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The Canadian Journal of Surgery aims to contribute to the effective continuing medical education of Canadian surgical specialists and to provide surgeons with an effective vehicle for the dissemination of observations in the areas of clinical, basic science and education research. Readers can find CJS online at canjsurg.ca. Submission of new manuscripts can be made at http://mc.manuscriptcentral.com/cjs.


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Trudeau government meddling in provincial mandates

The views expressed in this editorial are those of the author and do not necessarily reflect the position of the publisher.

Like it or not, health care is a provincial responsibility. The health care machine that runs well or doesn’t quite run, depending on your region, is a machine designed for and based on local concerns. Patient demographics and needs differ among provinces in some ways, and it is the legal right of the province to determine priorities, especially in these days of cost-containment measures. The federal government should have very little to do with the day-to-day running of medical care. The federal ministers currently are waging a slow war with provinces over the amount of health care transfer payments. Federal Finance Minister Bill Morneau and Health Minister Jane Philpott have offered the provinces a 3.5% annual increase in health transfer — less than the increase in gross domestic product. The provinces were demanding the previously standard 6% increase that more closely reflects the actual increase in cost.

Ontario estimates 5.2% as the absolute minimum needed to prevent the loss of essential services. The federal government has also offered another $11 billion over 10 years to be put into home care and mental health — basically more money with stipulations on its usage. Targeted money to fulfill federal electoral promises has been previously struck down in past offerings by other governments. The new offer was rejected by the provincial group at large, but many provinces are now cutting bilateral deals, which only weakens the bargaining power of the remaining provinces.

It appears we are heading to a messy debate, and a bad precedent is being created. If the federal bureaucrats want to influence health care, then there are better places to direct their energy. Holding provinces and patients hostage over transfer payments just threatens the well-being of the provinces. Partners like the Canadian Medical Association or provincial medical associations are great places to start initiatives that can be picked up by provincial health ministries as these projects mature. The Canadian Association of General Surgeons’ Canadian surgery initiatives, support for the World Health Organization trauma care policies, or a partnership with the Canadian Orthopaedic Association to decrease opioids are all fine examples of places for the federal government to start investing if it wanted a highly visible, partner-rich, politically responsible system in which to invest time and effort. If the Trudeau government wants evidence-based change, it should fund medical research to the level of other developed countries. Targeted funding goals could fulfill their need for political gains. Money for research on mental health care, trauma and other underfunded areas that affect Canadian society is needed at a level well above the current support these issues currently garner. These efforts would indeed bring about meaningful societal change.

What the federal government is doing now is not a proper or moral way to handle health care. Whatever the Trudeau government efforts are, such as trying to block private health care (an imprudent idea when coupled with cuts in transfer payments) or funding mental health care over all other concerns, these efforts should have nothing directly to do with the provincial mandate of health. In fact, the obscene amount of tax money that is turned back to the provinces in transfer payments begs another question: why are we being overtaxed? The reason might be fiscal responsibility — unlikely in the light of other ongoing federal policy — or an appeal for popularity by being perceived as champions of the people in health care. Trudeau would be a lot more popular if his government stopped overtaxing the population for the $37 billion they currently return on transfer payments in health.

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Competing interests: E.J. Harvey is the Chief Medical Officer of Greybox Healthcare (Montreal) and Chairman of the Board of NxtSens Inc. (Montreal).

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References


Le gouvernement Trudeau s’ingère dans les attributions des provinces

Les opinions exprimées dans cet éditorial sont celles de l’auteur et ne représentent pas nécessairement celles de l’éditeur.

Q u’on le veuille ou non, les soins de santé relèvent de la compétence des provinces. La machine des soins de santé, qu’elle fonctionne bien ou pas tout à fait, selon la région, est conçue en fonction des préoccupations locales et basée sur celles-ci. Les caractéristiques démographiques des patients et leurs besoins diffèrent à certains égards selon les provinces, auxquelles la loi confère le droit d’établir les priorités, particulièrement en période de confinement des coûts. Le gouvernement fédéral devrait avoir très peu à faire dans le fonctionnement quotidien des soins médicaux. Les ministres fédéraux livrent actuellement aux provinces une guerre lente au sujet du montant des paiements de transfert au titre des soins de santé. Les ministres fédéraux des Finances, Bill Morneau, et de la Santé, Jane Philpott, ont offert aux provinces une majoration annuelle de 3,5 % du transfert pour la santé — un pourcentage inférieur à l’augmentation du produit intérieur brut. Les provinces exigeaient l’augmentation auparavant habituelle de 6 % qui reflète plus fidèlement l’augmentation réelle des coûts. L’Ontario calcule que le minimum absolu nécessaire pour éviter la perte de services essentiels s’établit à 5,2 %. Le gouvernement fédéral a aussi offert 11 milliards de dollars de plus en 10 ans, montant à injecter dans les soins à domicile et les services de santé mentale — il s’agit essentiellement d’une augmentation de l’enveloppe budgétaire dont l’utilisation est assortie de conditions1. D’autres gouvernements ont déjà refusé par le passé de l’argent ciblé offert pour tenir des promesses électorales fédérales. Le groupe des provinces dans l’ensemble a rejeté la nouvelle offre, mais beaucoup de provinces concluent maintenant des ententes bilatérales, ce qui ne fait qu’affaiblir le pouvoir de négociation des autres.

Nous semblons nous diriger vers un débat houleux assorti de la création d’un mauvais précédent. Si les fonctionnaires fédéraux veulent exercer de l’influence sur les soins de santé, ils pourraient concentrer leur énergie sur de mieux-êtres cibles. En gardant en otage les provinces et les patients face aux paiements de transfert, on ne peut que menacer le bien-être des provinces. Des partenaires comme l’Association médicale canadienne ou les associations médicales provinciales sont d’excellents endroits où lancer des initiatives que les ministères provinciaux de la santé pourraient reprendre une fois qu’elles parviennent à maturité. Les initiatives canadiennes sur la chirurgie2 de l’Association canadienne des chirurgiens généraux, le soutien des politiques sur les soins aux traumatiques de l’Organisation mondiale de la Santé3 ou un partenariat avec l’Association canadienne d’orthopédie pour réduire l’usage des opiacés sont d’excellents exemples d’endroits où le gouvernement fédéral pourrait commencer à investir s’il voulait créer un système très visible, riche en partenaires, responsable sur le plan politique et auquel il pourrait consacrer du temps et des efforts. Si le gouvernement Trudeau souhaite des changements appuyés par des données probantes, il devrait financer la recherche médicale pour la porter au même niveau que celle d’autres pays industrialisés. Des objectifs financiers ciblés pourraient satisfaire le besoin pour le gouvernement de réaliser des gains politiques. La recherche sur les soins en santé mentale, les traumatismes et d’autres secteurs mal financés ayant une incidence sur la société canadienne a besoin d’un niveau de financement beaucoup plus élevé que ce qui lui est consenti actuellement. De tels efforts instaureraient vraiment un changement significatif dans la société.

Ce que fait actuellement le gouvernement fédéral face aux soins de santé est inconvenant et moralement inadmissible. Quels que soient les efforts déployés par le gouvernement Trudeau, notamment pour bloquer les soins de santé privés (idée imprudente lorsqu’elle s’associe à une réduction des paiements de transfert) ou pour financer les soins de santé mentale au détriment de tous les autres secteurs, ils ne devraient avoir aucun effet direct sur les attributions des provinces dans le domaine de la santé. En fait, le montant obsolète de recettes fiscales que l’on renvoie aux provinces sous forme de paiements de transfert soulève une autre question : pourquoi sommes-nous surtaxés ? Ce pourrait être pour des raisons de responsabilité budgétaire — ce qui est peu probable compte tenu d’autres politiques fédérales en vigueur — ou de recherche de popularité, le fédéral souhaitant être perçu comme le défenseur de la population dans le domaine des soins de santé. Or, Trudeau serait beaucoup plus populaire si son gouvernement cessait de surtaxer la population pour réunir les 37 milliards de dollars que son gouvernement réaffecte actuellement aux paiements de transfert au titre de la santé4.

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Références
Festschrift in honour of Dr. Roger Keith

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A festschrift is a collection of essays written to honour the contributions of a colleague during his or her career. These essays are not about the colleague, but about the science. A theme is often chosen to align with the interests of the honoree. In June 2017, several colleagues of Dr. Roger Keith will gather in Saskatoon, Sask., to discuss topics regarding the past and future of surgery and its subspecialties, particularly surgical education and hepatopancreatobiliary surgery. The Canadian Journal of Surgery is pleased to collaborate in the production of this festschrift for its former editor, Dr. Keith.

