change mitigation while also promoting health.

The current burden of injuries and deaths due to road crashes carries an estimated cost of \$492 million per year in BC;¹ the human cost of lives lost and altered cannot be assigned a dollar value. Health care related to road crashes is delivered in medical specialties including emergency medicine, family medicine, and orthopaedics. Likewise, physicians practising in the separate day-to-day worlds of public health and trauma surgery recently advocated to Vancouver City Council in favor of a motion to reduce local speeds, which passed unanimously. Just as the medical community advocated with others for seatbelt laws

a generation ago, we can work together today for safe transportation. ■

—Michael Schwandt, MD, MPH, FRCPC

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Re: Primary care needs more access to doctors, not less

I wish to affirm the Premise put forward by Drs Bell and Sloan that both patients *and* physicians benefit from increased access to primary care [*BCMJ* 2024;66:14-15].

I have been in family practice for 40 years. I have been on call for most of that time. Earlier in my career, I was generally available 24/7, as I was mostly doing locums in remote solo practices, often in the Arctic. For the past 28 years, I have “limited” my availability to about 14 hours/day, 7 days/week, year-round. This includes most days that I am away on holiday, which averages 13 weeks/year. Wherever I am, I turn off my phone at 8 p.m., guaranteeing a good night’s sleep. About half of my 2500 patients have my personal contact information. They know not to call me, but they may text or email anytime, in English, French, or Spanish.

What is the consequence of this engagement? Happy patients and a happy, healthy doctor. So far, I have accumulated 4 days of disability—1 day for a bad flu in 1986 (no flu vaccine back then), 1 day to recover from esophageal surgery for a Zenker diverticulum, and 2 days off after a total hip replacement (I cycled to the office on day 8 post-op). I have not experienced fatigue or burnout. On the contrary, I consider my life essentially stress-free. I continue to indulge in many other pursuits, including cycling a minimum of 10 000 km/year for the past 21 years, all over the world. At age 64, I enjoy practising medicine as much as ever and hope to continue to serve my patients for many years to come.

—Thomas DeMarco, MD
Whistler

Physician ignition: Promoting physician wellness through CME

The 69th Annual St. Paul’s Hospital CME Conference for Primary Care Physicians was held in Vancouver 21–24 November 2023. Close to 1000 family doctors and medical residents attended in person, and 500 attended virtually from all over North America. The dynamic planning committee innovated and led with a variety of wellness initiatives to engage and energize participants. By incorporating physician mental and physical health, we help doctors have the agency to treat patients more effectively.

Using an app to pose a daily question, we sparked discussions related to workplace and physician wellness. On day 1, we asked participants what advice they would give to a new medical graduate. The following is a collection of answers that I wish someone had discussed with me earnestly 22 years ago.

- Don’t be scared to ask a colleague for their opinion.
- Hold boundaries when answering the phone and emails.
- Have self-compassion. You can be good enough—a good physician, a good person—while making mistakes. We are also human beings.
- Never finish a vacation without planning the next one.

Professional fulfillment was another conference theme. The following pearls shared by physicians are some of the constructs that bring meaning to our work and give us purpose. On day 2, participants were

asked what aspect of their work makes them feel most fulfilled. These are some of the answers:

- Connecting with patients and developing a strong relationship.
- The goal of leaving the patient feeling reassured, validated, and genuinely understood.
- When patients take time to express their gratitude, it fills my emotional bucket.
- It is nice to hear positive feedback from specialists and colleagues.

As health care has become more complex, working in teams is essential for better patient care. Teamwork allows physicians to focus on the “doctoring” and can be fulfilling by supporting and being supported by other health care workers. On day 3, we asked participants to share best practices that help teams thrive in health care. These are some of the responses:

- Communication. Always explain why—everyone needs motivation and reasoning.
- Knowing your limit and when to ask for help is important.
- Define roles and let your team members shine in their roles. Positive feedback and appreciation go a long way!
- Regularly check in on each team member. This will encourage the team to speak freely about how they are feeling and for everyone to be on the same page.

We also hosted an ideas board outside the main conference hall where wellness tips were posted. Daily polls and word clouds were used prior to the start of half days and

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The creativity to do more with less in a constrained health care system

As doctors, we hear about and feel the daily challenges of a constrained health care system—the lack of adequate doctors, nurses, operating rooms, hospital beds, CT, and MRI, and the list goes on. How do we improve access for patients amid these ongoing challenges? How do we accomplish the difficult task of providing patients with the quality care they need when they need it?

In the words of former Lego CEO Jørgen Vig Knudstorp: “Many creative people are finding that creativity doesn’t grow in abundance, it grows from scarcity—the more Lego bricks you have doesn’t mean you’re going to be more creative; you can be very creative with very few Lego bricks.” What lessons have *we* learned from years of scarce resources in hospital-based and specialty care? How have we been creative in addressing a constrained system? And what actually works to increase patient access and reduce wait lists?

It has long been known in queuing theory that a single-entry model, where the first patient in line is directed to the first available physician, is the most efficient model to keep wait times as short as possible.¹ Multiple studies show that the key barrier to implementing this model revolves around the potential unwillingness of physicians to engage in this kind of practice and their ability to standardize their practices. Yet, the benefits are clear: reduced wait times for both consultation and surgery, high provider satisfaction, and, from an equity perspective, better outcomes for patients and physicians.

Understanding this, in 2018, the Specialist Services Committee, a partnership

between Doctors of BC and the Ministry of Health, launched the Enhancing Access Initiative, which supports interested groups of specialists to implement a single-entry model that strengthens patient access to specialist services by prioritizing patients to see the first available physician. Today, 34 specialist groups have implemented pooled referral models by working with local communities of practice, holding engagement

It has long been known in queuing theory that a single-entry model, where the first patient in line is directed to the first available physician, is the most efficient model to keep wait times as short as possible.

sessions with referring partners, and establishing true multidisciplinary clinics. In a thorough evaluation, it was noted that groups who underwent this process were able to decrease wait times by almost 70%, or 75 days!²

The Specialist Services Committee also created new fee structures in 2011 to support nurses in practice with rheumatologists. This was in response to significant data that showed multidisciplinary care reduces patient wait times, improves patient self-management, and leads to improved emotional and psychological well-being.³ More than a decade later, this has led to

a 15% increase in the number of patients seen by rheumatologists across the province.

Inspired by this, the Specialist Services Committee rolled out a specialist team collaborative in 2022, in which more than 10 different specialist groups embarked on a process to integrate multidisciplinary team members in complex specialist practices. Despite the specialists being spread across the province in both rural and urban locations and across the spectrum from procedural and nonprocedural specialties, the outcomes again demonstrated success across all metrics. For these specialist groups, the capacity to see patients increased by more than 50%!

In my last President’s Comment, I spoke about the necessary work to increase health human resources and infrastructure. Far too many patients remain on wait lists, uncertain when they’ll be seen by a physician or when their diagnostic test or surgery will take place. While we wait for those increases in resources and infrastructure to be realized, we cannot afford to stand still. By listening to physicians across BC and leaning on their successes, we can reduce wait times for patients and improve their experience of care in times of scarcity, if we are willing to be creative. Single-entry models and multidisciplinary team-based care are two examples of evidence-based interventions that can help increase capacity in a constrained system.

In scarce times, we need to rely on our innovation, motivation, and ability to be strategic with our resources so we can do more with less. Doctors of BC, by way of

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LETTERS

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were viewed by all participants on a big screen in the main lecture hall.

The transformation of CME has begun with new and innovative methods to promote physician wellness throughout medical education. Having a sense of community among health care providers is crucial for listening, sharing ideas, and feeling supported and valued.

This was the start of what I call CME 2.0. Medical education and conferences are more than academics. These concepts are crucial to support and develop a thriving family doctor. I can't wait for CME 3.0 in 2024. I want to change physician burnout to physician ignite!

—Daniel Y. Dodek, MD, CCFP, FCFP
St. Paul's Hospital CME Conference for
Primary Care Physicians, Physician Lead
Wellness

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Special thanks to St. Paul's Hospital CME Committee co-chairs Drs D. Ngui and T. Wasserfall and members Drs N. Strydom, R. Low, N. Levitt, L. McFarlane, C. Ryan, N. Baria, A. Villaruel, H. Chang, K. Rutherford, and C. Iturra.

PRESIDENT'S COMMENT

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the Joint Collaborative Committees, engagement partners and regional advisors and advocates based within the boundaries of each health authority, and several Doctors of BC departments, fully supports this work by prioritizing the physician voice and leaning in on collaborative care because we can all truly do better, together. ■

—Ahmer A. Karimuddin, MD, FRCSC
Doctors of BC President

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Re: The general surgery workforce versus population growth in BC

In the article "Chasing a moving train: The general surgery workforce versus population growth in British Columbia, 2012–2022" [*BCMJ* 2024;66:46-50], the authors recognize that "[c]ancer care is a resource-intensive area of medicine, requiring not only operating rooms but also oncologists, chemotherapy nurses, and radiation treatment infrastructure." However, pathology is also critical to cancer care, providing the link between general surgeons and oncologists. Diagnostic imaging is critical as well. Pathology infrastructure is resource-intensive, including physical laboratory resources (space, equipment, reagents, etc.) and skilled professionals (pathologists, pathologist assistants, medical laboratory technologists, cytotechnologists, medical laboratory assistants, and others).

The pathology workforce is also chasing a moving train.

—Valerie Taylor, MD, FRCPC, DRCPC
Kelowna



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In-office management of knee osteoarthritis

Treating knee osteoarthritis in the clinic using unloader braces, topical applications of NSAIDs, and intra-articular corticosteroid injections can help improve function and pain management.

Read the article: bcmj.org/articles/office-management-knee-osteoarthritis



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BC to fund in vitro fertilization: For whom and how?

BC is in a unique position to learn from other provinces and countries that offer fertility funding. We review the available data and consider how to provide equitable access for BC residents to a much-needed treatment.

ABSTRACT: Infertility is a common diagnosis: in its original, heteronormative definition, it is known to impact about 1 in 6 couples worldwide. Governments across Canada and beyond have been increasingly providing support for those undergoing fertility treatment, and BC is the most recent province to announce funding, beginning in 2025. As the amount of proposed funding is not sufficient to cover treatment for all who seek it, we look to examples from other provinces and countries to guide us in forming criteria that balance fair access with likelihood of successful treatment. A majority of Canadian provinces currently provide publicly funded fertility care, albeit with highly variable models. Quebec previously introduced a model with generous coverage, including up to three cycles of in vitro fertilization (IVF), along with medications, associated procedures, and embryo transfers for each live birth. Due to high costs, this funding was removed and reintroduced in 2021 with a more restrictive

model, as well as age cutoffs for IVF and embryo transfers. In Ontario, the current funding model was introduced in 2015 and covers intrauterine insemination cycles and one cycle of IVF in patients younger than 43 years of age. Other provinces have offered a fertility treatment tax credit. While the BC announcement stated that one cycle of IVF with medications will be covered, the details on how this finite resource will be distributed are still unclear. We hope BC will consider the lessons learned from other provinces and countries and implement a program that is fair and accessible to those who need it.

Defining infertility

Infertility is defined as a condition or disease that results in difficulties in achieving a successful pregnancy. It has been estimated to affect 1 in 6 heterosexual couples worldwide.¹ The true prevalence of infertility is likely higher if a more inclusive definition is used, because many members of the LGBTQIA2S+ community and single individuals will need access to fertility treatments to build their families. The traditional definition of infertility is heteronormative and includes regular, unprotected intercourse for 12 months (if the female partner is younger than 35 years of age) or 6 months (if the female partner is 35 years of age or older). In 2023, the American Society for Reproductive Medicine expanded the definition of infertility to acknowledge that age, medical history, sexual history, reproductive history, physical findings, and testing

also contribute to its diagnosis.² With this more inclusive definition, patients who require the use of donor gametes, either as a single individual or as a couple (for example, same-sex female couples), are addressed.² The impact of infertility stretches beyond the ability to create a family—the significant emotional and financial hardship experienced by patients is well documented, as is the stigma associated with the disease. Moreover, this diagnosis does not discriminate between individuals of varying socioeconomic classes, leading to a disparity in who can access treatment.¹

The economics of fertility

An aging population, combined with a reduction in birth rates, has led to population decline worldwide, and BC is not immune. In fact, for the first time in history, BC has experienced negative population growth.³ The potential impacts on the economy due to this trend—fewer people entering the workforce than leaving it—are concerning, and governments around the globe have been taking notice and providing increased funding for fertility services. For example, of the 43 countries providing in vitro fertilization (IVF) and intrauterine insemination (IUI) in Europe, 39 provide at least partial funding.⁴ Across Canada, the approach to public funding is highly variable but is available in a majority of provinces: Quebec, Ontario, Manitoba, Nova Scotia, Prince Edward Island, Newfoundland and Labrador, and New Brunswick.⁵⁻¹¹

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This article has been peer reviewed.

Fertility funding in BC

In February 2024, BC announced coverage for fertility treatments, with funding for one cycle of IVF with medications, starting 1 April 2025.^{12,13} The announcement acknowledged the aims of funding, including providing treatment for people experiencing infertility, same-sex and gender-diverse couples, and individuals wanting to build a family.¹² However, details on program eligibility and access to services and the definition of a “cycle of IVF” have yet to be determined.¹³ Beyond expanding access to fertility treatments, funding also helps break the stigma of infertility and raise awareness.¹⁴ While this news is exciting, a budget of \$64 million over 2 years leaves many questions unanswered. In BC, we are in a unique position to consider the key learning points that other provinces and countries have gained from their experiences. We review these points and present considerations to enable equitable access to a much-needed treatment for BC residents.

Fertility funding elsewhere in Canada and beyond

Quebec

In 2010, Quebec introduced the most generous public coverage for IVF, with no exclusion criteria. The program allowed self-referrals and included three cycles of IVF with medications and any associated procedures, such as surgical sperm retrieval or donor sperm. Embryo transfer for all created embryos was also included, and a successful live birth reset the cycle count to one. To tackle the IVF-related multiple pregnancy rate—one of the primary goals of the program—a strict limit was placed on the number of embryos transferred.¹⁵

During funding, single embryo transfer rates increased from 9.2% to 64.3%, with a subsequent drop in multiple pregnancies from 25.6% to between 3.3% and 7%. The number of IVF cycles, however, ballooned from 2000 per year prior to coverage to over 8000 per year by 2013, placing enormous pressure on the health care system and fertility clinics. With the increase in cycle

numbers came a decline of nearly 10% in the live birth rate.¹⁵

While the exact costs of the program are unclear, it is estimated that this unrestricted coverage policy cost the province \$60 to \$80 million annually (equivalent to between \$82.4 million and \$109.9 million in 2024).¹⁵⁻¹⁷ The program was terminated in November 2015 in favor of a restrictive policy covering only IUI, except in the case of fertility preservation for oncology.¹⁵

The current Quebec model came into practice in November 2021, and coverage for IVF was once again included. Only one cycle is covered, with specific restrictions, including age (< 41 for IVF and < 42 for embryo transfers) and no history of vasectomy or tubal ligation. Superovulation and donor insemination are also covered (including medications). However, despite a more restrictive model of IVF coverage, wait lists have lengthened to the point that some women age out of funding.⁵ In fact, a temporary reimbursement program was established in June 2022 to help reimburse expenses incurred for out-of-pocket IVF in these individuals and families.⁵

Ontario

Ontario also has a long history of fertility coverage and was the first province to fund IVF, in 1985.¹⁸ However, funding was withdrawn in 1993, except for the indication of bilateral tubal occlusion.¹⁸ Ontario reintroduced funding for fertility treatments in 2015: unlimited IUI cycles and one cycle of IVF in females younger than 43 years of age (including single embryo transfer of all viable embryos).^{6,19} Medications are not covered, although many individuals and families have coverage through private insurance providers.^{6,19} As in Quebec, coverage is not dependent upon having a diagnosis of infertility.^{6,19,20}

After its reintroduction, there was an influx of consultations and an increase in IVF cycles.²⁰ For example, the number of treatment cycles in females aged 40 to 42, a poorer-prognosis group, doubled.²¹ However, similar to the Quebec experience, there was an associated decrease in the live

birth rate per IVF cycle started.²¹ Initial wait times for IVF were listed as 1.5 years and settled to around 1 year a few years later,²⁰ although the wait time between clinics remains variable. Management of wait lists has been left to individual clinics, with minimal transparency to patients regarding the different allocation methods used: first come first served, lottery, priority to those approaching the age restriction, or priority to better-prognosis patients.²⁰ This has led to some patients attending consultations at multiple clinics, hoping to maximize their chance of receiving funded IVF as soon as possible,²⁰ further stretching finite resources.

Other provinces

A more generalized approach to coverage has been taken by other provinces, including tax credits or reimbursements up to a certain value or percentage for fertility treatments. Shortly after Quebec began funding IVF in 2010, Manitoba began offering a fertility treatment tax credit.⁷ The credit covers 40% of treatment costs, including the full spectrum of fertility treatments, to a maximum annual eligibility of \$20 000 (i.e., a maximum tax credit of \$8000).⁷ There is no limit on the number of treatments under this model.⁷ Nova Scotia provides the same tax credit as Manitoba, with a recent extension of its coverage to include surrogacy expenses.⁸

Funding outside Canada

Around the globe, programs vary widely in their coverage and implementation. The approach taken by the UK is coverage for IVF in the context of 2 years of unprotected intercourse for heterosexual couples or following six rounds of IUI for female same-sex couples.²² The details and cutoffs vary locally and are determined by an integrated care board.²² These cutoffs generally include a body mass index (BMI) between 19 and 30 kg/m², age younger than 42 years, and nonsmoking status of both partners.²² They also specifically state that at least one person in the couple must be childless (i.e., no adopted or biological children).²²

Currently, BC’s Medical Services Plan

PREMISE

(MSP) covers the initial consultation and office visits for infertility, as well as a large portion of fertility testing. Anti-Müllerian hormone—a crucial test for determining ovarian reserve—is not included in the coverage and costs, on average, between \$70 and \$80. Fertility-related surgeries, including hysteroscopy and laparoscopy, when indicated, are covered. While a hysterosalpingogram for uterine cavity and tubal patency assessment is covered by MSP, this test is becoming increasingly difficult for patients to access, as fewer and fewer hospitals and clinics are offering the service. While alternative forms of uterine cavity and tubal patency by ultrasound are available, these options are not currently covered by MSP. An influx of patients following the introduction of IVF coverage will likely worsen the current bottleneck, resulting in further delays in diagnosis and treatment for patients unless access to this testing is improved.

Treatment costs

In our current model, once history and testing indicate that IVF is the recommended treatment, most care is no longer covered by MSP. Treatment with IVF typically costs \$10 000 to \$12 000, with medications costing an additional \$5000 to \$9000. The large range in cost is a result of the type of fertilization method used and the dose of medications required, respectively. The funding would be able to cover approximately 1600 to 2250 cycles each year, which would not include the costs of future embryo transfers (approximately \$3000 to \$4000 per transfer) and storage fees. Additional optional costs include surgical sperm retrieval and genetic testing of embryos for aneuploidy or for indications such as translocations (a potential cause of recurrent miscarriage) or single gene disorders.

Repercussions of increased demand for treatment

Currently, fertility clinics in BC perform over 2500 IVF cycles annually for infertility. With financial barriers to treatment removed, demand will surely increase. As described above, experience in other

provinces indicates that the introduction of funded IVF will lead to a dramatic increase in the number of IVF cycles performed annually.^{15,20} Regardless of the number of cycles being funded, this demand may not be sustainable for fertility clinics, where there is a maximum number of cycles that can be safely performed from both the clinical and laboratory perspectives. Additionally, there is a North American shortage of specialists trained in reproductive endocrinology and infertility,²³ with only a handful of new physicians being trained in Canada annually.²⁴

Limitations in access to treatment

It is also important to consider how these services can be accessed by patients in geographically underserved regions, where visiting an IVF clinic requires time off work, travel, and other expenses. Fertility clinics are centred in the Lower Mainland and Victoria, with only a handful of satellite clinics with ultrasound and IUI capabilities present in other regions of the province. While telehealth and partnership with gynecologists in these regions can provide some assistance, patients are still required to be seen in a fertility clinic for procedures, which can be performed only by a reproductive endocrinology and infertility specialist connected with a fertility lab.²⁰ Consideration should be given to how funding can be provided to patients across BC in an equitable manner, regardless of their geographical location.

How to allocate finite funding

The finite funding will not cover IVF for all BC residents, so how can we allocate it to best serve the population? With funding available for a single treatment (IVF) there may be a desire to pursue IVF over nonfunded, less-invasive options (e.g., IUI or ovulation induction). For example, first-line therapy for polycystic ovarian syndrome (and resultant oligo-ovulation) is ovulation induction with an oral agent combined with timed intercourse, and, in unexplained infertility, both the American Society for Reproductive Medicine and the Canadian Fertility and Andrology

Society advocate for three to four cycles of medicated (i.e., superovulation) IUI in patients younger than 38 years of age before pursuing IVF.^{25,26} Funding will lead to challenges balancing these evidence-based recommendations with patients' desire to use the funded option, potentially resulting in lengthy wait lists.

As it is not financially feasible to provide IVF to everyone likely to seek treatment under the current proposed funding, restrictions and/or criteria are needed to balance fair access with the likelihood of successful treatment. When determining eligibility for funding, the most common criterion put in place is age—being mindful of the significantly lower success rates with advancing maternal age.⁴ For instance, when Quebec offered multiple cycles of IVF with no age limit, a retrospective analysis showed a 10% live birth rate per cycle at age 40, declining to 6.9% at age 41, 5.4% at age 42, and 4.1% at age 43, with 0 live births at age 44.²⁷ While each live birth is valuable, at age 43, the mean treatment cost per live birth (excluding medications) was \$103 994, and at age 44, the mean treatment cost was \$597 800, with no live births.²⁷ A recent study from Ontario found an 8.3% live birth rate per IVF cycle started for patients aged 40 to 42.¹⁹ Other regions have also considered predictors of success when determining exclusion criteria, including smoking and BMI. Regulations from the College of Physicians and Surgeons of BC for nonhospital surgical settings necessitate anesthesia involvement for patients undergoing egg retrieval who have a BMI greater than or equal to 40 kg/m².²⁸ This comes at an additional cost and is available at only certain clinics in BC.

How this funding will extend to all individuals wanting to create a family is unclear. To inclusively provide treatment for same-sex and gender-diverse couples and individuals wanting to have a child independently, it may be reasonable to consider funding the purchase of donor sperm and subsequent inseminations for same-sex female couples and single women wanting to conceive. For same-sex males wanting

to create embryos, donor eggs are either provided by a known donor or purchased, which is more costly.

Assuming a tax credit system is not used, thought will need to be given to moderating wait lists and creating a centralized wait list. With this, patients would be assessed based on set criteria and approved for treatment. If deemed eligible, they could use the provided funding at the fertility clinic of their choice. This system would prevent patients from feeling that they should seek consultations and be placed on IVF wait lists at multiple clinics, as documented in other provinces,¹⁹ further minimizing the unnecessary use of finite resources. Additionally, the question will be raised whether patients who have fertility coverage for procedures and medications through extended health benefits should have the same access to government funding as those without any coverage.

Another pressing concern is that patients who need treatment may delay care to wait for the funding. It is well known that IVF success is based largely on egg quantity and quality, both of which reduce with time. Time is crucial for patients with a low egg reserve and for patients at an age where dramatic reductions in egg quality are occurring.

Additionally, although funding breaks down the financial barrier to treatment, it can also open the door to indiscriminate use of the technology. IVF is not without risk, for both the patient and the pregnancy. It involves injection medications and a surgical procedure, with risks including ovarian hyperstimulation syndrome, infection, bleeding, and damage to surrounding organ structures. Pregnancies may be higher risk for babies small or large for their gestational age or preeclampsia.

While IVF has broken down many barriers faced by individuals and couples hoping to build a family, it should not be used indiscriminately. The funding announcement is exciting and requires careful consideration from interested parties on how to best use this finite resource to serve BC while still supporting medical recommendations. ■

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Osteoarthritis, Part 2



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In the first part of this two-part theme issue on the important medical problem of osteoarthritis, as exemplified by osteoarthritis of the knee, we discussed the diagnosis and nonoperative and surgical management of knee osteoarthritis. The second part of this theme issue includes the following articles:

Article 1: Shirvani and colleagues discuss disparity in access to osteoarthritis care for Indigenous patients, especially in rural BC. The socioeconomic status of Indigenous communities is highlighted as a contributing factor to disparities in osteoarthritis prevalence and care. Barriers to accessing health care services in remote areas are discussed, and the importance of culturally sensitive care and telehealth technologies is emphasized. The authors call for further research and highlight the need to address social determinants and implement policy changes to improve osteoarthritis care of Indigenous patients.

Article 2: Alenezi and colleagues provide an overview of the radiological diagnosis and image-guided percutaneous treatments for knee osteoarthritis. Radiographs, MRI, CT, and ultrasonography are discussed as diagnostic tools. Intra-articular steroid therapy, hyaluronic acid injections, platelet-rich plasma injections, and mesenchymal stem cell injections are highlighted as percutaneous treatment options. Newer treatments such as geniculate artery embolization, neuromodulation, radiofrequency ablation, and cryoablation are also discussed.

Article 3: Barber and Jahanbani discuss the role of physiotherapy in managing knee osteoarthritis. Physiotherapy interventions, including exercise therapy and patient education, have been shown to be effective in alleviating the symptoms of knee osteoarthritis. Exercises such as strength training, aerobics, and walking, and mind-body

practices like tai chi and yoga can reduce pain and improve physical function in osteoarthritis patients. Collaborating with family physicians, physiotherapists can educate patients about osteoarthritis and recommend suitable exercises, while also considering adjunct therapies for additional support.

Article 4: Zentner addresses the challenges of assessing surgical risk in orthopaedic patients with obesity and emphasizes the need to consider factors such as gender and weight that can have medical and surgical implications for complications in different types of surgery. Alternative approaches to risk assessment are discussed, highlighting the importance of addressing malnutrition, reducing comorbidities, and focusing on weight loss as a percentage of body weight. Physiological factors in weight regulation and the potential benefits of evidence-based treatments, including pharmacotherapy, for achieving weight loss are also discussed.

As the success of knee replacement procedures continues to grow, so does the demand, but without an increasing supply, patients are left waiting and have to seek alternative care. We are optimistic that the articles presented in this two-part theme issue will provide valuable insights on knee osteoarthritis. As guest editors, we express deep gratitude for the contributions of the diverse authors who have adeptly summarized this extensive topic with clarity and conciseness. ■

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Osteoarthritis in Indigenous populations in rural British Columbia: Disparities in prevalence and access to care

By better characterizing patient-level barriers to health care in rural Indigenous populations, more effective, culturally appropriate, and accessible care can be provided.

ABSTRACT: Osteoarthritis, a chronic degenerative disease of the joints, is highly prevalent among Canadians. Both the direct and indirect costs of osteoarthritis continue to rise in North America, yet the pathophysiology has not been fully elucidated, nor have the differential treatment and diagnosis outcomes in underserved and remote communities. Indigenous and rural patients are among the most overlooked patient subpopulations. The prevalence of osteoarthritis is greater among Indigenous than non-Indigenous Canadians due to a wide range of structural and colonial barriers that limit access to quality care. These barriers are exacerbated for rural Indigenous patients. As a result, several initiatives have been developed to improve chronic disease diagnosis and management within their communities. For example, the First Nations Health Authority's Medical Transportation Benefit program

assists with travel to a medical facility outside the community. In addition, efforts are being made to address bias within the health care system, provide more supportive and culturally appropriate care, integrate traditional healing practices into health care, develop a better understanding of the social determinants of poor health outcomes, and use technological advancements to improve access to health care in remote communities.