Roger Keith was born in Calgary in August 1940. After completing his medical doctorate at the University of Alberta and general surgery residency at the University of Toronto, Dr. Keith went to Toulouse (Professor Jean Escat), London (Sir Rodney Smith), Los Angeles (Dr. William Longmire) and Seattle (Dr. Thomas T. White) to gain the best training in liver and pancreatic surgery (known today as HPB surgery). Hepatopancreatobiliary surgery, including endoscopic retrograde cholangiopancreatography, became Dr. Keith’s specialty, and he led its development in Canada over the next 40 years. In 1990 he moved back west and became the professor and head of surgery at the University of Saskatchewan. He contributed to the rapid development of surgical education through leadership roles, many of which continue today, at the Royal College of Physicians and Surgeons of Canada, the American College of Surgeons, the Canadian Association of General Surgeons, the American Surgical Association and the James IV Association of Surgeons. Dr. Keith was editor-in-chief of the Canadian Journal of Surgery from 1992 to 1998.


The festschrift in honour of Dr. Roger Keith, past editor of the Canadian Journal of Surgery, includes essays (available at canjsurg.ca), written from a personal perspective, on the development of specialty surgery in Canada (Richard Nason, Michael Marcaccio, Michael Kelly and Lissa Peeling), evolution of the certification examination (Ward Davies), building of a megahospital (Gerald Fried) and on the changes in surgical education (Edward Davies, Christopher DeGara, E. Christopher Ellison, Richard Prinz and William Pollett), as well as personal reflections (Andrew Warshaw, Stewart Hamilton).

SUMMARY

The festschrift in honour of Dr. Roger Keith, past editor of the Canadian Journal of Surgery, includes essays (available at canjsurg.ca), written from a personal perspective, on the development of specialty surgery in Canada (Richard Nason, Michael Marcaccio, Michael Kelly and Lissa Peeling), evolution of the certification examination (Ward Davies), building of a megahospital (Gerald Fried) and on the changes in surgical education (Edward Davies, Christopher DeGara, E. Christopher Ellison, Richard Prinz and William Pollett), as well as personal reflections (Andrew Warshaw, Stewart Hamilton).
This festschrift is opened by a description of challenges facing medical schools in the 21st century (Dr. Grant Miller, University of Saskatchewan) and continues with essays on the development surgery in Canada: neurosurgery in Saskatchewan (Drs. Michael Kelly and Lissa Peeling, University of Saskatchewan); HPB surgery, including transplantation (Dr. William Wall, University of Western Ontario); head and neck surgery (Dr. Richard Nason, University of Manitoba) and endoscopy (Dr. Michael Marcaccio, McMaster University) as well as a personal account of participation in Canada’s military hospital in Kandahar, Afghanistan, as a civilian surgeon (Dr. Stewart Hamilton, University of Alberta). Essays on surgical education include the topics of undergraduate education (Dr. Christopher DeGara, University of Alberta), postgraduate education (Dr. E. Christopher Ellison, Ohio State University), academic surgery (Dr. Richard Prinz, University of Chicago) and continuing education (Dr. William Pollett, Memorial University of Newfoundland). Chief examiner Dr. Ward Davies (University of Western Ontario) reflects on the evolution of the certification examinations of the Royal College. Dr. Gerald Fried (McGill University) describes the development of Canada’s latest megahospital in Montreal. These essays are written from a personal perspective by surgical colleagues of Dr. Keith who also have a lifetime of contributions to the science. As Dr. Andrew Warshaw (Harvard Medical School) remarked referring to his idol of outcome research in surgery, Dr. Ernest Codman (1869–1940), that Dr. Keith’s career would have met with praise and approval from Dr. Codman, a sentiment echoed in the essays of this festschrift.

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Competing interests: None declared.

Reference

CORRECTION: NO BENEFIT TO SURGICAL FIXATION OF FLAIL CHEST INJURIES COMPARED WITH MODERN COMPREHENSIVE MANAGEMENT: RESULTS OF A RETROSPECTIVE COHORT STUDY

The name of the author Yahya Almarhabi was spelled incorrectly in the article by Farquhar and colleagues1 published in the October 2016 issue of CJS. A corrected version of the article is available on our website at canjsurg.ca. We apologize for the error.

Reference
Canada’s first indigenous physician? The story of Dr. O (1841–1907)

Michelle A. Hamilton, PhD

Presented in part as the 2016 Arthur Gryfe Memorial Dinner Keynote, Toronto Medical Historical Club

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As a physician, temperance advocate, chairman of the Grand General Indian Council of Ontario, the Supreme Chief Ranger of the Independent Order of Foresters, and mistakenly known as a Mohawk Chief, Dr. Oronhyatekha was a well-known, larger-than-life figure in North America and internationally. Since then, his memory has failed in mainstream society. Recently, however, he has re-emerged as a person of historical significance, designated as such by Parks Canada. Now the subject of the first full-length biography, co-authors Michelle Hamilton and Keith Jamieson, have separated out the true stories of his life from apocryphal ones. Although he was much more than a doctor, what follows is the story of how Oronhyatekha, a Mohawk boy baptized Peter Martin at the Six Nations of the Grand River, tenaciously pursued his dream of becoming a physician.

In 2005, Parks Canada erected a plaque near Dr. Oronhyatekha’s (Burning Sky) grave at the Tyendinaga Mohawk Territory and designated him a national historic person, partially based on the belief that he was the first accredited indigenous doctor in Canada. This is one of several apocryphal stories that surround him. He was not, in fact, the first. However, for a Native individual to graduate from medical school in 1867 was a remarkable achievement because of societal racial assumptions and the obstructive nature of the Department of Indian Affairs (DIA). Oronhyatekha’s education began at a 1-room schoolhouse run by the New England Company (NEC), an Anglican missionary society approved of by the DIA. At age 10, he entered the Mohawk Institute, the NEC’s residential school at the Grand River. The NEC missionaries included Reverend Abraham Nelles, who was first Oronhyatekha’s mentor and later his nemesis. What follows is the story of how Oronhyatekha, a Mohawk boy baptized Peter Martin at the Six Nations of the Grand River territory, tenaciously pursued his dream of becoming a physician, and how he used his medical knowledge to transform the fraternal group the Independent Order of Foresters.1–3

Oronhyatekha graduated from the institute as a shoemaker’s apprentice, but a chance meeting with a travelling phrenologist redirected him. Like many phrenologists, A. O’Leary toured North America, speaking at lecture halls and giving personal readings. In 1854, he was in Brantford and visited Oronhyatekha at home. After assessing his skull, O’Leary concluded Oronhyatekha should pursue further education, but also offered to take him on tour. Oronhyatekha agreed, if for no other reason than to see New York City. Eventually Oronhyatekha ended up working at the O’Leary family farm for 5 months before enrolling at Wesleyan Academy in Wilbraham, Massachusetts.

With Nelles’s approval, Oronhyatekha registered for the 1854 winter term, but without sufficient finances, he had to work. In addition to tuition, students paid for board, laundry and fuel to heat and light their rooms. For 3 terms, Oronhyatekha received free tuition in exchange for working as the...
college bell-ringer, and he took odd jobs, such as shoe-making, gardening and chopping firewood. In a much repeated quip, he later recalled that while he was paid only 40 cents per cord of wood, it kept him in bread even if he had not butter.4

After 2 years, he returned home to teach for the NEC. Pondering his future, he remembered Robert Lugger, an NEC missionary and physician, an inspiring combination. Oronhyatekha confided his career goals to Erastus Strong of the Missionary and Education Committees of the Diocese of Ohio, who visited the Grand River. Reverend Strong, a recruiter for Kenyon College in Gambier, Ohio, persuaded Oronhyatekha to consider Kenyon. Although Nelles disapproved, Strong also convinced the Anglican Bishop of Huron, so the NEC arranged a 3-year grant for Oronhyatekha. He enrolled in Kenyon’s preparatory grammar school in 1857 and Kenyon College proper in 1858, again working odd jobs to finance his education. Though newspapers often reported Oronhyatekha graduated from Kenyon College in 1860, having completed a 4-year program in 3 years, he did not return in fall 1859. Having only £10 left, Oronhyatekha returned home to Canada to teach without finishing his degree. Nelles had unilaterally cancelled his grant based on an unsubstantiated charge that Oronhyatekha had fathered and abandoned an illegitimate child while at Kenyon.

An unlikely event pushed Oronhyatekha toward medical school and even further away from Nelles. The Grand River council chose him as its representative for the 1860 royal visit of the Prince of Wales. Legend says that the prince encouraged Oronhyatekha to join him as a student at Oxford University. In reality, it was the prince’s physician, Dr. Henry Acland, who was also on tour and an Oxford professor, who made the suggestion. Acland’s friendship quickly supplanted Oronhyatekha’s relationship with Nelles.

Dr. Oronhyatekha later advertised himself as Oxford-trained, an exaggeration as he spent only 1 month registered. When he arrived in February 1862, Acland took him under his wing, but Nelles soon interfered. When the NEC in England contacted Nelles about Oronhyatekha attending Oxford, he was incensed. He accused Oronhyatekha of embezzling Grand River council funds, even though he had been earlier acquitted, and repeated his charge of abandoning his child. There was also the matter of his supposed expulsion from Kenyon. After a late-night concert, Oronhyatekha’s entire class skipped morning recitations to sleep in. Kenyon’s president expelled the entire class unless they signed a document promising to abide by all rules in the future. Most students, including Oronhyatekha, signed the document and finished the term.