Osteoarthritis is characterized by the chronic degeneration of articular cartilage, combined with periarticular bone remodeling, and is the greatest contributor to disability in older adults.¹⁻⁴ There is no known cure for osteoarthritis; thus, treatment strategies focus on managing the disease and reducing symptoms.^{5,6} However, high clinical variability renders some patients asymptomatic during onset only to present a permanently disabling disorder months later.^{7,8} Osteoarthritis is similar to other chronic conditions in that several risk factors comprise its etiology, including joint injury, age, gender, and ethnicity.^{9,10} Additionally, increases in sedentary lifestyles, rising rates of obesity, and aging populations accelerate the global burden of osteoarthritis.^{4,11,12} Thus, early identification and diagnosis of osteoarthritis is paramount.¹³

A common factor overlooked in the prevalence of osteoarthritis in Canadian populations is the differential treatment and diagnosis outcomes in underserved and remote communities. Literature on these disparities is sparse, and only recently has there been any focus on Indigenous and rural experience regarding osteoarthritis onset and treatment. It is estimated that 18.4% of adults in BC suffer from joint-specific osteoarthritis.¹⁴ Although no research has been conducted on Indigenous morbidity rates in BC, the prevalence of osteoarthritis in the First Nations population in Alberta was reported to be twice that of the non-First Nations population.¹⁵ Historical discrimination, poor social determinants, and resulting poor overall health outcomes in Indigenous populations lead to increased risk of osteoarthritis development and reduced quality of accessible treatment.⁴ The effect of race and geographical remoteness of rural Indigenous patients on the treatment of osteoarthritis has yet to be explored in depth.

Risk factors and treatment barriers

Evaluating socioeconomic status is important in assessing the disparity in osteoarthritis prevalence, diagnosis, and treatment between Indigenous and non-Indigenous communities. Few data about

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BC's Indigenous communities have been collected; however, general trends can be identified in Indigenous populations across Canada. There is a high prevalence of poverty among non-reserve Indigenous Canadians: 11.8% as of 2020.¹⁶ Indigenous Canadians also have significantly higher chronic disease rates and lower self-reported health conditions compared with non-Indigenous Canadians.^{17,18} These disparities can be attributed to several historical factors, including the devastating impacts of the Indian Act, institutionalized marginalization, and systemic barriers to accessing educational and economic opportunities.¹⁹ These are direct results of historical oppression of Indigenous Peoples, which in turn contributes to poor socioeconomic status and poor health outcomes in their communities.

The collective trauma experienced by Indigenous Peoples has also impacted their socioeconomic and health status.²⁰ The destruction of Indigenous culture through system-level discrimination, residential schools, and the child welfare system has resulted in lasting damage to Indigenous identity and heritage.²¹ Emotional, physical, and sexual abuse caused by these institutions adds to the intergenerational trauma experienced by Indigenous communities, which has resulted in higher rates of substance use, depression, and suicide compared with non-Indigenous communities.^{22,23} These mechanisms perpetuate health care disparities and are amplified by present-day racism and marginalization of Indigenous Peoples.²⁰

Historical systemic discrimination of Indigenous Peoples has had numerous negative and lasting consequences, including a greater incidence of food insecurity than for non-Indigenous populations, loss of support systems, loss of traditional land, and poorer health outcomes than in non-Indigenous populations.²⁴ The combination of these outcomes has resulted in lower educational attainment, lower annual income, and greater distrust in institutions such as health care.²⁵ All these factors contribute to individual health, both directly and indirectly,

and to the development of chronic conditions such as osteoarthritis. For example, Indigenous and rural communities have disproportionate incidences of obesity due to a combination of food insecurity, limited physical activity, and social factors.^{5,26,27} Obesity and diabetes have been linked to osteoarthritis development, which may contribute to the disparities in occurrence between Indigenous and non-Indigenous communities.²⁶

Barriers to accessing health care services pose a serious challenge for Indigenous people who reside in remote and rural areas. In some cases, hours or days of travel are required to visit a physician, which greatly impedes an individual's ability to access timely health care. As a result, rural residents have less contact with physicians and specialists and are less likely to report their health needs than are urban residents.⁵ This type of delay, and in some cases complete inability to access diagnosis and treatment, may exacerbate the progression of diseases such as osteoarthritis. Furthermore, fears of judgment, government intervention, racism, and disrespect are significant barriers for Indigenous patients in accessing quality health care services.²⁸ Not surprisingly, then, Indigenous Canadians have been reported to access orthopaedic consults, specialists, and joint replacements at significantly lower rates than non-Indigenous Canadians.¹⁵ Indigenous patients who receive osteoarthritis treatment may experience a series of challenges related to lack of culturally sensitive care and unbiased medical treatment in health care settings. Lack of cultural safety may also worsen health disparities between Indigenous and non-Indigenous populations.²⁹

A patient's journey from Takla Nation

For members of Takla Nation, situated 5 hours from Prince George, the nearest city with orthopaedic care, accessing the health care pathway is complex and multifaceted. The process begins with a doctor's notification and necessitates arranging travel support via Carrier Sekani Family

Services and the First Nations Health Authority and adhering to specific criteria for transportation approval. The long drive to Prince George, on bumpy gravel roads, can be difficult at the best of times, even for experienced travelers. The weather can be bad, and the drive uncomfortable. For those with health conditions, the journey can be anything but easy.

Then there is the flight to an urban centre—a new experience for many residents. This can be particularly intimidating and overwhelming, especially for those such as Elders who have never ventured far beyond Takla or Fort St. James.

Upon arrival at urban centres such as Surrey, Langley, or Vancouver, patients often find themselves with minimal or no social support, which adds to the stress of navigating an unfamiliar environment. The challenges are compounded by the anxiety of reaching medical appointments on time and coping with the underlying health concerns that necessitated the travel. This anxiety may be worsened by past trauma or distrust of the medical system. An additional concern arises for long-term patients or those requiring follow-up, who may need to stay in hotel rooms without kitchen facilities. This forces them to rely on takeout food, which deprives them of home-cooked meals and traditional foods. In some instances, traditional foods have been confiscated at the airport, which further disconnects patients from their cultural dietary practices. Overall, the journey for Takla Nation members to obtain medical support is fraught with logistical, emotional, and cultural challenges, which highlights the need for more tailored and sensitive health care support systems for Indigenous communities. Having to travel challenging roads and navigate flights, new places, and large, unfamiliar hospitals would be difficult for all people, not just those from Takla.

Current policies and solutions

Despite the challenges faced by rural Indigenous patients in accessing health care services, several initiatives have been developed to improve chronic disease

diagnosis and management within their communities.

First Nations Health Authority

The First Nations Health Authority was created to serve the diverse health needs of BC's Indigenous populations. Its most noteworthy program for rural residents is the Medical Transportation Benefit program, which provides Indigenous patients with meals, accommodation, and transportation to assist with travel to a medical facility outside the community.³⁰ The program also provides access to traditional healers.³⁰ However, treatment facility proximity is paramount in the approval process for the program. Based on our clinical experience, the Medical Transportation Benefit accounts minimally for the quality of care and timeliness with which it is received. A closer facility with a longer wait time and less specialized medical team may take precedence in approval, thereby reducing the quality of specialized care that remote Indigenous patients may be able to access.

Additionally, the loss of autonomy to choose a provider is especially concerning given the history Indigenous Peoples have had with Canadian health care. The inability to select a provider who understands and respects Indigenous cultures perpetuates the cycle of mistrust and dissatisfaction. Furthermore, funding is unlikely to be allocated for visits if an Indigenous patient prefers to see a doctor they have an established relationship with, if that doctor is not the nearest option available. An approval process that gives greater consideration to these variables would improve the quality of health care available to remote Indigenous communities.

Culturally sensitive care framework

The culturally sensitive care framework in Canada was proposed more than 15 years ago to draw attention to social, political, and historical factors that underlie the health care of Indigenous patients. The framework seeks to shift the attitude of practitioners from the status quo to a more

supportive and culturally appropriate form for minority populations.²⁹ However, much of the research on culturally sensitive care has been theoretical, and we have yet to see pragmatic applications of the system in BC.²⁹ The Declaration on the Rights of Indigenous Peoples Act and the BC Cultural Safety and Humility Standard outline additional cultural awareness principles and insight on how to implement best practices in provincial institutions.³¹ Further investigation into the implementation of culturally sensitive care frameworks will better establish their effectiveness and methods to maximize patient comfort.

Addressing bias

Addressing bias and practices that perpetuate negative perceptions of Indigenous Peoples is imperative to improving the quality of care provided to remote Indigenous communities. Emphasis is placed on fostering self-awareness, empathy, and respect from health care providers who interact with Indigenous patients. The *In Plain Sight* report highlights the need for systemic change in health care and advocates for training in cultural safety and humility.³² The report emphasizes the importance of health care providers being culturally competent and respecting Indigenous patients' unique needs, which is crucial for dismantling systemic racism and improving health outcomes.³² Thus, addressing bias deserves recognition as a pillar to equitable care.

Traditional healing

The integration of traditional healing into the treatment of osteoarthritis may improve long-term care outcomes and patient comfort. In the Prince George area, the Takla Nation Health Clinic has integrated land-based healing into the treatment of chronic conditions such as addiction and osteoarthritis. This method involves reconnecting Indigenous patients with their heritage rather than employing a narrow focus on pharmacological and Western medicines.³³ This holistic approach increases patient engagement and links physical,

emotional, and spiritual access to health care. More research is needed on these integrative approaches.

Social determinants

The social determinants of health approach and awareness of this approach are fundamental to understanding how poor health outcomes in remote Indigenous populations arise from poor social determinants. Recognizing that Indigenous community health reflects the impact of larger social, economic, and colonial structures allows for more robust interventions that address the intersecting factors that influence one another and produce vast health inequities in osteoarthritis diagnosis and treatment. Adequately addressing these social determinants requires fundamental changes in the policies, funding, jurisdiction, education, service delivery, and infrastructure that are available to and impact Indigenous and rural communities.

Technological advancement

Attention to technological advancement in health care, such as the integration of telehealth, may significantly improve osteoarthritis care for rural Indigenous patients. Telehealth can connect health care providers across the province. However, challenges involving limited Internet connectivity in remote areas and loss of the physician-patient relationship should be kept in mind. A reasonable balance may be to monitor osteoarthritis symptoms via telehealth during provider shortages but opt for regular in-person consultations otherwise. Depending on the visit, having a nurse physically present to assist and evaluate the patient during a telehealth visit with the physician may be beneficial. Additionally, the role of electronic medical records should be evaluated. Given that remote patients are more likely to travel to disparate sites to receive care, there is an increased likelihood of fragmentation of patient data across different sites. Without having the full context of a patient's health history, providers may be unable to optimize treatment to the fullest extent. Therefore, electronic medical records

with interoperability infrastructure may be beneficial for these patients. More research is required to investigate the role of electronic medical records in remote patient care.

Summary

Osteoarthritis is a complex and debilitating condition that remains poorly characterized. The understanding of its presentation and treatment is limited, particularly in Indigenous and rural populations. We have highlighted the epidemiology and risk factors of osteoarthritis and the unique challenges faced by remote Indigenous populations in BC. The multifactorial etiology of osteoarthritis extends into social and historical domains that must also be addressed. The scarcity of osteoarthritis research for these populations makes it difficult to build effective and holistic solutions to their care. We recommend that future research focus on better characterizing the patient-level barriers that rural Indigenous populations face. By increasing our knowledge and awareness of osteoarthritis in these communities, we can work toward more effective, culturally appropriate, and accessible care for all British Columbians. ■

Competing interests

None declared.

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Radiologists as clinicians: Radiological interventions for knee osteoarthritis

Radiologists can offer a number of image-guided percutaneous therapies in the treatment of knee osteoarthritis, including newer nonpharmacological options such as neuroablation, neuromodulation, and genicular artery embolization.

ABSTRACT: Knee osteoarthritis is often treated surgically (knee joint replacement) or non-surgically (physiotherapy, pharmacological treatment). However, interventional radiologists can also offer a number of image-guided percutaneous therapies, including pharmacological treatments (intra-articular steroid, local anesthetic, and hyaluronic acid injections), biological options (platelet-rich plasma or mesenchymal stem cell injections), and newer nonpharmacological therapies (neuroablation, neuromodulation, and genicular artery embolization). Intra-articular steroid injection is the most widely used radiologically guided therapy; it provides pain relief and can help confirm the joint as the source of pain. However, platelet-rich plasma injection may provide greater pain relief and functional improvement compared with other intra-articular injections.

Mesenchymal stem cell injections may improve pain, function, and cartilage volume, but the therapy is still under clinical investigation. Neuroablation and neuromodulation achieve pain reduction by targeting the sensory nerves of the knee joint. Radiofrequency ablation has been shown to be more effective than intra-articular steroid injections at treating knee osteoarthritis pain and function. Potential advantages of neuromodulation over conventional radiofrequency ablation include less intraprocedural pain and lower risk of thermal damage to adjacent structures. Genicular artery embolization aims to downregulate inflammation and its downstream effects by altering synovial blood flow; it is considered a promising therapy for osteoarthritis-associated knee pain.

Knee osteoarthritis is a common disorder with increasing prevalence due to the aging population. Osteoarthritis has a complex pathophysiology with resultant disability and places a significant burden on the health care system and economy. Osteoarthritis is a common problem managed by both orthopaedic surgeons and rheumatologists, as well as family physicians in the community.

Although knee joint replacement therapy is commonly performed in more advanced cases and where conservative

measures have failed, nonsurgical options are desirable for many patients, such as those with milder disease, those on surgical wait lists, and those who are unsuitable for surgery or prefer to avoid it. Nonsurgical treatment includes physiotherapy to strengthen joint-stabilizing muscles and pharmacological treatment (including acetaminophen and NSAIDs). Additionally, an increasing number of image-guided percutaneous therapies can be offered by interventional radiologists.

We review the current therapies for knee osteoarthritis that can be offered by the radiologist, as well as newer and potential future treatments, beginning with a guide to imaging workup for osteoarthritis, followed by a brief description of current and emerging imaging-guided interventions.

Radiological diagnosis

Radiographs

When clinical history and examination findings are consistent with osteoarthritis, a radiograph of the knee joint is often sufficient to confirm the diagnosis. A weight-bearing radiograph is advantageous when assessing the degree of osteoarthritis because it allows for better assessment of joint space loss. Osteoarthritis severity on radiographs can be graded

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according to the Kellgren–Lawrence score, which assigns a grade to the degree of osteoarthritis-related change based on the presence of osteophytes, periarticular ossicles, joint space narrowing, subchondral sclerosis, pseudocystic areas (sometimes referred to as geodes), and altered shape of the bone ends.