A former Governor General of Canada, Sir Edmund Head, wrote to David Thorburn, an Indian agent at the Grand River, inquiring about Nelles’s charges. Thorburn replied that he knew of nothing. After much discussion, the NEC ultimately ignored Nelles’s charges and disagreed with the revocation of Oronhyatekha’s grant while at Kenyon. Thus supported by the NEC, Oronhyatekha enrolled at Oxford’s St. Edmund Hall in May 1862. But the spectre of his expulsion persisted. Just over 1 month to the day that Oronhyatekha enrolled, he sailed home to clear his name.

Why was Nelles so adamant about Oronhyatekha’s moral character, to the point that he destroyed his chances at Oxford, despite his patronage by Acland, British NEC officials, and the former Governor General of Canada? According to Oronhyatekha, Nelles strongly believed that no Mohawk could succeed without his guidance, and acting without it angered him. It would also undermine Nelles’s authority. Years later, Daniel Wilson who taught Oronhyatekha at University College, Toronto, explained that he possessed a sense of firmness and self-reliance that discomfited missionaries. Indigenous peoples were treated like children; if individuals showed independence, they were labelled rebellious rather than ambitious.5 With continued NEC support, Oronhyatekha entered the Toronto School of Medicine in 1863. A few months later Nelles raised the question of Oronhyatekha’s supposed immorality again, but it did not alter the NEC’s decision. Oronhyatekha wrote his final M.B. exams in 1866 and enrolled in the M.D., which required a thesis. He sat the license exam administered by the newly established provincial College of Physicians and Surgeons and registered on May 22, 1867.

Unfortunately, Dr. Oronhyatekha left behind no records of his practice, but most 19th century doctors ran general practices that included minor surgery and delivering babies. In 1873, the DIA appointed him as consulting physician for Tyendinaga, the home of his wife Ellen Hill. This appointment was controversial because Nelles’s charges still had not yet dissipated, but it was greased by Dr. Oronhyatekha’s friendship with John A. Macdonald, Prime Minister of Canada. Still surrounded by controversy in 1874, Dr. Oronhyatekha resigned. By late 1875 he had been appointed DIA physician for the Oneida of the Thames, and opened a practice in downtown London, Ontario.

In London, he joined the Independent Order of Foresters (IOF), a fraternal organization that offered its members life insurance. First elected medical examiner, Dr. Oronhyatekha quickly moved through the ranks to become the Supreme Chief Ranger in 1881, a position he held until his death. He used his expertise to tighten membership medical exams, and as new tests became ubiquitous, he incorporated them as well. Thus he reduced the risk borne by the IOF by accepting only the healthiest applicants. Of all the fraternal insurance plans of the time, under Dr. Oronhyatekha that of the IOF became the largest and most successful.
Until recently, Dr. Oronhyatekha has been remembered as Canada’s first indigenous physician. Dr. Allan Sherwin’s recent biography of the Mississauga doctor, P.E. Jones, however, demonstrates that he received his license 6 months earlier. Nevertheless, Dr. Oronhyatekha’s attainment of 2 degrees in the mid-19th century, a time when racism and the restrictions of the DIA hindered many from higher education, is remarkable and should not be dismissed simply because he was not the first.

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Competing interests: None declared.

References

CORRECTION: A RETROSPECTIVE QUALITY CONTROL STUDY OF GOALS OF CARE DESIGNATION IN GERIATRIC TRAUMA PATIENTS

The abstract by Taheri and colleagues1 published in the 2016 Trauma Association of Canada Annual Scientific Meeting abstract supplement was missing the names of several authors and had an incorrect affiliation. A corrected version of the supplement is available on our website at canjsurg.ca. We apologize for the error.

Reference
Treatment of enemy wounded: evidence from the No. 7 Canadian Stationary Hospital (Dalhousie University)

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SUMMARY

Dalhousie University, with the help of the other Maritime universities formed and sent a hospital to Europe during the First World War (WWI). They served from January 1916 to April 1919. There is no comprehensive account of the treatment of German wounded by Canadian Medical Services in WWI; however, there is direct photographic and written evidence from the No. 7 Canadian Stationary Hospital that the relationship was one of mutual trust, more characteristic of that between a health care provider and patient than between combatants. The activities of the No. 7 in treating German wounded from the Western Front provide insight into this undocumented aspect of the medical services in WWI. A previously unrecognized painting by Sir William Orpen, one of the leading artists of the 20th century, of the unit at work in France is described. An appendix to this commentary is available at canjsurg.ca.

In December 1915 the No. 7 Canadian Stationary Hospital (Dalhousie University) formed for the first time on the grounds where Dalhousie Medical School now stands. The 165-strong unit was composed of surgeons, physicians, a pharmacist and 27 nurses. The majority of the unit comprised non-medical support staff. Following a 6-month stay in England, they crossed to France in June 1916 where they were involved in the care of both German and Allied wounded until their repatriation in 1919 (Appendix 1, available at canjsurg.ca).¹

On the Western Front where the No. 7 served, 1.5 million German soldiers were killed, 2.6 million wounded and 750 000 captured.² Inevitably some of the captured soldiers were wounded and required medical care.

The official history of the Canadian Medical Services does mention the care of German wounded, but there is no comprehensive account.³ The experience of the No. 7, which has been documented in their war diary, letters home, photographs and in other materials that have survived, provides insight into how German wounded were treated by a Canadian hospital in France.

We do not know how the staff of the No. 7 felt about treating combatant wounded before they actually encountered them. The only insight we have is from a collection of postcards, now in the Dalhousie libraries, that were sent back from one of the support staff, Fraser Tupper, to his nephew in Halifax. They reflect the anti-German feeling of the time, and he advises his nephew, “you must not love the Germans for they are very bad people even if they live in Nova Scotia.” Whether that attitude was pervasive among the medical staff is not known, but likely there was a range of emotions.

In May 1917 the unit moved to the village of Arques in northwest France. While there, they regularly received wounded soldiers, including Germans, from the battlefield around Ypres and Messine. The war diary is a terse administrative document and does not record the tone of the interaction between the No. 7 staff and former combatants.

Dr. John Stewart was the commanding officer of the unit. At age 67 he had respect and stamina. While travelling in Europe in his younger days he had
German wounded with Dalhousie medical and nursing staff. June 1917, Arques, France. Dalhousie archives.

William Orpen’s painting “German Sick, Captured at Messines, in a Canadian Hospital.” Imperial War Museum IWM ART 3043. Reproduced with permission from the IWM.
learned German and was able to converse with the wounded enemy soldiers. Stewart wrote home regularly, and in one of his letters to the Dalhousie newspaper he gave an account of a small gesture of kindness to a German captive. A Christmas tree with a German flag sent to the captive by his girlfriend was allowed on the dining table — a small gesture, but a definite message to the more belligerent home front.

We also have some idea of how the Germans may have felt about their captors. A scrapbook kept by one of the Dalhousie nurses has survived. There are 80 pages of photographs, poems, flowers and locks of hair from wounded soldiers. Tucked away on one page is a field postcard from one of the Germans thanking the sister for the gift of strawberries, which might suggest that relations were cordial.

More direct evidence of the interaction comes from the photographic record. A number of images of the hospital at Arques have been preserved, and in those photographs are several of the hospital medical and nursing staff posing with German wounded, with no suggestion of antagonism from either side. There are no guards, and they look perfectly comfortable in each other’s company. It is fair to assume that once a wounded combatant reached the care of the rear line Canadian Medical Services that both sides adopted a patient-health care provider relationship and left the war at the front lines.

In June 1917, the hospital had a visit from the war artist, Sir William Orpen. He was born in Dublin in 1878 and became one of the greatest British painters of the early 20th century. His work is in many national galleries as well as the Musée d’Orsay in Paris and the Tate Gallery in London. Orpen joined the British army in December 1915 and went to France as an official British war artist in April 1917. After the war Orpen donated 144 of his war works to the British nation and published a diary of his wartime experience. One painting of a hospital in France, now in the Imperial War Museum, shows a wounded soldier being treated in a tent while others talk and rest.

The title of the painting “German Sick, Captured at Messines, in a Canadian Hospital,” the known situation of the Dalhousie hospital, the war diaries of other Canadian hospitals and the timing of Orpen’s visit make it reasonably certain that the painting, not previously ascribed to a particular Canadian unit, portrays the Dalhousie Stationary hospital in the village of Arques, France, in June 1917. The mood of the painting mirrors that from the photograph of the German wounded with the Dalhousie medical and nursing staff; some wounded are being treated, others chat in the shade of a tree. There is no sense of urgency or antagonism. It is not a very war-like scene and likely captures the mood between captives and medical personnel very well.

The evidence that we have from the work of the No. 7 indicates that wounded enemy combatants in WWI were well treated by the Canadian Medical Services. Once the enemy made the transition from combatant to patient, the war was left behind and care was given to German wounded in the same manner as it was to Canadians.

The care given to the German combatants by the No. 7 would have been governed by the earlier iterations of the Geneva Conventions (1864 and 1906), whereas currently the care of wounded adversaries is covered by the Geneva Convention of 1949. As the practices of modern warfare have changed over the last 2 centuries, the Geneva Conventions have had to be continuously reviewed and revised to ensure their relevance and ability to cope with changing technologies and tactics.

During Canada’s time managing the Role 3 Multinational Medical Unit in Kandahar, Afghanistan, detainees were treated with the same high level of medical care that was offered to all of our patients. The interactions were not as informal as they appeared to be during the time of the No. 7. Strict protocols involving security and the segregation of detainees were in place to ensure the safety of both staff and patients. Unlike, Dr. Stewart’s knowledge of German, many of us had only had rudimentary knowledge of Dari or Pashtun, and thus we relied on local language experts for both communication and social context. Also unlike the experience of the No. 7, our adversaries were from a cultural background that was vastly different from that of Canada in many aspects. That being said, the basic human tenets of kindness and compassion are universal, and many of the detainees we treated were appreciative of the care received, and many reacted with gratitude toward the hospital staff.

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Contributors: Both authors contributed substantially to the conception, writing and revision of this article and approved the final version for publication.

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Sustainability of a proactive geriatric trauma consultation service

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Background: Proactive geriatric trauma consultation service (GTCS) models have been associated with better delivery of geriatric care and functional outcomes. Whether such collaborative models can be improved and sustained remains uncertain. We describe the sustainability and process improvements of an inpatient GTCS.

Methods: We assessed workflow using interviews and surveys to identify opportunities to optimize the referral process for the GTCS. Sustainability of the service was assessed via a prospective case series (July 2012–December 2013). Study data were derived from a review of the medical record and trauma registry database. Metrics to determine sustainability included volume of cases, staffing levels, rate of adherence to recommendations, geriatric-specific clinical outcomes, trauma quality indicators, consultation requests and discharge destination.

Results: Through process changes, we were able to ensure every eligible patient was referred for a comprehensive geriatric assessment. Compared with the implementation phase, volume of assessments increased and recommendation adherence rates were maintained. Delirium and/or dementia were the most common geriatric issue addressed. The rate of adherence to recommendations made by the GTCS team was 88.2%. Only 1.4% of patients were discharged to a nursing home.

Conclusion: Workflow assessment is a useful means to optimize the referral process for comprehensive geriatric assessment. Sustainability of a GTCS was shown by volume, staffing and recommendation adherence.

Contexte: Les modèles de services de consultation proactifs en traumatologie gériatrique ont été associés à une amélioration des soins gériatriques et des capacités fonctionnelles. Toutefois, on ignore toujours s’il est possible de perfectionner et de maintenir ces modèles collaboratifs. Nous décrivons donc ici la viabilité et l’amélioration des procédures d’un service de consultation en traumatologie gériatrique en milieu hospitalier.

Méthodes : Nous avons réalisé des entrevues et des sondages afin d’évaluer le déroulement du travail et de trouver des occasions d’optimiser le processus d’orientation des patients dans ce type de services. La viabilité du service a été évaluée par étude prospective de cas (juillet 2012 à décembre 2013). Les données analysées provenaient de dossiers médicaux et d’une base de données sur les traumas, et les indicateurs de viabilité utilisés comprenaient le nombre de patients rencontrés, l’effectif, le taux de respect des recommandations, des résultats cliniques propres aux personnes âgées, des indicateurs de la qualité des soins de traumatologie, le nombre de demandes de consultation et la destination au moment du congé.

Résultats : Grâce à des changements aux procédures, nous avons pu veiller à ce que chaque patient admissible soit orienté vers une évaluation gériatrique complète. Comparativement à la phase de mise en œuvre, le nombre d’évaluations a augmenté, et le taux de respect des recommandations s’est maintenu. Le délire et la démence étaient les problèmes gériatriques les plus fréquents. Le respect des recommandations faites par le service était de 88,2 %, et seuls 1,4 % des patients sont allés dans un centre de soins infirmiers à leur congé.

Conclusion : Bref, l’évaluation du déroulement du travail est un bon moyen d’optimiser le processus d’orientation des patients vers une évaluation gériatrique complète. La viabilité d’un service de consultation en traumatologie gériatrique a été démontrée par le nombre d’évaluations réalisées, l’effectif du service et le respect des recommandations proposées.
Adu


t of 40% of all trauma patients by 2050. Delays in recognizing the special needs of older trauma patients may result in suboptimal care. Postinjury complications in elderly trauma patients negatively impact survival and contribute to longer lengths of stay in hospital (LOS) among survivors and nonsurvivors than in younger trauma patients. Among other interventions, a comprehensive geriatric assessment conducted by a dedicated geriatric trauma team may contribute to improved functional recovery after traumatic injury in elderly patients. A comprehensive geriatric assessment is a multidimensional, interdisciplinary diagnostic process to determine the medical, psychological and functional capabilities of a frail elderly person in order to develop a coordinated and integrated plan for management and longitudinal follow-up.

We previously reported on the implementation of a proactive geriatric trauma consultation service (GTCS) model, in which all older trauma patients receive a comprehensive geriatric assessment within 72 hours of admission. The goals of this model include the prevention and management of age-specific complications and early attention to discharge planning. In a before/after case series comparing clinical outcomes pre- and postimplementation of a GTCS, the GTCS was associated with significant reductions in delirium, consultation with psychiatry, consultations with internal medicine and discharge to a nursing home. There was also a trend toward decreased LOS in the intervention group. However, the potential impact may have been suboptimal as only 60% of all eligible patients were seen by the GTCS in the implementation phase; specifically, 28% of the patients were not seen because the referral process was not activated for unknown reasons. Other studies have shown that GTCS improves geriatric quality of care indicators and functional recovery.

Implementation is the initial process of embedding interventions within a setting; sustainability is the process by which interventions can continue to be delivered over time with the necessary elements built to support their delivery. Measurement of outcomes over time to determine continued benefit has been shown to support sustainability of a practice. Often, studies evaluate only the initial intervention adoption and implementation. Sustained practice change and optimization of interventions are rarely investigated. In this study, we report on strategies used in the sustainability of the proactive GTCS service and on the outcomes of these efforts.

**METHODS**

**Study sample and setting**

St Michael’s Hospital is a level 1 trauma centre providing quaternary trauma services in an academic setting. The GTCS implementation study period participants (September 2007–March 2010) have been described previously, and participants with complete data (n = 246) were used for comparison. In this sustainability study, all patients aged 65 years or older admitted to the trauma service between July 2012 and December 2013 were eligible, excluding those who were dead on arrival or who died in the emergency department (ED). Ethics approval for the study was granted by the Research Ethics Board at St. Michael’s Hospital.

**Sustainability interventions**

To identify gaps in the referral process, we used 3 steps. First, one of us (R.A.) conducted a workflow assessment, reviewing the identification, referral and referral handling processes over 8 sessions to achieve data saturation. This information was then used to map the GTCS referral process. Second, we conducted individual semi-structured interviews with the 2 frontline staff who identify eligible patients and with the administrative staff who processes the completed referral in order to understand the barriers and facilitators to referral completion. Third, we distributed an online survey to 12 key individuals who were part of either the GTCS or trauma teams. The survey asked stakeholders which components of the existing referral process should be kept and which should not be kept. As a result of this 3-step process to identify gaps in the referral process, several changes were implemented in the GTCS process. These changes included keeping a log of the referrals, simplifying the referral form, linking the referral form on the hospital intranet, developing a standard operating procedure and assigning referral responsibility to an alternative individual if the regular staff is absent. The GTCS continued to be staffed by an advanced practice nurse in geriatrics, a geriatrician and occasionally a resident physician. There were no changes in the funding model.

**Data sources**

Data sources for sustainability and clinical outcomes included paper medical records, electronic medical records and the hospital trauma registry database. All eligible patients were approached prospectively for consent to abstract and analyze data on clinical outcomes. Demographic data and clinical outcomes for all patients admitted to the trauma service at St. Michael’s Hospital are systematically tracked in a prospectively maintained database: the St. Michael’s Hospital Trauma Registry Database. The registry is routinely reviewed by the Canadian Institute for Health Information and the National Trauma Data Bank in the United States to ensure accuracy of the registry database.
**Data abstraction**

Data were abstracted on the basis of the study protocol guidelines by 1 of 3 designated researchers (R.A., H.Y.L., or C.V.). A subset was abstracted in duplicate to ensure interrater reliability was achieved for geriatric-specific outcomes.