MRI

For patients with appropriate demographics, typical symptoms, and radiographic findings of osteoarthritis, MRI is rarely useful and rarely adds further information compared with radiographs. Meniscus tears commonly coexist with knee osteoarthritis and do not appear to correlate with pain and function, which limits the value of using MRI to assess for meniscus tears in knee osteoarthritis. In instances where patients have atypical symptoms, normal radiographs, or locking of the knee, MRI may be beneficial to assess for internal derangement, flipped meniscal fragments, intra-articular osteochondral fragments, subchondral fracture, inflammatory arthritis, or earlier signs of degeneration. The assessment for inflammatory arthritis and synovitis is best achieved with administration of gadolinium to determine the degree of synovial thickening in the joint. There may also be a role for contrast MRI when assessing the degree of synovitis associated with osteoarthritis, as discussed in the section on geniculate artery embolization, since synovial inflammation can be a target for embolization.

CT scan

CT scan may be beneficial in cases of trauma and osteoarthritis to exclude fractures; to further assess abnormalities, such as bone lesions, seen on radiograph; or for preoperative planning when requested by the surgical team. Dual-energy CT is of value in the assessment of suspected gouty arthropathy because it can detect monosodium urate crystals in the knee joint or surrounding tendons and ligaments. Dual-energy CT can also aid radiologists in making more definitive diagnosis of equivocal

findings that are suspicious for fractures by detecting surrounding bone marrow edema.

Ultrasonography

Ultrasonography has a limited role in the assessment of internal derangement of the knee joint due to the blockade of the acoustic waves by the surrounding bone. However, it is sensitive enough to detect joint effusions and juxta-articular knee joint cysts (e.g., Baker cysts), although confirming these entities is of dubious clinical benefit. Ultrasonography also has a role in the detection of synovitis. This involves measurements and comparison of synovial thickness and vascularity, assessed with color Doppler. Associated erosions in cases of inflammatory arthropathy may also be visualized. Limited views of the menisci, including meniscal tears, can be obtained, as well as visualization of marginal osteophytes; however, other modalities described previously remain superior in the detection of these abnormalities. In general, ultrasonography is a valuable tool when looking for soft tissue pathology around, rather than within, the knee joint. As such, it is not a first-line modality for osteoarthritis assessment. It remains an excellent modality for guiding aspiration of the knee joint in cases where infection or crystal arthropathy is suspected. Some centres use contrast-enhanced ultrasonography to assess for synovitis. Recent advances such as superb microvascular imaging (Canon Medical Systems) have allowed for detection rates of synovial vascularity in rheumatoid arthritis comparable to contrast-enhanced ultrasonography.

Image-guided percutaneous treatments

Radiologically guided therapy for knee osteoarthritis encompasses a variety of treatments, including drug delivery through image-guided joint injection, energy-based neuromodulation, and embolotherapy. The oldest and most widely performed is intra-articular steroid injection. Other options include hyaluronic acid and biological injections, radiofrequency nerve therapy, and genicular artery embolization. In

general, these pain management therapies work best for mild to moderate knee osteoarthritis and are less effective for severe osteoarthritis.

Pre- and post-procedure pain scoring is key, both when using interventions to confirm the joint as the pain source and as a longer-term therapeutic option for the patient, because it establishes the potential value of repeat treatment in the future. Assessment of pain by the patient can be recorded according to a visual analog scale or graded from 0 to 10, both prior to and immediately after the procedure. Patients are also advised to score their pain daily following the procedure and record it in a pain diary so they can review it with their referring physician to assess the degree and duration of pain relief in the longer term.

For all image-guided procedures, the radiologist provides the patient with a basic description of the procedure and discusses expected outcomes and possible complications. For most procedures performed on the knee, it is preferred to have the patient lie supine. Local anesthetic is sufficient for analgesia in most cases. The radiologist may use ultrasonography or fluoroscopy guidance to ensure proper placement of the needle. Following the procedure, a simple dressing, such as a Band-Aid, is placed over the injection site.

Treatments can be divided into pharmacological, biological, and nonpharmacological.

Pharmacological treatments

Intra-articular steroid therapy: Intra-articular steroid injection for knee osteoarthritis is widely used for pain relief and can help confirm the joint as the source of pain. The mechanism of action is not fully understood but is believed to be due primarily to the anti-inflammatory role of steroids. Multiple steroid formulations for intra-articular joint injection are available, including triamcinolone, methylprednisolone, betamethasone, and dexamethasone.

Local anesthetic is usually injected alongside intra-articular steroids and is

responsible for immediate analgesic effects and short-term relief of pain. Depending on the local anesthetic that is used, the analgesic effect wanes within a few hours, while the steroid may take a few days to take effect. Therefore, patients may experience a transient discomfort in the interval between local anesthetic cessation and steroid activation. Increased activity during the analgesic period immediately following injection should therefore be discouraged to avoid a pain flare later. A single intra-articular steroid injection may last from 2 weeks to beyond 6 months and is variable among different patients.

Local complications related to the use of intra-articular steroids include transient pain flare, rash, and local skin changes (atrophy or pigmentation). Steroid-related pain flare affects up to 10% of patients and usually resolves within 5 days. More severe adverse effects are rarer but include rapidly progressive osteoarthritis, subchondral insufficiency fractures, and avascular necrosis.

Although intra-articular steroid injections are considered local therapy, systemic effects may occasionally be seen, such as hyperglycemia, Cushingoid symptoms, or osteoporosis; therefore, physicians need to advise diabetic patients to closely monitor glucose levels after injections. Generally, injection frequency should be limited to four treatments per year.

Local anesthetic as a single agent: Intra-articular local anesthetic injection alone is occasionally performed in patients for diagnostic rather than therapeutic purposes—for example, in cases of atypical pain or suspected referred pain from the hip joint to the knee. In these instances, the patient receives intra-articular local anesthetic and is instructed to perform the activities that would usually trigger their pain. Resolution of the pain after the injection confirms the knee as the source of the pain. A few local anesthetics, which have different half-lives and potentially chondrotoxic effects, can be used. The most commonly used short-acting local anesthetic is lidocaine; common long-acting local anesthetics are

bupivacaine and ropivacaine. In our centre, we use ropivacaine 0.5% because it is a long-acting local anesthetic with the least chondrotoxic effect.

Hyaluronic acid: Hyaluronic acid is an important component of synovial fluid, secreted by the joint capsule, which lubricates the articular surfaces and acts as a shock absorber. Hyaluronic acid may also play a role in inflammatory cascade regulation, reduction of pain and cartilage degeneration,

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and cartilage regeneration.¹ In the synovial fluid of patients with knee osteoarthritis, hyaluronic acid levels are low.²

Multiple hyaluronic acid preparations are available for intra-articular injection. Hyaluronic acid injections are typically performed as one injection or two to four spaced injections. Compared with intra-articular steroids, hyaluronic acid onset of action is typically delayed, with noticeable pain improvement starting after 3 to 4 weeks and lasting longer, for up to 6 months.³⁻⁵

Other clinical parameters, such as physical function, improve with hyaluronic acid injections compared with intra-articular steroids or placebo.^{3,6} Some studies suggest there is a potential synergistic effect when steroids are combined with hyaluronic acid steroids, which results in greater and longer-lasting pain relief.⁷ Obesity, the presence of large joint effusions, severe degenerative changes, and isolated severe

patellofemoral degenerative changes may reduce the benefits associated with hyaluronic acid injections.⁸ Complications associated with hyaluronic acid injections are usually self-limited and include injection site pain, swelling, and arthralgia, which usually subside within a few days of the procedure.^{2,9}

Biological treatments

Platelet-rich plasma: Platelet-rich plasma is produced by withdrawing a blood sample from the patient on the day of the procedure. An anticoagulant is typically used. The blood then undergoes centrifugation to achieve a high platelet concentration. Concentrations used vary significantly: reports include 1.6 to 18 times that of whole blood in commercially available kits, although some practices achieve 45 times baseline with manual protocols. Several other parameters are also variable, including recovery rate, viability rate, WBC levels, RBC levels, and pH. At the time of injection, the platelets may be activated with exogenous or autologous thrombin. Injections can be performed as a single injection or a series of injections. Antiplatelet agents and NSAIDs are usually withheld prior to blood sampling. The platelet-rich plasma mechanism of action is complex and poorly understood, but it is likely related to growth factors and cytokine regulation of the inflammatory process, with possible cartilage production and preservation, as well as promotion of hyaluronic acid production.¹⁰

Platelet-rich plasma injection may provide greater pain relief and functional improvement in 12 months compared with other intra-articular injections such as hyaluronic acid or steroids.^{9,11} A meta-analysis of 20 randomized controlled trials showed that platelet-rich plasma was superior to hyaluronic acid in terms of short-term functional recovery, long-term pain relief, and physical function improvement.¹¹

A larger meta-analysis of 30 randomized controlled trials that compared platelet-rich plasma to hyaluronic acid, steroid therapy, and placebo indicated that platelet-rich plasma had the best visual analog scale and

Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scores up to 12 months posttreatment.⁹ Complications related to platelet-rich plasma injections are usually self-limited and similar to those of other injections, such as injection site pain, joint stiffness, and localized swelling/bruising. Platelet-rich plasma is contraindicated in patients with septicemia, anemia, thrombocytopenia, and hematological or skeletal malignancy.

Currently, platelet-rich plasma therapy for knee osteoarthritis is considered an off-label use and is not available in the public health care system in BC, though it is offered in some private facilities.

Mesenchymal stem cell therapy: Mesenchymal stem cell therapy has received much interest in recent years. Research has been conducted on applications for a wide variety of anatomical locations and pathologies, with the goal of promoting regeneration and restoration of function. Similarly, the intention of intra-articular injections of mesenchymal stem cells is symptomatic improvement through cartilage repair/regeneration via differentiation of mesenchymal stem cells into chondroblasts. Mesenchymal stem cells can be obtained from bone marrow or subcutaneous fat from the patient's body (autologous) or from amniotic membrane or fluid (allogenic). Initial reports suggested improved pain, function, and cartilage volume posttreatment with mesenchymal stem cell injections.¹²⁻¹⁴ Adverse outcomes are usually minor, such as injection site pain and swelling, and tend to resolve within 1 week.¹⁵ While of great potential interest for the future, this therapy is not currently offered in the public health care system in BC and is actively under clinical investigation.¹⁶

Nonpharmacological treatments

Nonpharmacological procedures are usually conducted in the tertiary centre setting and are best planned in conjunction with joint specialists. Geniculate artery embolization is currently performed at the Vancouver General Hospital, and neuromodulation

is performed at the University of British Columbia Hospital.

Neuroablation and neuromodulation: These therapies aim to achieve pain reduction by targeting the sensory nerves of the knee joint. The most commonly used modality is radiofrequency ablation, although cryoablation and chemical ablation are also used. Prior to the day of the procedure, a preliminary diagnostic block of the genicular nerves with lidocaine may be performed to assess pain alteration as a prognostic indicator of the potential success of ablation.

A recent systematic review concluded that radiofrequency ablation is more effective at treating knee osteoarthritis pain and function compared with intra-articular steroid injections, with pain relief clinically notable up to 24 months.

Neuroablation: The usual targets of neuroablation are three of the geniculate nerves (superior lateral, superior medial, and inferomedial); the inferolateral nerve (a branch of the common peroneal nerve) is spared to avoid risk of foot drop.¹⁷ Nerve stimulation tests can also be performed to ensure no motor nerves are ablated.

In radiofrequency ablation, the target nerves are heated to 60 °C to 80 °C using continuous current to achieve tissue destruction and neurolysis and, therefore, pain relief through sensory neural destruction. There is potential for nerve regrowth and thus pain recurrence; however, the treatment can be repeated.

A recent systematic review concluded that radiofrequency ablation is more effective at treating knee osteoarthritis pain and function compared with intra-articular steroid injections, with pain relief clinically

notable up to 24 months.¹⁷ No serious adverse events were documented. Potential complications after radiofrequency ablation of genicular nerves are usually self-limited and include injection site pain, bruising, and temporary altered sensation (allodynia and hypoesthesia). Vascular complications such as genicular artery pseudoaneurysm or arteriovenous fistula are rare.

In contrast to radiofrequency ablation, cryoablation produces extremely low temperatures (as low as -40 °C) to achieve neurolysis with Wallerian degeneration of genicular nerves. The nerve sheath usually remains intact, so, as with radiofrequency ablation, there is the potential for pain recurrence though nerve regrowth, though the treatment can be repeated. Cryoablation has been less extensively studied in this setting than radiofrequency ablation; however, in a randomized, double-blind, sham-controlled trial of 180 patients, cryoablation reduced pain related to osteoarthritis for up to 150 days, with no serious adverse events related to the procedure.¹⁸

Neuromodulation: Neuromodulation, in contrast to neuroablation, involves little, if any, tissue damage. The principle is to use pulsed radiofrequency to improve pain through altered sensory nerve function rather than nerve destruction. Pulsed radiofrequency is used with short energy bursts, which keeps temperatures lower than conventional radiofrequency (under 42 °C) and below the threshold of permanent damage (45 °C to 50 °C).^{19,20} Potential advantages of neuromodulation over conventional radiofrequency ablation include less intraprocedural pain and lower risk of thermal damage to adjacent structures.