**Sustainability outcomes**

The outcomes of interest for the sustainability study were volume of patients seen by the GTCS, percentage of patients who were eligible to be seen by the GTCS but who were not assessed, and percentage of GTCS recommendations that were adopted by the primary team. We determined volume based on the mean number of patients seen per month by the GTCS. We categorized the reasons why patients in the sustainability phase were not seen by the GTCS within the first 72 h of admission into 1 of 7 groups: died within first 72 h, referral not sent, discharged from hospital within the first 72 h, transferred to a different service within the first 72 h, imminent death or withdrawal of care anticipated, referral sent but reason not seen, or unknown. The recommendation adherence rate was defined as a proportion of the number of recommendations implemented among the total number of recommendations made.

**Clinical outcomes**

Clinical outcomes of interest were geriatric-specific inhospital complications (i.e., falls, delirium, physical restraint use), trauma quality indicators and discharge to nursing home. Delirium was identified via a validated medical chart abstraction instrument. Trauma quality indicators of interest included decubitus ulcer, thromboembolism, myocardial infarction, pneumonia, cardiac arrest and missed injuries. Discharge to nursing home was defined as a transfer from the trauma service directly to a facility designed for people requiring the availability of 24-h nursing care and supervision within a secure setting, as defined by the Ontario Ministry of Health and Long-Term Care.

**Statistical analysis**

We calculated means and standard deviations for continuous variables, and absolute and relative frequencies were measured for discrete variables. Continuous variables were compared using the Student t test, and we evaluated proportions using the $\chi^2$ or Fisher exact test, as appropriate. We considered results to be significant at $p < 0.05$. Statistical comparison of clinical outcomes between the implementation and sustainability phases was not performed owing to different methods in participant recruitment. All data were analyzed using SAS software version 9.1.

**RESULTS**

In this sustainability phase, 89.9% (124 of 138) of patients aged 65 or older admitted to the trauma service received a comprehensive geriatric assessment compared with only 59.4% during the implementation phase ($p < 0.001$). The volume of patients seen per month increased in the sustainability phase to $6.9 \pm 2.7$ compared with $4.9 \pm 2.1$ during the implementation phase. The distribution of reasons for no assessment by the GTCS in the sustainability phase ($n = 14$) are outlined in Table 1. Notably, there were no instances where a referral was not sent for an eligible patient.

Seventy-seven of 138 patients (55.8%) were prospectively recruited and consented for data abstraction and analysis of clinical outcomes (26 declined participation, 14 died before the consent process, 10 did not return the consent form, 11 did not consent for other reasons). Of the 77 patients, 76 were seen by the GTCS (1 patient was not seen because imminent death was anticipated). The participants in the sustainability period were older and had more comorbidities, but had similar injury severity as participants in the implementation period (Table 2). This may have been...
because of different strategies used for participant recruitment; that is, retrospective in the implementation phase and prospective in the sustainability phase. Thus, we did not perform statistical comparisons. Rates for various outcomes and quality indicators are shown in Table 3. In total, 1.4% of participants were discharged to a nursing home.

At least 1 recommendation was made by the GTCS in 73 of the 76 patients. The mean number of issues identified in the implementation phase participants (4.3) was similar to that in the sustainability phase participants (4.7). The most common issues addressed by the GTCS were delirium/dementia (83.0%) and mobilization (71.4%; Table 4). The adherence by the trauma team to recommendations made by the GTCS in the sustainability phase was 88.2% and 93.2% in the implementation phase.

**DISCUSSION**

Our centre and others have previously shown that proactive geriatric consultation for older patients admitted with trauma may improve geriatric quality indicators and functional recovery.4,6,7 To our knowledge, this is the first study to report on the sustainability of this type of care model. We showed that the combination of a workflow assessment, semistructured interviews and survey of stakeholders is a useful means to optimize the referral process for comprehensive geriatric assessment, such that all eligible patients were identified and referred. Sustainability of a GTCS was shown by volume, staffing and recommendation adherence.

**Strengths and limitations**

Strengths of this study include the evaluation of the sustainability of a model of care beyond the initial intervention adoption and implementation. A limitation of this study was that the participant recruitment strategy in the implementation phase was retrospective and that in the sustainability phase was prospective; this resulted in differences in the characteristics of the participants, which precluded statistical comparison of clinical outcomes. It is thus unclear whether the improvements in geriatric quality indicators were sustained. The patients in the sustainability phase had more comorbidities and were older than those in the implementation phase, and thus were likely at higher risk for adverse outcomes.

Collaboration between trauma and geriatric specialists needs to continue to develop innovations and process-based quality indicators to meaningfully improve outcomes in elderly patients. Future directions include standardizing a comprehensive set of quality indicators that can be incorporated prospectively into existing trauma registries.

**CONCLUSION**

Workflow assessment is a useful means to optimize the referral process for comprehensive geriatric assessment. Sustainability of a geriatric trauma consultation service, as defined by volume, staffing and recommendation adherence is attainable.

**Contributors:** C. Wong designed the study and acquired the data. R. AlAtia, A. McFarlan, H. Yee and C. Valiaveettil acquired and analyzed the data, which B. Haas also analyzed. C. Wong and B. Haas wrote the article, which all authors reviewed and approved for publication.

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**Competing interests:** None declared.
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Antegrade versus retrograde nailing techniques and trochanteric versus piriformis intramedullary nailing entry points for femoral shaft fractures: a systematic review and meta-analysis

Background: There are several different techniques commonly used to perform intramedullary (IM) nailing of the femur to fix femoral fractures. We sought to identify significant differences in outcomes of studies comparing 1) trochanteric and piriformis entry and 2) antegrade and retrograde entry in IM nailing of the femur.

Methods: We searched MEDLINE, Cochrane and Embase databases and the Orthopaedic Trauma Association and American Academy of Orthopaedic Surgeons websites for comparative studies published from inception to November 2015. Criteria used to select articles for detailed review included use of antegrade and retrograde entry point or use of trochanteric and piriformis entry point for IM nailing of the femur in adult patients. Functional and technical outcomes were extracted from accepted studies.

Results: We identified 483 potential studies, of which 52 were eligible. Of these, we included 13 publications and 2 abstracts (2 level I, 7 level II and 6 level III studies). Trochanteric entry significantly reduced operative duration by 14 min compared with piriformis entry ($p = 0.030$). Retrograde nailing had a greater risk of postoperative knee pain than antegrade nailing ($p = 0.05$). On the other hand, antegrade nailing had significantly more postoperative hip pain ($p = 0.003$) and heterotopic ossification ($p < 0.001$) than retrograde nailing. No significant differences in functional outcomes were observed.

Conclusion: Although some significant differences were found, the varying quality of studies made recommendation difficult. Our meta-analysis did not confirm superiority of either antegrade over retrograde or trochanteric over piriformis entry for IM nailing of the femur.

Level of evidence: Level III therapeutic.

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Contexte : Plusieurs techniques différentes sont couramment utilisées pour l'enclouage intramédullaire (IM) du fémur afin d’immobiliser les fractures fémorales. Nous avons voulu dégager les différences significatives sur le plan des résultats d’études ayant comparé 1) l’entrée par le trochanter et par la fossette piriforme et 2) l’entrée par voies antérogade et rétrograde pour l’enclouage IM du fémur.


Résultats : Nous avons recensé 483 études potentielles, dont 52 se sont révélées admissibles. Parmi elles, nous avons inclus 13 publications et 2 résumés (2 études de niveau I, 7 de niveau II et 6 de niveau III). Le point d’entrée par le trochanter a significativement réduit la durée des interventions, soit de 14 min, comparativement à l’entrée par la fossette piriforme ($p = 0.030$). L’enclouage rétrograde a comporté un risque plus élevé de douleur postopératoire au genou comparativement à l’enclouage antérogade ($p = 0.05$). Par ailleurs, l’enclouage antérogade a donné lieu à significativement plus de douleur à la hanche ($p = 0.003$) et d’ossification hétérotopique ($p < 0.001$) postopératoires comparativement à l’enclouage rétrograde. Aucune différence significative n’a été observée sur le plan des résultats fonctionnels.
Intramedullary (IM) nailing is a proven and effective method for the management of femoral shaft fractures.1,2 The appropriate entry point can make nail insertion easier, affect fracture reduction, and may prevent complications.1,3 Although both ends of the femur are suitable, there is debate in the literature concerning antegrade versus retrograde entry and, in antegrade nailing, the choice of the piriformis fossa versus greater trochanter as an entry point.1,4 Antegrade nailing is useful for the treatment of proximal femoral fractures; however, studies have found it to result in damage to the hip abductors and sometimes the pudendal nerve if the patient is in the supine position on a fracture table.5 Retrograde nailing is advantageous for patients with multiple injuries, patients sustaining ipsilateral femoral neck and shaft fractures and obese patients;6 however, it may be accompanied by higher rates of knee pain and lower rates of union.7 The entry point for antegrade nailing is also controversial, with advocates for both piriformis and trochanteric entry.4,8,9 The piriformis fossa is colinear with the medullary canal, allowing for straight nails to be inserted easily. However, the piriformis is difficult to access in obese patients, leading to interest in the greater trochanter as an alternative antegrade entry point.1 To our knowledge, a comprehensive systematic review or meta-analysis to summarize the effects of various entry points for IM nailing of the femur has not been performed.