The mechanism of action in neuromodulation is thought to relate to electric fields that induce transmembrane potentials that may result in cellular deformation and ion channel dysfunction, with resultant disruption of nerve conduction but without prolonged high-heat tissue damage.^{19,21,22}

Neuromodulation can be performed using a three-needle genicular nerve technique, or by a single-probe intra-articular

technique to target intra-articular nerve endings. Intra-articular pulsed radiofrequency has shown clinically significant and reproducible pain relief in patients with knee osteoarthritis.^{23,24} Pain reduction up to 12 months has been reported.²³⁻²⁶ Studies that have targeted the three geniculate nerves have also reported pain reduction up to 12 months.²⁷⁻²⁹

Genicular artery embolization: Contrary to popular teaching, the presence of synovitis has been implicated in the pathogenesis and progression of osteoarthritis. Osteoarthritis has traditionally been considered a noninflammatory degenerative condition that arises from mechanical cartilaginous and osseous degeneration (“wear and tear”). More recent pathogenetic models of osteoarthritis focus on imbalances in cell signaling pathways within the joint favoring pro-inflammatory cytokines, which induce chronic synovitis, neovessel formation (angiogenesis), and alterations in chondrocyte function. By facilitating the distribution of pro-inflammatory cytokines within the local microenvironment, angiogenesis is believed to play a critical role in the maintenance and propagation of inflammation within the joint. Angiogenesis also induces the genesis of parallel sensory/pain fibres, which become sensitized in the local hypoxic, inflamed, and mechanically stressed environment. The milieu of structural and physiologic events leads to neovessels that may serve as a treatment target for osteoarthritis and osteoarthritis-related pain.³⁰

Originally described in 2015 by Okuno and colleagues, genicular artery embolization is a minimally invasive procedure that involves selective catheterization and embolization of the genicular arteries that perfuse the knee capsule, resulting in alterations to synovial blood flow that are thought to downregulate inflammation and its downstream effects.³¹ Phase I to IIB clinical trials have established genicular artery embolization as a promising therapy for osteoarthritis-associated knee pain.

In a recent meta-analysis of 11 publications that investigated the outcomes of

geniculate artery embolization in mild to moderate knee osteoarthritis (225 patients, 268 knees), the procedure was associated with rapid and sustained improvements in knee pain reported by visual analog scale (54% and 80% improvement within the first week and at 2-year follow-up, respectively).³² Genicular artery embolization also resulted in improvement in functional status (58% and 85% improvement in WOMAC scores within the first week and at 2-year follow-up, respectively) and in the number of patients who employed other analgesic strategies (27%, 65%, and 73% reduc-

As our understanding of the disease processes of osteoarthritis of the knee increases, so does the potential for exciting new diagnostic and therapeutic options.

tion in the use of opioids, NSAIDs, and intra-articular hyaluronic acid injections, respectively). Sustained pain reduction has not been achieved after genicular artery embolization in cases of severe osteoarthritis.³³

No severe or life-threatening adverse events have been reported for genicular artery embolization. Rates of minor adverse events may be as high as 25% and include transient, self-resolving complications such as local skin discoloration, puncture site hematoma, plantar paresthesia, and mild fever.³⁴ The most common minor adverse event, skin discoloration, is thought to reflect mild transient skin ischemia and has been successfully reduced by using ice packs applied intraprocedurally over the knee to temporarily constrict cutaneous vessels and divert blood flow.³⁴

Several major randomized controlled trials designed to further explore the efficacy, prognosticators, and long-term outcomes of genicular artery embolization are currently underway.

Referral procedures and pathways

For most of the percutaneous therapies we have described, referrals can be made directly to radiology by any physician, including joint specialists and family practitioners, where these therapies are available in BC. Weight-bearing knee radiographs are very helpful for radiology triage, along with a brief description of symptoms, an indication of the working clinical diagnosis, and dates and types of previous treatments. This information is reviewed by the radiologist prior to injection.

For injections, the injectate (e.g., local anesthetic, steroid, hyaluronic acid) should be generally specified by the referring doctor. Doses are typically decided by the radiologist. These procedures are available in most hospital settings.

Neuromodulation referrals can be made to the radiology department at UBC Hospital. Inquiries can be made to other centres regarding the availability of this procedure.

Geniculate artery embolization is an area with ongoing clinical trials, which benefits from specialist clinical assessment. Referrals can be made to Dr Maziar Badii at the Artus Health Centre.

Conclusion

As our understanding of the disease processes of osteoarthritis of the knee increases, so does the potential for exciting new diagnostic and therapeutic options. A variety of image-guided percutaneous therapies are currently available, including pharmacological and nonpharmacological options. Corticosteroids and hyaluronate are currently the most widely used and are popular in BC. Biologics such as platelet-rich plasma and mesenchymal stem cells show promising results, with a growing evidence base, though they are not currently available in the public health care system in BC. Nonpharmacological options include geniculate artery embolization and neuromodulation, which have the potential to offer longer-term pain relief than traditional corticosteroid injection. ■

Competing interests

None declared.

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Physiotherapy and knee osteoarthritis

Physiotherapy is a safe and effective nonpharmacological intervention that can be used to manage knee osteoarthritis and improve patients' quality of life.

ABSTRACT: Knee osteoarthritis is a prevalent and debilitating condition affecting millions of people worldwide. Physiotherapy is a noninvasive intervention that is effective in managing knee osteoarthritis symptoms by aiming to reduce pain, improve function, and enhance quality of life. The main interventions are exercise therapy, including strength training, aerobic exercise, and neuromuscular training, and patient education about self-management strategies, such as weight loss, activity modification, and pain coping skills. Research on the benefits of biomechanical interventions is limited, but walking aids (e.g., canes, crutches, frames, wheeled walkers) are generally considered to be effective in reducing mechanical loading through the knee, relieving

pain, improving balance and function, and enhancing independence and safety; evidence of the benefit of shoe inserts is mixed. There is also a lack of high-quality research on the benefits of adjunct therapies such as heat or ice, low-level laser therapy, therapeutic ultrasound, manual therapy, and acupuncture, but they may be conditionally recommended based on patient preference if they are used in combination with exercise. Individualized and patient-centred care in physiotherapy for knee osteoarthritis is important, and tailored interventions that take into account patient preferences and goals are needed. A combination of several interventions, depending on patient preference, is recommended for optimal outcomes in managing knee osteoarthritis.

for younger people who may need to manage their osteoarthritis alongside family and work commitments. Current evidence shows that education, physical exercise, and weight management constitute the first-line approach for managing knee osteoarthritis in all age groups.^{4,5}

Physiotherapy plays an integral role in managing and caring for patients with osteoarthritis.⁶ Patients may be referred to physiotherapy by a physician or may be self-referred. The primary goals of physiotherapy for knee osteoarthritis are to manage pain, educate the patient about the nature of osteoarthritis and how it affects their knee, and provide tools to help them enhance their quality of life living with osteoarthritis.

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Osteoarthritis is often diagnosed clinically; its management is guided by symptoms and physical function.¹ The knee is the most common site of self-reported, physician-diagnosed osteoarthritis in BC.² Arthritis of the knee not only affects the specific joint, but can also impact overall health. It limits daily activity, particularly walking; participation in sports; and quality of life.

Although osteoarthritis is traditionally associated with older age, it is increasingly recognized as also impacting younger people. International data from the Global Burden of Disease study show that the prevalence of knee osteoarthritis peaks around 50 years of age.³ The pain and physical impairments associated with knee osteoarthritis can be particularly problematic

Assessment

In the initial visit to the physiotherapist, a clinical history of the patient's medical condition is taken, including the onset and duration of their knee pain and any aggravating and alleviating factors. Asking about the patient's general health is crucial for identifying any comorbidities and helping them manage their knee symptoms appropriately. The patient should also be asked if there are any specific challenges or limitations that affect their quality of life at home or at work, and if there are any activities they have had to stop and would like to return to.

The physical assessment consists of evaluating the range of motion and strength of the patient's whole lower limb, including the

knee; observing their gait for any obvious antalgic patterns or compensatory movements; and testing their ability to perform activities of daily living and functional tasks such as getting on and off a chair and negotiating stairs. In addition, any imaging reports should be reviewed.

Treatment

Core treatments for knee osteoarthritis focus on providing relevant education and support, discussing therapeutic exercise and how weight can affect knee osteoarthritis, and making recommendations, if needed, on where to find appropriate weight management information. In a few cases, adjunct therapies may be beneficial, given patient preference, but only if they are used in combination with education and exercise.¹

Education and support

Physiotherapists can support family physicians in treating knee osteoarthritis by reinforcing patient education about the disease, which includes explaining what it is and, as important, what it is not. This can help patients better understand the disease process, progression, and risk factors, and it counters misconceptions, especially about radiological findings and activity levels.

Education can include information on disease-modifying factors such as exercise (balanced with appropriate rest); the management of activities of daily living; and the benefits and limitations of non-pharmaceutical pain management options, such as braces, shoe inserts, and manual therapies. Educating patients and teaching them self-management techniques enables them to actively participate in their own care, which can be crucial to ensuring their long-term adherence to treatment programs and sustained positive effects on symptoms, impairments, physical activity levels, and comorbidities.⁷ Education interventions can be 20% to 30% more effective than using NSAIDs to treat pain in osteoarthritis.⁸

Physiotherapists can also provide ongoing support with managing flare-ups and disease progression over time, including where to find additional information if

needed. How people receive this information may also be important, depending on their age. People aged 20 to 55 years prefer emailed and online information about their knee osteoarthritis.⁹ Providing written information sheets and referrals to trustworthy websites (e.g., Arthritis Society Canada, Mary Pack Arthritis Program, Canadian Arthritis Patient Alliance, Arthritis Research Canada) is paramount for this age group.⁹ In our experience, older patients prefer in-person discussion and typed booklets.

Exercise therapy

The primary goal of exercise therapy is to provide a tailored program that is focused on strengthening the muscles of the legs and improving joint mobility. In collaboration with the patient, physiotherapists can

also explore options for aerobic exercise to help improve overall fitness while protecting the knee joint.

Osteoarthritic knees show evidence of increased pro-inflammatory markers and degradative enzymes, which impair the cartilage matrix. In addition to helping maintain bone density and muscle strength, exercise can combat articular cartilage degradation by reducing the concentration of proteins that are hostile to articular health and can result in increases in anti-inflammatory markers;¹⁰ therefore, it is favored in treating osteoarthritis. A meta-analysis of 60 randomized controlled trials that compared 12 types of exercise interventions with no exercise in adults with knee or hip osteoarthritis showed that exercise provided significant benefits over no exercise.¹¹

Physiotherapists prescribe certain types of exercise therapy to achieve specific therapeutic goals. For example, muscle weakness may be an important risk factor for knee

osteoarthritis and may impair function and increase disease progression.¹² Therefore, the physiotherapist will prescribe appropriate strengthening exercises as part of the primary treatment approach.

Traditional exercise interventions such as strength, aerobic, and mobility training, and some nontraditional forms such as yoga, tai chi, and aquatic training, have all been shown to improve joint symptoms and mobility.^{6,7} This in turn can lead to increased quality of life, psychological health, musculoskeletal strength, and body composition, and improved sleep and reduced fatigue. The benefits of therapeutic exercise appear to be greater when general exercise guidelines for healthy adults are met. For example, the Canadian Society for Exercise Physiology's 24-hour movement guidelines for adults aged 18–64 recommend 150 minutes per week of moderate to vigorous aerobic physical activity, muscle strengthening activities using major muscle groups at least twice per week, and several hours of light activities, including standing.¹³ Using a combination of exercises that increase muscle strength, aerobic capacity, and flexibility may be the most effective approach to managing lower limb osteoarthritis.¹¹ Numerous international organizations, including the Osteoarthritis Research Society International,⁴ Ottawa Panel, American College of Rheumatology,¹⁴ and European Alliance of Associations for Rheumatology,⁵ recommend using a combination of strengthening and aerobic exercises and some form of mind-body exercise, such as yoga or tai chi.

Therapeutic exercise is safe for patients with knee osteoarthritis and has shown minimal risk of negative consequences.⁹ However, since it is common to initially have an increase in joint pain, physiotherapists educate patients about this possibility and explain that despite any initial discomfort, exercise is beneficial for the long-term management of their osteoarthritis.^{4,5,13,14} Regular monitoring, reassurance, and exercise modifications to reflect any changes that arise are essential to helping the patient maintain their exercise regimes and activities.

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Physiotherapists play an important role in assessing joint function and level of activity in order to prescribe appropriate exercises following FITT (frequency, intensity, type, and time) principles while considering patient preferences.¹⁵ Patient preference regarding level of supervision and mode of exercise may be key predictors in exercise adherence and degree of outcome improvement.¹⁶

Strength training: Muscle weakness, particularly of the quadriceps, may be an important risk factor for knee osteoarthritis, especially in women. In one study, the quadriceps muscle was on average 20% weaker (even after controlling for body mass and other covariates) in patients with radiographic signs of osteoarthritis and appeared to predate the onset of the disease in women.¹²

Strength training includes progressive force output of the muscles through various exercises to target specific muscle groups. These exercises may involve the use of weights, body weight, or machines, and the application should include appropriate resistance load, number of repetitions, velocity of movements, and frequency of sessions. The benefits of therapeutic exercise appear to be greater when exercise is adequately dosed.¹⁶

General exercise guidelines for healthy adults recommend a minimum of two and optimally three sets of 8 to 12 repetitions in three sessions per week.^{16,17} Strength gains occur from progressive training, and improvements in symptoms and function are directly related to exercise intensity.¹⁸ There is insufficient evidence that any one type of strength training is superior, so physiotherapists can tailor exercise options individually for patients who prefer to use different equipment and/or locations. Future research may add to the existing high-quality evidence of beneficial exercise by providing more detail on exercise treatment parameters, which will assist in prescribing individualized exercise protocols based on patient preference.¹⁶

Walking: For individuals who are 50 years of age or older, walking can be associated with less frequent development of knee pain.¹⁹ Therefore, physiotherapists often recommend walking as a simple, low-cost exercise option that can be helpful in managing osteoarthritis of the knee; however, it needs to be of sufficient intensity to produce beneficial change.²⁰ Aerobic walking significantly reduces disability and pain and is associated with a decreased risk of functional limitation.²⁰

Physiotherapists play an important role in assessing joint function and level of activity in order to prescribe appropriate exercises following FITT (frequency, intensity, type, and time) principles while considering patient preferences.

Running: Whether to continue running is a common question for some patients with knee osteoarthritis, and the myth that running is bad for osteoarthritic knees is still pervasive in the public forum. A 2022 systematic review concluded that “middle-aged runners did not present greater imaging or clinical signs of osteoarthritis compared with non-runner controls.”²¹ While some knee osteoarthritis patients stop running due to pain in their knee(s), not all experience the same amount of discomfort. An eight-year study that followed runners over the age of 50 indicated that for some individuals with knee osteoarthritis, running at a self-selected pace was not associated with any increase in pain, and some runners reported some improvement in their pain; there also was no worsening of “radiographically defined structural progression.”²² These results suggest that self-selected running

is probably influenced by knee symptoms; therefore, running at a lower intensity and for shorter durations does not necessarily need to be discouraged among keen runners.²² Physiotherapists will discuss the risks versus benefits with patients who wish to continue running and will recommend that they run at their preferred speed and at an intensity and distance that are manageable for their symptoms.

To be clear, this section is not intended to advocate for running as a therapeutic modality. It is simply intended to provide information and reassurance for dedicated runners who wish to continue participating in their preferred sport.

Aquatic exercise: Given patient preference, physiotherapists may also suggest water-based training (including swimming, aquafit classes, and pool running). These activities are recommended by the Osteoarthritis Research Society International, American College of Rheumatology, and European Alliance of Associations for Rheumatology to assist in controlling osteoarthritis symptoms.^{4,5,14} A meta-analysis of 20 studies showed that aquatic exercise was beneficial for reducing pain and improving physical function, knee extension muscle strength, and walking ability.²³

Mind-body exercise: Yoga is very popular, and many options are available in most communities. Although there is less high-quality evidence of the benefits of using tai chi and yoga in treating knee osteoarthritis compared with other exercise modalities, research indicates that these forms of exercise may enhance flexibility, balance, self-efficacy, and muscle strength, thereby leading to improved physical function and reduced pain, depression, and anxiety in patients with chronic osteoarthritis.^{4,24} Therefore, they are good options for patient exercise programs.

Supervised exercise programs: For some patients, supervised exercise programs may be preferred. One option is Good Life with osteoArthritis in Denmark (GLA:D), an

internationally known physiotherapist-led program that originated in Denmark. Following the original protocol from the Danish studies, GLA:D Canada offers programs that include two or three detailed education and self-management sessions delivered by physiotherapists and other health care professionals. Osteoarthritis patients, who can speak as peers, also provide presentations about their personal experience with the program. The program offers twice-weekly supervised exercise sessions (focusing on strengthening and neuromuscular exercises) over a 6-week period.

A 2019 report from GLA:D Canada suggested that, overall, improvements in pain, quality of life, and physical function for patients in Canada who had knee arthritis reflected the type and magnitude of the findings reported by GLA:D in Denmark. “Based on program implementation by clinical sites and participant outcomes to date, the GLA:D program is successfully supporting people with knee osteoarthritis to manage their symptoms, improve their function and enhance their quality of life.”²⁵ Participants reported a decrease in pain, use of pain medications, use of intra-articular injections, and fear of damaging their knee, and an increase in function and self-efficacy scores.²⁵

While these programs can be extremely beneficial for the participants, not everyone will have access to or prefer a supervised exercise program. The Better Management of Patients with Osteoarthritis register shows that home exercise and supervised exercise lead to similar reductions in pain intensity and are more effective than education alone.²⁶

Barriers to exercising are common due to patient beliefs, fear of movement, affordability, time commitment, and equality of access. Therefore, physiotherapists should discuss the various options with their patients, taking into account their preferences and tolerance, as well as access to equipment or exercise venues, in order to promote exercise as a primary treatment approach.²⁷ Strategies for improving adherence to therapeutic exercise, such as education, goal

setting, monitoring, and feedback, may help maintain participation and optimize clinical benefits over the longer term.⁶

Although there is good evidence that patients with osteoarthritis benefit by staying active, there is little research on whether they should continue to participate in popular sports such as tennis, pickleball, downhill skiing, and cross-country skiing. Therefore, general advice on exercising within pain tolerance and monitoring pain levels/response over 24 hours can help determine whether a patient’s preferred activity is appropriate, given their symptomatology. Physiotherapists often use visual guides; a common one is the pain and activity traffic light [Figure]. This can help patients decide what is safe and acceptable for them when exercising and can reassure them that some discomfort with activity is normal and not damaging to the knee joint.

Biomechanical interventions

Biomechanical interventions include a broad range of apparatuses and appliances that are intended to improve patients’ function, relieve pain, and potentially reduce disease progression. The main mechanisms underlying these approaches are to reduce stress on the knee by redistributing load and to enhance joint stability by increasing proprioceptive input. For knee osteoarthritis, shoe inserts, walking aids, footwear, and braces (addressed by Sidhu and colleagues in Part 1 of this two-part theme issue) are of the most interest in the physiotherapy clinical practice.

Physiotherapists may recommend a trial of using shoe inserts and may assess for any symptomatic change at follow-up appointments. Evidence of the benefit of using shoe inserts, such as lateral wedged insoles, is mixed. For some patients, they can be a safe and low-cost orthosis option that may help symptoms, but they do not appear to improve the biomechanics of the knee.²⁸

Compared with other biomechanical interventions, there is a dearth of research on using walking aids to manage knee osteoarthritis. However, the Arthritis Foundation website, National Institute for Health and



FIGURE. Traffic light analogy explaining that pain with activity can be safe and acceptable as long as it is within the patient’s tolerance and resolves back to their baseline within approximately 24 hours.

Care Excellence guidelines, and Osteoarthritis Research Society International suggest that walking aids (e.g., canes, crutches, frames, wheeled walkers) are appropriate and effective and help increase independence and safety.^{1,4} They can reduce mechanical loading through the knee, relieve pain, and improve function.¹ Thus, most guidelines recommended them as an option for patients with knee osteoarthritis. Physiotherapists can educate patients about how to use any walking aid correctly to help improve balance, reduce the risk of falling by widening the base of support, and reduce weight on lower-body joints.²⁹

Adjunct therapies

Adjunct therapies have traditionally been a component of physiotherapeutic intervention for osteoarthritis. However, there is a lack of high-quality research on the additional benefits of using adjunct therapies such as heat or ice, low-level laser therapy, therapeutic ultrasonography, manual therapy, and acupuncture.^{4,5,14} It has yet to be determined if any adjuncts have complementary effects when combined with education and exercise.

Anecdotally, many patients report benefits from using either heat or ice, and many international guidelines suggest their use can be beneficial for short-term pain management. There is evidence that self-administered heat and/or ice provides a mild improvement in pain, functional status, and quality of life. The use of heat or ice for pain relief may depend on personal preference and/or gender.³⁰

The Osteoarthritis Research Society International guidelines recommend against using low-level laser therapy and ultrasonography, citing very low-quality evidence of their benefit in managing osteoarthritis.⁴ However, there may be some value for the patient depending on their personal beliefs and preferences. The American College of Rheumatology recommends taking into account patient preferences regarding the use of ultrasonography.¹⁴

According to the National Institute for Health and Care Excellence, Osteoarthritis Research Society International, European Alliance of Associations for Rheumatology, and American College of Rheumatology guidelines, there is low-quality evidence that manual therapies such as massage, mobilization or manipulation, and passive range of motion provide additional benefit in treating knee osteoarthritis; therefore, their use should be considered only alongside therapeutic exercise.^{1,4,5,14} The National Institute for Health and Care Excellence and the United States Bone and Joint Initiative both recognize the potential contributions that manual therapy can make to patient outcomes, given individual preferences, and they recommend considering using manual therapy, but only if it is combined with exercise.^{1,7}

Research shows low-quality evidence in favor of using acupuncture to treat knee osteoarthritis. The Osteoarthritis Research Society International states that acupuncture is “an implausible biological mechanism”⁴ and strongly recommends against its use. However, the American College of Rheumatology conditionally recommends its use when considering patient preferences.¹⁴

In summary, thermal modalities are recommended for knee osteoarthritis, therapeutic ultrasonography is not recommended for use, and there is insufficient evidence to provide a general recommendation for the use of acupuncture. According to the United States Bone and Joint Initiative,

Physiotherapy should be considered as a safe and effective nonpharmacological intervention to manage knee osteoarthritis and enhance patients’ quality of life.

multiple organizations agree on many of the recommendations made for managing knee osteoarthritis. There is not a lack of quality guidelines but rather a deficit in dissemination and implementation of the recommendations.³¹ Ideally, future efforts should focus on optimizing implementation in primary care settings, where most osteoarthritis care occurs.

Conclusion

Given the primary importance of education and exercise in managing osteoarthritis, physiotherapists are well suited to assisting general practitioners in managing all levels of arthritis through a continuum of care. The effects of these key management options compared with usual care or surgical procedures result in cost savings and improvement in quality of life. Physiotherapy should be considered as a safe and effective nonpharmacological intervention that can be used to manage knee osteoarthritis and enhance patients’ quality of life. ■

Competing interests

Ms Barber works in private practice at Envision Physiotherapy in Vancouver. Mr Jahanbani is a personal trainer at Elevate Training, Health, and Wellness in Vancouver.

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“Lose 70 pounds and you get a new knee”: The current approach to obesity in patients awaiting total joint arthroplasty

Significant advancements in obesity medicine have led to evidence-based treatments for patients who were once denied care and have provided them with legitimate clinical options for managing both obesity and arthritis.

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ABSTRACT: Obesity is a risk factor for osteoarthritis. Excess weight has been associated with increasing joint symptoms and the need for joint replacement surgery. Obesity is also a contributing risk factor for postoperative complications associated with total joint arthroplasty. Between 2020 and 2021, more than 100 000 total joint arthroplasties were performed in Canada. The demand for total joint arthroplasty among patients with obesity continues to increase. Despite higher complication rates, total joint arthroplasty is a cost-saving measure in patients with obesity. To mitigate the risk of complications, physicians encourage weight loss in patients with obesity before recommending total joint arthroplasty. This often involves just telling patients

to “lose weight,” which has marginalized and stigmatized a patient population and left them to manage their own health. Obesity medicine—pathophysiology and treatment—has expanded significantly over the last decade. This has led to evidence-based treatments and has allowed patients who were once denied care to be provided with legitimate clinical options for managing both obesity and arthritis. Our system is changing. Our bias is real. The science is undeniable, and the call to action has come to us all.

Beatrice is a 70-year-old woman with severe bilateral knee pain. She presented to her family doctor with a story of progressive immobility over the last 4 years. Although she was very active during much of her life, over the last decade, her knees began to hurt. She became less mobile. She has taken to swimming instead of walking, and she continues to swim 4 days per week. X-ray showed she has significant arthritis of both knees, and her right knee is worse than her left. She was referred to an orthopaedic surgeon for assessment for possible bilateral total knee replacement. Her X-rays confirmed that her left knee has end-stage osteoarthritis that can benefit from a knee replacement as soon as possible; the right knee is likely soon to follow.

Beatrice’s height is 170 cm (5 ft. 6 in.),

her weight is 133 kg (293 lb.), and her BMI is 46 kg/m². She carries her weight quite uniformly.

An orthopaedic surgeon has told Beatrice if she loses about 33 kg, her knees will be replaced. Her goal weight before surgery needs to be 100 kg.

“Just lose weight” has been the constant refrain we have told patients with obesity for decades. “Just lose weight, and they will replace your hip/knee.” “Just lose weight, and they will fix your abdominal hernia.” “Just lose weight, and your diabetes/hypertension/sleep apnea will get better.” “Just lose weight, and they will list you for a kidney transplant.”

When did this shift happen? When did medicine ask patients to bear the sole responsibility for access to life-changing, and in many cases lifesaving, care?

The weight of the matter

Worldwide, more than 240 million people have symptomatic and activity-limiting osteoarthritis of their hips or knees. More than half of patients with osteoarthritis of the knee will undergo a total knee arthroplasty during their lifetime.¹ In Canada, arthritis affects more than 6 million people. More than 23% of women and 17% of men in Canada live with arthritis.²

Between 2020 and 2021, 55 300 total hip arthroplasties and 55 285 total knee

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arthroplasties were performed in Canada; 8892 total hip arthroplasties and 9093 total knee arthroplasties were performed in BC. In the year prior to the onset of the COVID-19 pandemic (i.e., 2019–2020), 63 496 total hip arthroplasties and 75 073 total knee arthroplasties were performed in Canada; 9945 total hip arthroplasties and 11 469 total knee arthroplasties were performed in BC. Almost 70% of those surgeries were a result of osteoarthritis, and approximately 55% to 56% of patients were women.³

More than 650 million people worldwide have obesity,¹ currently defined as a BMI greater than 30 kg/m². Obesity is a risk factor associated with the development of osteoarthritis and is overrepresented in patients who present for total joint replacement surgery. Excess weight has been associated with increasing joint symptoms and the need for joint replacement surgery.^{4,5}

In Canada, 73% of men with arthritis have increased weight or obesity compared with 59% of men without arthritis. Likewise, 61% of women with arthritis have increased weight or obesity compared with 43% of women without arthritis.^{2,3}

Obesity is also a contributing risk factor for postoperative complications associated with total joint arthroplasty. Patients with a BMI greater than 40 kg/m² have increased risk for surgical site infection, dislocation, early loosening of prostheses, revision surgery, periprosthetic fracture, and thromboembolism after total joint arthroplasty compared with those patients who have a lower BMI.^{4,6–9}

The demand for total joint arthroplasty among patients with obesity continues to increase. Despite a higher risk of complications, patients with obesity experience similar improvements in function and quality of life after total joint arthroplasty as those without obesity.^{10,11} Despite higher complication rates, total joint arthroplasty in general and total knee arthroplasty in particular are cost-saving in patients with obesity—even in patients with a BMI greater than 40 kg/m².^{10,11}

To mitigate the risk of complications,

many physicians and surgeons encourage weight loss in patients with severe obesity before recommending total joint arthroplasty. Most hospitals in the US have set a “cutoff” BMI of 40 kg/m², above which they refuse to offer arthroplasty due to the preoperative risk. This arbitrary cutoff has been based primarily on a “cost decision,” with additional pressure from insurance companies on American hospitals and the need to reduce hospital stay time and complications in order “to stay competitive.”^{6,12,13}

Only 8% of patients who are denied surgery for a high BMI eventually reach the BMI cutoff and have total joint arthroplasty.¹⁴ Without a reliable pathway for weight loss, should we categorically withhold an operation that improves pain and function for patients in all BMI classes to avoid risk?