The purpose of this study was to identify significant differences in outcomes of studies comparing 1) trochanteric and piriformis entry and 2) antegrade and retrograde entry in IM nailing of femoral shaft fractures. We conducted a systematic review and meta-analysis using randomized controlled trials (RCTs) and prospective and retrospective comparative studies assessing rates of reoperation, dynamization, union, malalignment, nonunion, delayed union, pain, complications, mortality, operative duration, blood loss and functional outcomes in patients with femoral shaft fractures.

METHODS

Eligibility criteria

Three authors (F.N.H., A.S. and P.K.) reviewed each article independently and determined their eligibility based on the following preset inclusion criteria: use of antegrade, retrograde, trochanteric entry or piriformis entry for IM nailing of the femur in adult (age >18 yr) patients. Based on the search strategy developed, 3 authors (F.N.H., A.S. and P.K.) independently screened the results based on title and abstract alone and then screened all potentially eligible articles via full text. Disagreements were resolved by a consensus meeting.

Search strategy

Comparative studies in English were identified through a systematic search of MEDLINE, Embase, and Cochrane databases from inception to November 2015. The database search strategy was “femur AND fracture AND nail AND (antegrade OR retrograde).” The search strategy used was broad in order to encompass all potentially relevant articles. We examined the bibliographies of retrieved studies. We also searched the Orthopaedic Trauma Association (OTA) and American Academy for Orthopaedic Surgeons (AAOS) websites.

Assessment of study quality

Eligible studies were read in full by 3 authors (F.N.H., A.S. and P.K.). Each author independently assessed the methodological quality of included studies using the Cochrane Bone, Joint and Muscle Trauma Group reporting quality assessment tool.10 This 12-item questionnaire assesses the methodological quality of reports of RCTs. The final reported scores for each study were determined by consensus.

Data abstraction

The relevant data were extracted from each study and recorded in a database. Information on the manufacturer and type of IM nails; number of patients and femoral shaft fractures; patient sex, age and body mass index (BMI); follow-up rate; functional outcome measures; operative duration; presence of pain; and rates of nonunion, malunion, reoperation, dynamization and femoral shortening was included.

Evaluation of agreement

Agreement among the 3 reviewers (F.N.H., A.S. and P.K.) on scoring the studies was evaluated using the \( \kappa \) statistic.
with a score of 0 indicating chance agreement and a score of 1 indicating perfect agreement among the raters.11

**Statistical analysis**

We calculated the mean difference for operative duration and used the standard deviation (SD) to estimate the variance. If the SD was not available, it was calculated using standard error derived from a p value. If p values were unavailable, the SD was estimated using the range. All calculations were made according to methodology in the Cochrane Handbook.10 The values obtained may be imprecise because the imputation methods used make assumptions about unknown data.10

We calculated risk ratios (RR) and 95% confidence intervals (CI) for the following dichotomous outcomes: union, nonunion/delayed union, malalignment (varus-valgus, longitudinal angular and rotational), femoral shortening, knee pain, hip/thigh pain, dynamization, heterotopic ossification and reoperations. A random-effects model was used to pool the relative risk estimates from these studies.12

Two-tailed tests of significance for treatment effects were used. We considered results to be significant at \( p < 0.05 \). RevMan software version 5.0 (The Nordic Cochrane Centre) was used to statistically analyze all pooled outcomes.

**Evaluation of heterogeneity**

To evaluate the extent to which the results of the subgroups differed from one another, stratified analyses and a statistical test of interaction were performed.13 The \( F \) statistic was used to quantify heterogeneity among studies, with an \( F \) value of 0%–40% representing low heterogeneity and values greater than 40% representing moderate to high heterogeneity.10 As a result, we evaluated heterogeneity on the basis of study design and overall study quality when \( F \) was above 40%.

**RESULTS**

We identified 483 potential studies. We eliminated 431 studies after reviewing their titles and abstracts, leaving 52 studies for full text screening. Following full text screening, we included a total of 13 publications and 2 abstracts, 4 of which compared greater trochanter with piriformis entry, and 11 of which compared antegrade with retrograde entry (Fig. 1). Our assessment of study quality is summarized in Table 1. Studies were excluded for several reasons, including a lack of an adequate comparator group and a lack of live human participants. Our review includes articles reporting on a total of 1140 femoral shaft fractures treated with antegrade or retrograde nailing and 267 femoral shaft fractures treated with antegrade nailing from the greater trochanter or piriformis fossa (Table 2 and Table 3).

**Sample demographics**

Overall, the population sampled was similar among studies and was representative of the typical femoral shaft fracture population. The mean age of patients ranged from 21.75 to 52.15 years. The percentage of male patients ranged from 55% to 91%. The BMI ranged from 24 to 29. Except for 1 study in each comparison, the studies followed patients for longer than 12 months. The follow-up rate, when reported, was 14%–100% (Table 2 and Table 3).

Among the studies comparing antegrade with retrograde entry, 5 reported a greater number of distal femoral fractures in the retrograde group14,16–18,25 (Table 2). Although not significant, the reported BMI tended to be greater in patients assigned to trochanteric entry over piriformis entry4,8 (Table 3).

**Description of surgical techniques used for placement of IM nails**

Two surgical methods were used for placement of IM nails. In studies comparing trochanteric with piriformis entry, 2 used a fracture table for both groups (Table 3). In studies comparing antegrade with retrograde entry, 3 used...
a radiolucent table in both groups, 3 used a fracture table for antegrade nailing and a radiolucent table for retrograde nailing, and 1 used both methods for antegrade nailing and a radiolucent table for retrograde nailing (Table 2).

**Operative duration and blood loss**

Six studies comparing antegrade with retrograde entry in 396 fractures reported operative duration. Two studies did not report an SD, p values or ranges, so the mean difference could not be estimated; however, these 2 studies reported no significant difference in operative duration. Therefore, 4 studies reporting on 242 fractures were included in this analysis. There was no significant difference in operative duration between the 2 groups in this analysis (95% CI –21.31 to 15.61, p = 0.76, F = 85%; Fig. 2). Two studies comparing trochanteric with piriformis entry in 125 fractures reported operative duration. Operative duration was 14 min shorter when trochanteric entry was used than when piriformis entry was used, and this difference was significant (95%CI –26.67 to –1.34, p = 0.030, F = 0). Heterogeneity was not successfully resolved when the results were categorized by study design. Further exploration on the basis of overall study quality also did not resolve heterogeneity.

Four studies estimated blood loss in patients treated with either antegrade or retrograde nailing (Table 4). The results could not be pooled owing to unreported p values and/or ranges. Ricci and colleagues reported significantly higher levels of blood loss in patients treated with antegrade nailing, while Ostrum and colleagues, Tornetta and Tiburzi, and Dougherty and colleagues found no significant differences.

**Union**

Four studies reported rates of union and delayed/nonunion in patients treated with trochanteric or piriformis nailing (Table 5). One study did not indicate the number of patients allocated to each treatment arm and was excluded from this analysis. Therefore, 3 studies reporting on 233 fractures were included. There was no significant difference between the 2 treatment groups.

Six studies examining 576 fractures reported rates of union and delayed/nonunion in patients treated with either antegrade or retrograde IM nailing (Table 4). There were no significant differences found among the studies between the 2 treatment groups.

**Malalignment and femoral shortening**

We defined malalignment as ≥ 5° of deformity in any plane. Two studies examining 125 fractures treated with either trochanteric or piriformis nailing reported rates of malalignment (Table 5). There was no significant difference between the 2 treatment groups (RR 2.3, 95% CI 0.57–9.34, p = 0.24, F = 0%). Six studies examining 693 fractures treated with either antegrade or retrograde nailing reported rates of malalignment (Table 4). There was no significant difference between the 2 treatment groups (RR 0.9, 95% CI 0.57–1.56, p = 0.82, F = 42%). Heterogeneity was not successfully resolved when the results were categorized by study design. Further exploration on the basis of overall study quality also did not resolve heterogeneity. Reported rates of

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**Table 1. Quality of the 13 comparative studies assessed using the Cochrane Bone, Joint and Muscle Trauma Group reporting quality assessment tool**