Is it risk or is it bias?

All surgeries involve risk. As clinicians, we accept a certain amount of risk in our practices. Should a patient’s size be held to a higher standard than other risk factors? Could weight bias be influencing our clinical decision making beyond the data on risk?^{14,15}

BMI is a weak risk factor for several reasons, which are discussed below. Despite its flaws, increased BMI is comparable in magnitude to other risk factors that are commonly accepted in all surgeries. In studies with more than 5000 patients, odds ratios for any complication in patients with BMI greater than 40 kg/m² range from 1.18 to 1.47. Patients older than 80 years of age have odds ratios of 1.94, and an American Society of Anesthesiologists score greater than 2 gives an odds ratio of 1.49. In terms of specific complications, the data are similar. In total joint arthroplasty, the odds ratio for infection in patients with a BMI between 40 and 50 kg/m² is 3.2, which is comparable to an odds ratio of 3.1 in patients with diabetes.^{7,8,16,17}

Benefits and risks of total joint arthroplasty

Patients with significant obesity (defined as a BMI greater than 40 kg/m²) have lower

baseline function and mobility. After successful and uncomplicated total joint arthroplasty, they have equal or greater changes in validated outcome scores, improved function scoring, and patient satisfaction relative to patients with BMIs lower than 40 kg/m², despite having a higher risk of complication.^{10,11,18}

The establishment of an exclusion criterion of a BMI greater than 40 kg/m² draws on both a consensus document from a group of leading experts at the American Association of Hip and Knee Surgeons and a body of research that demonstrates that obesity presents an independent risk for complications following total joint arthroplasty. This has created barriers that limit surgery for patients who are most in need of these procedures.¹⁹

Problem 1: The BMI

Obesity is a disease. But our diagnostic tool (BMI) is antiquated and inappropriate. We measure the height and weight of a patient, look up the numbers on a chart, and boom: disease. Nowhere else (except perhaps in dermatology) has a spot diagnosis been so overused. Other systems, such as the Edmonton Obesity Staging System, have been proposed, but with all of them, we still compare the new system to the BMI.²⁰

The BMI was invented sometime between 1830 and 1850, at a time when “social physics” was becoming increasingly popular in the scientific community. Its creator was Adolphe Quetelet, an astronomer and mathematician who never studied medicine. He never intended the BMI to be used in a medical context. “Quetelet’s Quotient,” as it was first called, was established by taking the heights and weights of soldiers from the Scottish and Flemish armies and using them to create the statistical formulary of *l’homme moyen*—the average man—who, to Quetelet, represented a social ideal. This formulary, unchanged, is what we now refer to as the BMI.^{21,22}

It was not until the early 20th century that weight was considered a primary indicator for health. In the late 1940s, American life insurance companies began to compile

tables of height and weight to determine premiums for future policyholders. Like Quetelet's Quotient, these actuarial tables represented only a small set of people: those with the resources to purchase a policy. By the early 1950s, these actuarial tables found their way into mainstream medicine. Dr Ancel Keys used the BMI as a measurement of "the overall size of the population" in his seven-continent study.²⁰

From there, the BMI became well established in the clinical setting. In 1985, the National Institutes of Health established the BMI as the clinical tool for diagnosing obesity. Over the next 20 years, the World Health Organization and every other national governing body followed suit, using the BMI to diagnose obesity in adults and children. The basis of this research continued to be unfounded and flawed, but the horse had already left the barn.²¹⁻²³

And so, the use of BMI as an isolated measurement of orthopaedic surgical risk is founded on the very basics of biased evidence.²⁴

BMI does not account for age, gender, fat distribution, metabolic risk, muscle mass, body frame size, or fitness, all of which are important when calculating perioperative risk and technical challenges associated with any orthopaedic surgery, especially joint replacement.²⁴⁻²⁶

Problem 2: A knee is not a hip; a man is not a woman

In orthopaedic studies, surgical risk often groups all joint replacements together. We know that a knee is not a hip. Some studies go so far as to group all orthopaedic surgeries together. If a knee is not a hip, certainly neither is a back.

This is further complicated by grouping men and women together in such studies. For example, there is a higher rate of complications related to increased weight in women who have total hip replacements compared with men. Women tend to carry weight around their hips; therefore, the location of fat tissue would impact infection rates.^{8,25,27} There is increased surgical risk in this population, but such "broad strokes" in

interpretation of the data lead to dangerous sweeping exclusions of patient populations. A more individualized evaluation of each patient's risk and benefit is necessary. Medicine, by its nature, evaluates a risk-benefit ratio at all times. Although an increased

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risk from total joint arthroplasty in patients with significant obesity has been adopted, there is a volume of data to support significant benefit of the surgery despite the increased risk.¹¹

Problem 3: Risk is not absolute—it is nuanced

Hard BMI cutoffs oversimplify preoperative risk assessment. Greater muscle mass mitigates the health effects of BMI, and in knee replacement, thickness of prepatellar fat predicts complications better than BMI.^{20,24,27} A much more sophisticated and accurate way to assess preoperative risk is to use risk calculators, which consider BMI, demographics, and other comorbidities.⁸

In all the studies that examined BMI and risk of joint replacement surgeries, patients were grouped together based on a clustering of BMI at every 5 points. The flaw is that most of those studies grouped together all patients with a BMI greater than 40 kg/m². Does a patient with a BMI of 41 kg/m² have the same risk as one with a BMI of 60 kg/m²?²⁶

In addition to evaluating body habitus and BMI, a preoperative risk assessment should include an evaluation of comorbidities. Addressing a patient's glycemic control, sleep apnea, thrombotic risk, fitness, and hypertension prior to surgery will affect their postoperative complications. These are modifiable risks that can be addressed independent of weight loss.^{8,20}

Denying access to care

A BMI cutoff is dangerous medically because BMI does not solely or strongly predict complications.^{5,17-19}

In the Veterans Health Administration, enforcing a strict BMI eligibility criterion of 40 kg/m² would deny complication-free surgery to 14 patients in order to avoid one complication; for a BMI cutoff of 35 kg/m², it would be 16 to 1. To put this into perspective, if you flipped a coin to determine surgical eligibility, it would be 19 to 1.⁹

In short, by grouping together all patients with a BMI greater than 40 kg/m², men and women, and hip and knee surgeries, we have oversimplified a complicated risk assessment and thus excluded a population whose risk-benefit ratio of surgery likely favors surgery.⁹⁻¹¹

The solution

In medicine, there are two approaches to changing risk in the delivery of care: change the disease or change the system.

Option 1: Change the disease

In the last decade, there has been significant improvement in our understanding of energy regulation in the body. An overwhelming amount of research has shown that complex genetic and physiological factors are involved in weight gain and neurohormonal energy dysregulation. This has led to the establishment of evidence-based treatments that offer legitimate, safe, and significant weight loss.

Goals of perioperative optimization: The goal of treatment, or surgical optimization, should consider three factors or surgical risks and address each one:^{22,28,29}

- Address malnutrition.
- Reduce comorbidities.
- Focus on weight loss as a percentage of body weight rather than an absolute number.

Address malnutrition: A large percentage of patients with obesity have malnutrition due to an inappropriate starvation response. Patients with obesity have a fourfold

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increased likelihood of having hypoalbuminemia.^{23,30,31} Low serum prealbumin and albumin are predictors of poor surgical outcomes. Some data suggest that improvement in this marker of malnutrition translates to better surgical outcomes. Therefore, part of the preoperative assessment should include a review of the patient's albumin, vitamin D, and iron levels. Vitamin D and iron can easily be supplemented, and patients can be counseled on protein intake.²⁸

Reduce comorbidities: Mitigating perioperative risk has been a cornerstone of surgical optimization since the first preoperative clinics were established by Dr Alfred Lee in the 1940s.^{32,33} The benefits of and evidence for preoperative optimization have been well established in literature and practice since 2000. Preoperative clinics are now mainstream across North America and Europe; they focus on assessing and treating cardiovascular risk factors and comorbidities to lower a patient's overall surgical perioperative risk.²⁹

Develop a better understanding of weight and weight loss: Our approach to weight loss in the past was ineffective, because we came to it with a primitive understanding of body energy regulation. The entire premise of weight loss prior to the turn of this century was simple. We believed that weight gain occurred as a result of excess caloric intake. Our physiological understanding was wrongly based on the model that human beings, like machines, have a specific rate of energy function—we need a certain amount of “fuel” to function. If we consume more of the fuel than we need, we store it; if we consume less than we need, we burn it. And so, the “calories in, calories out” model persisted, and our approach to treatment of obesity was simple: “Eat less; move more.”

We were wrong.^{22,34,35}

Volumes of data have confirmed the complex genetic and neurohormonal dysregulation that causes one person to gain weight or maintain a higher body weight and another person not to do so. To date, more than 5500 genes have been implicated

in both monogenic and polygenic patterns that predispose people to inappropriate weight gain.^{22,36}

It is now well understood that there is a series of hormonal connections between gut, brain, fat, and muscle tissue. The gut produces “hunger” and “satiety” hormones; fat and muscle tissue produce “storage” and “usage” hormones. All of these hormones send feedback to the brain, which then communicates with our tissues to regulate how much we eat, how much we use, and how much we store. Although this is a simplification of highly sophisticated neurohormonal feedback, we now understand that brain function is based on both homeostatic and hedonic drives toward food intake that are rooted in evolutionary biology.^{34,35,37} We evolved highly sophisticated endocrine systems to prevent starvation. When the brain thinks it is starving, it will store fat and hunt food.³⁴

In short, obesity is not a function of the simple behavior of excess consumption; it is the result of an inappropriate activation of the physiological starvation response that exists in all mammals and is a function of complex neurohormonal feedback.

Although the physiology of fat tissue regulation is complex, the principal goal of treatment is to essentially “trick” a starving brain into believing it is not starving. When this happens, the body no longer stores fat inappropriately or hunts food inappropriately. Clinically, this translates into weight loss; symptomatically, it translates into less food thought, less hunger, and fewer food cravings.³⁵

Weight loss mechanisms: There are potential benefits for patients if obesity is treated before total joint arthroplasty. Studies of diet-induced weight loss before total joint arthroplasty report improved outcomes compared with treatment as usual but tend to include patients with a lower BMI and involve short-term follow-up.³⁸

Emerging data have shown that medical management of weight loss is effective and sustained as long as the treatment is continued. We understand this principle

in other areas of chronic disease management. Hypertension and dyslipidemia are well managed when patients continue their antihypertensives and statins, respectively.

In Canada, four medications have been approved for treatment of obesity: orlistat, liraglutide, semaglutide, and naltrexone-bupropion. All of the studies on these medications were based on randomized placebo-controlled trials, which supported their use. Their efficacy ranges from 5% to 20% body weight loss.³⁷

Orlistat (120 mg three times per day) is a selective inhibitor of pancreatic lipase and was approved as pharmacotherapy for obesity management in Canada in 1999. Although its use has resulted in 3% to 5% body weight loss in patients in randomized controlled trials, it is rarely used in obesity treatment at present.³⁹

Liraglutide (3.0 mg subcutaneously daily) is a human glucagon-like peptide 1 (GLP-1) analog that acts centrally on the pro-opiomelanocortin or “fullness” neurons in the hypothalamus. It also increases insulin release and suppresses glucagon during times of glucose elevation. Clinically, liraglutide improves satiety and reduces hunger because there are GLP-1 receptors throughout the brain, liver, and gut that affect both hedonic and homeostatic neurohormonal feedback.

Liraglutide was first approved in Canada in 2010 for the management of type 2 diabetes, and in 2015 for the long-term treatment of obesity. In randomized placebo-controlled trials on liraglutide versus placebo, 63.2% of patients on liraglutide had lost at least 5% of their body weight at 1 year, 33.1% had lost more than 10%, and 15.0% had lost more than 20%. Both the treatment group and placebo group were on dietary management. The amount of weight loss in the liraglutide group was more than double that in the “diet alone” group, which shows the superiority of medication in addition to diet alone.⁴⁰

Semaglutide (2.4 mg subcutaneously once per week) is a human GLP-1 analog. Like liraglutide, semaglutide acts centrally on the hypothalamic pro-opiomelanocortin

neurons as a “fullness signal.” Semaglutide increases insulin release and suppresses glucagon during times of glucose elevation. It was approved in Canada in 2018 for the management of type 2 diabetes at a dose of 0.5 or 1.0 mg weekly, and in 2022 at a dose of 2.0 mg weekly. Semaglutide was approved in Canada in 2021 for long-term obesity management at a dose of 2.4 mg weekly in people with or without type 2 diabetes. In a randomized placebo-controlled trial, use of semaglutide 2.4 mg resulted in 14.9% weight loss at 68 weeks compared with 2.4% with placebo in patients with obesity. Both groups had health-behavior modification.⁴¹

The naltrexone-bupropion (16 mg/180 mg twice per day) sustained-release formulation was approved in Canada in 2018 for long-term obesity management, at a dose of 16 mg naltrexone and 180 mg bupropion twice daily. In a randomized placebo-controlled trial of patients with obesity but not diabetes, use of naltrexone-bupropion 16 mg/180 mg twice per day was associated with weight loss of 6.1% versus 1.3% in the placebo group. In the naltrexone-bupropion treatment group, at least 5% weight loss was recorded in 48% of patients and at least 10% was recorded in 25% of patients, compared with 16% and 7% in the placebo group, respectively.⁴²

When the anatomy of a tissue is changed, its hormonal signaling changes. Bariatric surgery was once thought to be effective for weight loss because of its “restrictive and malabsorption” effects. Further understanding of physiology has shown that bariatric surgery is truly a metabolic surgery that causes significant elevations in fullness hormones and changes in bile salts and gut flora. All of these hormonal and metabolic shifts happen because of the alteration in the “gut landscape.” Metabolic changes are responsible for the shift in starvation response and significant positive effects on patients’ metabolic comorbidities.^{43,44}

The bariatric surgical procedures currently performed in Canada are sleeve gastrectomy, Roux-en-Y gastric bypass, biliopancreatic diversion with or without

duodenal switch, adjustable gastric banding, single anastomosis gastric bypass, and single anastomosis duodenoileostomy with sleeve gastrectomy. Bariatric surgery offers between 30% and 70% body weight loss depending on the procedure. Most long-term data have been recorded in the population of patients who have had Roux-en-Y gastric bypass.^{45,46}

If we, as a medical system, truly want to be better and do better, we need to examine our old ways, dismantle their origins, and use our science to build a better way.

Option 2: Change the system

Beatrice has to lose weight in order to have surgery. What if her surgeon was retrained and better equipped to deal with hips and knees of women with obesity?

A different way to address the issue of risk may be to change the system in which we practise. Obesity, by any definition, is not going away. In addition to broadening the term of perioperative optimization, we can, as a medical community, subspecialize our obesity joint replacement. Recent data point to the importance of surgeon experience in reducing risk in patients with increased BMI who undergo total joint arthroplasty.^{47,48}

In a population-based cohort study of 4781 patients, the volume of obesity-specific procedures was associated with fewer major surgical complications after total hip arthroplasty performed in patients with severe obesity (reduction in risk by 35% for every 10 additional patients).⁴⁷

In addition to optimizing the patient, it is clear that there is an opportunity to optimize the system. Increased training in total joint arthroplasty in patients with obesity allows for the development of centres of excellence for patients with a BMI greater than 50 kg/m².

Summary

Until now, our view of a patient population has been based on our own weight bias and very little rudimentary data. The science is mounting to support more comprehensive evaluations of risk in patients with obesity and more comprehensive management plans for mitigating risk prior to surgery and in the operating room. This is the beginning of a change in how we approach patients with obesity in the orthopaedic world and how we as a medical community move forward.

If we, as a medical system, truly want to be better and do better, we need to examine our old ways, dismantle their origins, and use our science to build a better way. Never before have we known more about human physiology, disease, and treatment. Never before have we had such technology and advancements to treat disease. Never before has there been such a demand for compassion, inclusivity, and empathy. It is our obligation and our imperative to repair the future by changing our present practice. ■

Competing interests

Dr Zentner is founder of the not-for-profit organization No Fat Shame. She has received honoraria and speaking fees from Bausch Health, Novo Nordisk, Eli Lilly, and Valeant, and an unrestricted educational grant from Bausch Health and Novo Nordisk.

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Complexities of artificial intelligence in health care

The rise of artificial intelligence (AI) has the potential to drastically improve physicians' professional lives. With the release of ChatGPT—a generative AI tool that engages in human-like conversation equipped with the vast knowledge of the Internet—public attention has been captivated, along with mixed feelings of fear and awe regarding future implications.

At its core, the power of modern-day AI lies in its ability to self-learn and recognize patterns. Combined with fast computational speed and a seemingly limitless memory, AI programs work much like a human mind by anticipating problems, adapting, and learning from past mistakes. Recently, this formidable tool has made strides in health care. While AI solutions expand and work toward optimizing patient care, it is especially important that policy keeps up with this technological surge to ensure effective and safe implementation in our health care system.

AI in health care is developing rapidly, particularly in the realm of automating routine tasks. For example, primary care and emergency physicians are overwhelmed with patients. AI's ability to assist in paperwork, prioritize labs, and solve scheduling challenges should alleviate administrative burden and release time back to physicians. Administrative load remains a significant contributor to physician burnout and compassion fatigue, as highlighted by the Canadian Medical Association's National Physician Health Survey.¹ Companies have

created tools to address these concerns—for example, automatic SOAP notes, where AI listens in on a patient encounter, analyzes it, and organizes points into a chart instantaneously. Some applications are integrated with scheduling, allowing follow-up appointments, lab requisitions, and specialist referrals to be sent out by voice. The time saved allows physicians to focus on human interaction in patient care, without sacrificing efficiency.

AI's development in diagnostics may be the most incredible. The Massachusetts Institute of Technology trained a program with over 32 000 mammogram images of women diagnosed with cancer. The algorithm demonstrated remarkable accuracy in detecting disease presence and subtleties often incomprehensible to humans.²

The utility of such tools is exciting; however, concerns regarding data quality and security persist. If poor-quality, biased, or incomplete data is used during the algorithm, AI may perpetuate or exacerbate social inequities present in our health care system today, leading to a phenomenon known as “algorithmic bias,” as termed by Harvard University.³

Additionally, security risks may occur during construction of AI algorithms, which have historically lacked privacy measures. A notable instance was when DeepMind (an AI company owned by Google) partnered with the Royal Free London NHS Foundation Trust to use machine learning in management of acute kidney injury.⁴ The UK's Department of Health and Social Care noted that no privacy measures were discussed, and patient data was obtained on an “inappropriate legal basis.” Google took control of DeepMind's application, transferring control of patient data from the UK to the US. While the actions taken were legal, it is reasonable to believe individuals

would have concerns about their health data being used in this manner.

As AI in health care evolves, policy frameworks must adapt to ensure ethical, legal, and societal considerations are addressed in tandem with technology. Policies may differ between provinces. In March and April 2024, the College of Physicians and Surgeons of BC issued two statements, one for all registrants and one specific to registrants who work in diagnostic facilities. During medical encounters, registrants may use AI, adhering to principles such as privacy, confidentiality, and consent.⁵ Importantly, physicians will maintain responsibility for interpreting and making final decisions about patient care. For registrants working in diagnostic facilities, only AI approved by the Diagnostic Accreditation Program may be used as supplementary aids for triage, diagnostics, and quantifying aspects in practice.⁶ For BC, this is a great step in the right direction.

The ever-evolving nature of AI requires continuous reassessment of regulatory frameworks from a multidisciplinary lens of law, ethics, and medicine. By being aware of developments, we can harness the power of AI while prioritizing patient-physician benefit, societal trust in our health care system, and ethical standards. ■

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Understanding chronic conditions in BC

Chronic diseases are leading causes of disability and death. They have a major impact on individual well-being and result in significant costs to the health care system.¹ In BC, the number of people living with chronic disease is increasing. Among adults in the 2022/23 fiscal year, 67% of females and 60% of males had at least one record of a common chronic condition in their lifetime, up from 59% and 47%, respectively, in 2002/03.² The prevalence of multimorbidity—having two or more chronic diseases—is also on the rise, affecting over one-quarter of adults and over half of seniors.

Understanding the local burden of chronic conditions informs planning, policy, and program development, as well as disease prevention and management. The Chronic Disease Dashboard² is a publicly available interactive data tool with visualizations of changes over time in patterns of chronic conditions. Estimates of incidence (new cases) and prevalence (the total number of people living with a condition) are sourced from the BC Chronic Disease Registries, which are derived from records of physician visits, hospital admissions, and prescription drug dispensations for 25 common chronic conditions, excluding cancer (see the BC Cancer Statistics Online Dashboard³). Population rates are updated annually and are available by age group, sex, and geographic health region. Information on gender is not available. For chronic disease indicators pertaining to First Nations and Métis Peoples in BC, see other reports.^{4,5}

People living with chronic conditions were disproportionately impacted by the

pandemic, including disruptions to screening and health care, social isolation, and, in some cases, heightened risk of COVID-19 morbidity and death.^{6,7} In 2020/21, new cases in BC based on health care encounter records temporarily decreased for many chronic conditions but have since returned to prepandemic levels. Mental health was an exception to this trend, with visits continuing to increase and peaking in 2021/22, especially among younger females. While the pandemic uniquely impacted youth in terms of mental health outcomes,⁸ the pre-existing growing trend prior to the pandemic suggests that additional factors are at play. Among adults aged 35–64 years, mood and/or anxiety disorders are currently the most common condition in the BC Chronic Disease Registries, with approximately 1 in 2 females and 1 in 3 males having a record for a related health care encounter in their lifetime. For older age groups, other conditions, such as hypertension, are more prevalent. Approximately 6 in 10 individuals aged 65 to 79 years and 9 in 10 individuals aged 80 years and older have a history of hypertension, underscoring the importance of early screening and prevention.

Chronic diseases pose significant burdens, and in the context of an aging population, they will likely become even greater. The Chronic Disease Dashboard provides useful situational awareness and contextual information that can inform priorities and strategies for chronic disease prevention, management, and care at the practice, regional, and provincial levels. Protective factors such as physical activity, sleep, healthy diet, and social connection can prevent or delay the onset of many chronic conditions, reduce their impact on quality of life, or help reverse them. Prioritizing policies, programs, and services that focus on chronic disease prevention and management plays

a pivotal role in helping communities maximize their health and wellness and address this slower, but no less significant, growing epidemic. ■

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Notes

The BC Chronic Disease Registries are produced by the Office of the Provincial Health Officer. The Chronic Disease Dashboard is produced by the BC Observatory for Population and Public Health and is housed on the BCCDC website.

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This article is the opinion of the BC Centre for Disease Control and has not been peer reviewed by the BCMJ Editorial Board.

Preventing heat-related illness: Identifying workers at risk of heat stress due to hotter days in the context of climate change

As days with recorded temperatures above 30°C become increasingly frequent in BC, the risk of heat-related illness increases, with workers who primarily work outdoors more likely to be affected.¹ For example, data show an increase in WorkSafeBC claims for heat-related illness rising from an average of 40 claims in 2018 to 81 claims in 2022, with a peak in 2021 of 112 claims, corresponding to an extreme heat event that year.² Heat generation or exposure may be caused by factors other than hotter ambient temperatures. These include high humidity, heavy physical exertion without rest, and wearing heavy protective clothing. This article focuses on heat stress occurring on hotter days, which are likely to occur more often due to climate change.

This article is the opinion of WorkSafeBC and has not been peer reviewed by the BCMJ Editorial Board.

Risk factors for heat stress

It is important to take an occupational history to determine your patient's work-related risk of heat stress. Risk factors for heat stress may be grouped into (1) environmental factors (e.g., temperature, air flow), (2) individual factors (e.g., acclimatization; certain chronic diseases; medications including antipsychotics, antidepressants, antihistamines, and diuretics; tight-fitting or insulating clothing), and (3) work-related factors (e.g., exertion, nature of work). Workers at a higher risk of heat exposure include those who work during hot days indoors without air conditioning (such as restaurant kitchens or bakeries), those who are exposed to hot days working outdoors (such as construction, agriculture, and motion picture location shooting), and those who work year-round in hot conditions regardless of outdoor environmental temperatures (such as those working in boiler rooms or smelters or firefighting). Workers aged 45 to 54 and those under the age of 34 have been shown to have a

higher likelihood of making a heat-related illness claim.³ Temporary foreign workers are especially vulnerable to heat exposure in the workforce due to a large portion of the workforce performing work outdoors.²

Preventing heat-related illness in the workplace

In addition to taking an occupational history, providers can help educate workers to prevent heat-related illness. Workers with chronic disease or on certain types of medications (such as those listed above) should work in collaboration with their provider to adjust self-management while in hot environments and discuss this with their employer so a personal heat safety plan can be put in place. It is also recommended that workers, especially those with medical risk factors, not work alone during hot conditions. Working with other people can allow for mutual monitoring for signs of heat stress.

At the onset of hot weather, especially during the first heat wave of the season,

BOX. Four common heat-related syndromes and corresponding measures to take.

Heat rash

Signs and symptoms: New or worsening rash in response to heat.

Measures: Move to a cooling environment. Make sure to change clothing often and wear loose-fitting clothing.

Heat cramps

Signs and symptoms: Muscle cramps, persistent sweating.

Measures: Immediately move to a cooling environment and cool with fanning or water. The worker should rehydrate with water and electrolytes. Continuing to work despite heat cramps may lead to heat exhaustion.

Heat exhaustion

Signs and symptoms: Headache; nausea; weakness; fatigue; sweaty, cool, and pale skin; increased heart rate and breathing rate.

Measures: Immediately move to a cooling environment, sponge with cool water, remove tight-fitting clothing, and provide oral fluids if conscious. Urgent medical attention is warranted. If not treated, the worker may develop heat stroke.

Heat stroke

Signs and symptoms: Dry, hot, and red skin; no sweating; altered level of consciousness; irregular pulse and increased breathing; cardiac arrest; body temperature above 41 °C.

Measures: Move to the coolest place possible and apply cold water. Call emergency health services. Heat stroke is a medical emergency.

risk of heat-related illness is the highest. During these periods, workers should be instructed to take more breaks and implement precautions to a greater degree than normal as they slowly acclimatize to hotter weather. Some measures to prevent heat stress include staying hydrated, taking frequent breaks in a cooler environment, wearing loose-fitting and light-colored clothing made of cotton or silk, and learning to recognize and act on early signs and symptoms of heat stress.

Providers may also inform workers that their employers have a responsibility to protect them from heat exposure. Employers should be training workers on signs and symptoms of heat stress; providing cool potable water; regularly monitoring thermal conditions; allowing frequent breaks; adjusting work scheduling, workload, or duties to reduce the risk of heat stress to workers; and removing workers from the hot environment if they show signs or report symptoms of heat stress (see more examples at www.worksafebc.com).

[.com/en/health-safety/hazards-exposures/heat-stress](https://www.worksafebc.com/en/health-safety/hazards-exposures/heat-stress)). If you're concerned that a worker is subjected to unsafe work, you can inform them that they have a right to refuse unsafe work and may contact the Prevention Information Line at WorkSafeBC, either online at <https://prevruw.online.worksafebc.com> or by phone at 604 276-3100 (Lower Mainland) or 1 888 621-7233 (toll-free).

Heat-related illness early recognition and action

Providers should educate patients on the stages of heat-related illness so they can recognize signs and symptoms early and take action to prevent progression. See the **Box** for four common heat-related syndromes and the corresponding measures to take. ■

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Suggested reading

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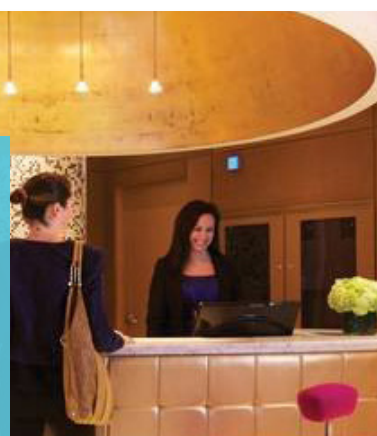
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