<table>
<thead>
<tr>
<th>Question</th>
<th>κ (no. valid cases)*</th>
<th>Asymptomatic SE†</th>
<th>Approx. #</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Was the assigned treatment adequately concealed before allocation?</td>
<td>0.27 (10)</td>
<td>0.11</td>
<td>1.16</td>
<td>0.25</td>
</tr>
<tr>
<td>Were the outcomes of participants who withdrew described and included in the analysis (intention to treat)?</td>
<td>0.09 (13)</td>
<td>0.09</td>
<td>0.74</td>
<td>0.46</td>
</tr>
<tr>
<td>Were the outcome assessors blinded to treatment status?</td>
<td>0.40 (13)</td>
<td>0.35</td>
<td>1.39</td>
<td>0.17</td>
</tr>
<tr>
<td>Were the treatment and control group comparable at entry? (likely confounders may be age, activity level)</td>
<td>0.22 (13)</td>
<td>0.23</td>
<td>1.08</td>
<td>0.28</td>
</tr>
<tr>
<td>Were the participants blind to assignment status after allocation?</td>
<td>1.00 (13)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Were treatment providers blind to assignment status?</td>
<td>1.00 (13)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Were care programmes, other than the trial options, identical?</td>
<td>0.22 (13)</td>
<td>0.20</td>
<td>1.11</td>
<td>0.27</td>
</tr>
<tr>
<td>Were inclusion and exclusion criteria clearly defined?</td>
<td>0.56 (13)</td>
<td>0.21</td>
<td>2.55</td>
<td>0.010</td>
</tr>
<tr>
<td>Were the interventions clearly defined?</td>
<td>0.40 (13)</td>
<td>0.35</td>
<td>1.39</td>
<td>0.17</td>
</tr>
<tr>
<td>Were the outcome measures used clearly defined (by outcome)?</td>
<td>0.40 (13)</td>
<td>0.35</td>
<td>1.39</td>
<td>0.17</td>
</tr>
<tr>
<td>Were diagnostic tests used in outcome assessment clinically useful (by outcome)?</td>
<td>1.00 (13)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Was the surveillance active, and of clinically appropriate duration?</td>
<td>0.40 (13)</td>
<td>0.35</td>
<td>1.39</td>
<td>0.17</td>
</tr>
</tbody>
</table>

SE = standard error.

*The κ values are reported for the 3 reviewers (F.N.H, A.S. and P.K.).
†Not assuming the null hypothesis.
‡Using the asymptotic standard error assuming the null hypothesis.
varus–valgus, longitudinal and rotational malalignment or deformity did not differ significantly between the 2 groups. Femoral shortening was defined as inequality in limb length ≥ 10 mm. Data from 3 studies\(^{16,19,20}\) comparing

### Table 2. Characteristics of included trials comparing antegrade with retrograde intramedullary nailing of the femoral shaft

<table>
<thead>
<tr>
<th>Study</th>
<th>Study design</th>
<th>Functional measurement</th>
<th>Treatment groups</th>
<th>No. femurs</th>
<th>Nailing technique</th>
<th>Mean age, yr</th>
<th>% male</th>
<th>BMI</th>
<th>ISS</th>
<th>% follow-up (range), mo</th>
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</thead>
<tbody>
<tr>
<td>Daglar et al.(^{21})</td>
<td>Level II quasi-randomized</td>
<td>Lysholm knee score</td>
<td>Antegrade (piriformis)</td>
<td>41</td>
<td>Radiolucent table</td>
<td>34</td>
<td>69</td>
<td>15.2</td>
<td>43</td>
<td>44 (25–80)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Retrograde</td>
<td>30</td>
<td>Radiolucent table</td>
<td>44.1</td>
<td>14.3</td>
<td>43</td>
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</tr>
<tr>
<td>Ostrum et al.(^{19})</td>
<td>Level II quasi-randomized</td>
<td>Antegrade (piriformis)</td>
<td>46</td>
<td>Fracture table, radiolucent table</td>
<td>26.6</td>
<td>61</td>
<td>24.6</td>
<td>85</td>
<td>7.28 (2.5–14.83)</td>
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<td></td>
<td>Retrograde (titanium femoral nail, Biomet)</td>
<td>54</td>
<td>Radiolucent table</td>
<td>29.4</td>
<td>63</td>
<td>26.4</td>
<td>87</td>
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<tr>
<td>Tornetta and Tiburzi(^{19})</td>
<td>Level II quasi-randomized</td>
<td>Antegrade (piriformis)</td>
<td>38</td>
<td>Fracture table</td>
<td>31</td>
<td>12.4 (4–42)</td>
<td>92</td>
<td></td>
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<td></td>
<td>Retrograde</td>
<td>31</td>
<td>Radiolucent table</td>
<td>33</td>
<td>12.5 (4–42)</td>
<td>97</td>
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<td>Toluse et al.(^{22})</td>
<td>Level II prospective cohort</td>
<td>Antegrade</td>
<td>20</td>
<td></td>
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<tr>
<td></td>
<td></td>
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<td>41</td>
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<tr>
<td>Herscovici et al.(^{16})</td>
<td>Level II prospective cohort</td>
<td>Antegrade (femoral nail, Synthes)</td>
<td>69</td>
<td>28.2</td>
<td>72</td>
<td>76</td>
<td>18.3 (12–59)</td>
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<tr>
<td></td>
<td></td>
<td>Retrograde (femoral nail, Synthes)</td>
<td>56</td>
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<tr>
<td>Dougherty et al.(^{25})</td>
<td>Level III retrospective</td>
<td>Antegrade</td>
<td>25</td>
<td>Fracture table</td>
<td>33.6</td>
<td>91</td>
<td>89</td>
<td>26 (3–112)</td>
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<td></td>
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<td>Retrograde</td>
<td>43</td>
<td>Radiolucent table</td>
<td>30.5</td>
<td>86</td>
<td>81</td>
<td>41 (3–148)</td>
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<td>Kuhn et al.(^{23})</td>
<td>Level III retrospective</td>
<td>Antegrade</td>
<td>35</td>
<td>Radiolucent table</td>
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<td>80</td>
<td>26.0</td>
<td>12.87 (3–38)</td>
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<tr>
<td></td>
<td></td>
<td>Retrograde</td>
<td>34</td>
<td>Radiolucent table</td>
<td>34.3</td>
<td>59</td>
<td>33.1</td>
<td>15.42 (3.5–68.25)</td>
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<tr>
<td>Ricci et al.(^{8})</td>
<td>Level III retrospective</td>
<td>Antegrade</td>
<td>134</td>
<td>32</td>
<td>69</td>
<td>70</td>
<td>23 (5–64)</td>
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<tr>
<td></td>
<td></td>
<td>Retrograde</td>
<td>147</td>
<td>34</td>
<td>73</td>
<td>71</td>
<td>23 (6–66)</td>
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<td></td>
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<tr>
<td>Salem et al.(^{16})</td>
<td>Level III retrospective</td>
<td>Antegrade (piriformis (JFN, Synthes; RFN, Synthes)</td>
<td>29</td>
<td>Radiolucent table</td>
<td>69</td>
<td>14.4 (4.4–24)</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Retrograde (DFN, Synthes: IMSC Nail, Smith &amp; Nephew)</td>
<td>33</td>
<td>Radiolucent table</td>
<td>64</td>
<td>13 (2.4–32.4)</td>
<td></td>
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</tr>
<tr>
<td>Ricci et al.(^{19})</td>
<td>Level III retrospective</td>
<td>Antegrade</td>
<td>183</td>
<td>Fracture table</td>
<td>31</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>Retrograde</td>
<td>172</td>
<td>Radiolucent table</td>
<td>33</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Murray et al.(^{17})</td>
<td>Level III retrospective</td>
<td>Antegrade</td>
<td>19</td>
<td>34.5</td>
<td>15.21 ±12.40</td>
<td>14</td>
<td>56.8</td>
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<td>14</td>
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<td>16.36 ±10.40</td>
<td>36.5</td>
<td></td>
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</table>

BMI = body mass index; DFN = distal femoral nail; HOOS = hip dysfunction and osteoarthritis outcome score; IMSC = intramedullary supracondylar; ISS = injury severity score; KOOS = knee injury and osteoarthritis outcome score; RFN = reamed/unreamed femoral nail; UFN = unreamed femoral nail.
antegrade with retrograde nailing in 140 fractures yielded no significant difference (RR = 0.6, 95% CI 0.16–1.98, \( p = 0.38, F = 35\% \)).

**Pain**

Rates of postoperative pain in the knee and hip/thigh were pooled from studies comparing antegrade with retrograde nailing. Three studies\(^{14,19,25}\) examining 291 fractures reported knee pain (Table 4). The results were significantly in favour of antegrade nailing (RR 0.4, 95% CI 0.25–0.61, \( p < 0.001, F = 15\% \); Fig. 3). Two studies\(^{14,25}\) examining 256 fractures reported hip/thigh pain (Fig. 2). The risk of having hip/thigh pain was significantly greater in those receiving antegrade nailing than in those receiving retrograde nailing (RR 4.3, 95% CI 1.66–11.10, \( p = 0.003, I^2 = 0\% \); Fig. 4). No studies examining trochanteric versus piriformis entry reported rates of postoperative pain.

**Reoperations and dynamization**

There were no significant differences in rates of reoperation (RR 1.0, 95% CI 0.57–1.72, \( p = 0.98, F = 5\% \)) or dynamization (RR 0.6, 95% CI 0.19–1.65, \( p = 0.30, F = 12\% \)) in studies comparing antegrade with retrograde nailing (Table 4).

**Functional outcomes**

The studies that reported functional outcomes used different tools for assessment. Therefore, the results could not be pooled. Three studies\(^{4,8,9}\) comparing trochanteric with piriformis nailing reported postoperative functionality (Table 5). None of the studies found significant differences. Archdeacon and colleagues\(^{24}\) reported significant differences in hip range of motion (ROM; \( p = 0.025 \)) favouring trochanteric nailing. Three studies\(^{16,17,29}\) that examined outcomes after antegrade or retrograde IM nailing reported postoperative functional outcomes (Table 4). Murray and colleagues\(^{17}\) reported that the Knee Injury and Osteoarthritis Outcome Scores were significantly worse (\( p = 0.005 \)) in the retrograde group (Table 4).

**Mortality and complications**

Reported deaths in both comparisons were found to be nonsignificant (Table 4 and Table 5).

Radiographic evidence of heterotopic ossification (HO) around the hip was reported in 3 studies\(^{19,23,25}\) comparing antegrade and retrograde nailing (Table 4). There was a significantly greater risk of HO with antegrade nailing than with retrograde nailing (RR 19.51, 95% CI 3.80–100.20, \( p < 0.001, F = 0\% \)) favouring retrograde nailing (Fig. 5); however, only 1 study\(^{23}\) reported on symptomology associated with HO. Of the 10 patients who had radiographic evidence of HO, only 1 had associated symptoms.

For the remainder of the complications, each study reported different outcomes, which could not be statistically pooled. Within the studies comparing antegrade with retrograde nailing, Ostrum and colleagues\(^{14}\) reported that a Trendelenburg gait was present in all 39 patients treated.

<table>
<thead>
<tr>
<th>Study</th>
<th>Study design</th>
<th>Functional measurement</th>
<th>Treatment groups</th>
<th>No. femurs</th>
<th>Nailing technique</th>
<th>Mean age, yr</th>
<th>% male</th>
<th>BMI</th>
<th>ISS</th>
<th>% follow-up</th>
<th>Mean follow-up (range), mo</th>
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</thead>
<tbody>
<tr>
<td>Stannard et al.(^{9})</td>
<td>Level I randomized</td>
<td>WOMAC</td>
<td>Trochanteric</td>
<td>59</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>84</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Piriformis</td>
<td>55</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10 (7–25)</td>
</tr>
<tr>
<td>Archdeacon et al.(^{26})</td>
<td>Level I randomized</td>
<td></td>
<td>Trochanteric</td>
<td>47</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>24</td>
</tr>
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<td>Piriformis*</td>
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<td></td>
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<td>18 (10–80)</td>
</tr>
<tr>
<td>Ricci et al.(^{8})</td>
<td>Level II prospective cohort</td>
<td>Lower extremity measure</td>
<td>Greater trochanter (Trigen TAN, Smith-Nephew)</td>
<td>38</td>
<td>Fracture table</td>
<td>28 (16–88)</td>
<td>66</td>
<td></td>
<td></td>
<td>24</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Piriformis (Trigen FAN, Smith-Nephew)</td>
<td>53</td>
<td>Fracture table</td>
<td>29 (16–79)</td>
<td>55</td>
<td></td>
<td></td>
<td>24</td>
<td>18 (18–45)</td>
</tr>
<tr>
<td>Starr et al.(^{4})</td>
<td>Level II quasirandomized</td>
<td>Harris hip score</td>
<td>Trochanteric (Long Gamma Nail version 2, Howmedica)</td>
<td>17</td>
<td>Fracture table</td>
<td>37 (19–60)</td>
<td>29</td>
<td></td>
<td>15</td>
<td>16</td>
<td>76</td>
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<td></td>
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<td>Piriformis (Russel-Taylor Recon Nail, Smith-Nephew)</td>
<td>17</td>
<td>Fracture table</td>
<td>32 (19–45)</td>
<td>26</td>
<td></td>
<td>15</td>
<td>88</td>
<td>15 (12–28)</td>
</tr>
</tbody>
</table>

BMI = body mass index; FAN = femoral antegrade nail; ISS = injury severity score; TAN = trochanteric antegrade nail; WOMAC = Western Ontario and McMaster Universities Arthritis Index.

*Not reported.
Table 4. Summary of outcome measures for antegrade versus retrograde studies

<table>
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<tbody>
<tr>
<td>Operative duration</td>
<td>NS</td>
<td>$p &lt; 0.05$‡</td>
<td>$p = 0.029$§</td>
<td>NS</td>
<td>$p &lt; 0.01$</td>
<td>(unreamed)§</td>
<td></td>
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<tr>
<td>Estimated blood loss</td>
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<td>NS</td>
<td>NS</td>
<td>NS</td>
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<tr>
<td>Malalignment</td>
<td>NS</td>
<td>$p = 0.05$</td>
<td>$p = 0.05$‡</td>
<td>$p = 0.44$</td>
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<td>Functional outcome measure*</td>
<td>$p = 0.70$</td>
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<td>NS</td>
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<td>(KOOS)‡</td>
<td>NS (HOOS)</td>
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<td>Hip ROM</td>
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<tr>
<td>Trendelenburg gait</td>
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<td>Other medical complications†</td>
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HOOS = hip dysfunction and osteoarthritis outcome score; KOOS = knee injury and osteoarthritis outcome score; NS = not significant; ROM = range of motion.
*Functional outcome measures include lower extremity measure, Harris hip score, Lysholm score, Lysholm and Tegner score, Western Ontario and McMaster Universities Arthritis Index, Merle d’Aubigne and Postel, KOOS and HOOS.
†Other medical complications include: pulmonary embolism, fat emboli syndrome, deep venous thrombosis, postoperative haematoma, haemarthrosis, infection, hyperbilirubinemia, and pneumonia.
‡Favours antegrade nailing.
§Favours retrograde nailing.
with antegrade nailing and absent in the 35 patients treated with retrograde nailing. Differences between antegrade and retrograde treatment groups in other reported complications were not significant\(^{14,15,17,22,23,25}\) (Table 4).

In studies examining trochanteric versus piriformis nailing, Stannard and colleagues\(^7\) reported greater HO of the hip in the piriformis group. This difference was not significant \((p = 0.10; \text{Table 5})\).

**DISCUSSION**

The results of this systematic review and meta-analysis suggest that retrograde nailing is favourable over antegrade nailing in terms of hip pain and HO of the hip. However, the results also are in favour of antegrade nailing with respect to knee pain. Moreover, there was level-II\(^14\) evidence showing Trendelenburg gait, favouring retrograde nailing, and level-III\(^17\) evidence showing significant differences in knee function and ROM, favouring antegrade nailing. The only significant difference in the trochanteric versus piriformis pooled data was operative duration, which favoured trochanteric entry. There was also level-I evidence showing significant differences in hip ROM, favouring trochanteric nailing.

Studies show that the incidence of postoperative knee pain after retrograde nailing can be as high as 70%.\(^7,29\) Our

![Fig. 2. Trials comparing operative duration in patients treated with antegrade or retrograde nailing of the femur. CI = confidence interval; SD = standard deviation.](image)

**Table 5: Summary of outcome measures for trochanteric versus piriformis studies**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Archdeacon et al.(^{24}) Level I randomized</th>
<th>Stannard et al.(^8) Level I randomized</th>
<th>Starr et al.(^3) Level II quasirandomized</th>
<th>Ricci et al.(^8) Level II prospective cohort</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operative duration</td>
<td>(p = 0.26)</td>
<td>(p = 0.15)</td>
<td>(p = 0.3)</td>
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<tr>
<td>Estimated blood loss</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Malalignment</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>Union</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>Delayed union</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>Nonunion</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>Malunion</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deaths</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>Functional outcome measure*</td>
<td>NS</td>
<td>(p = 0.60)</td>
<td>NS</td>
<td>(p = 0.025)</td>
</tr>
<tr>
<td>Hip ROM</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Knee ROM</td>
<td>(p = 0.60)</td>
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<td></td>
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</tr>
<tr>
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<td>Dynamization</td>
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<tr>
<td>Femoral shortening</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Reoperations</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Heterotopic ossification around the hip</td>
<td>NS</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Pudendal nerve injury</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trendelenburg gait</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other medical complications†</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NS = nonsignificant; ROM = range of motion.

*Functional outcome measures include lower extremity measure, Harris hip score, Lysholm score, Lysholm and Tegner score, Western Ontario and McMaster Universities Arthritis Index, Merle d’Aubigne and Postel, knee injury and osteoarthitis outcome score and hip dysfunction and osteoarthitis outcome score.

†Other medical complications include pulmonary embolism, fat embolus syndrome, deep venous thrombosis, postoperative hematomata, hemorrhaxis, infection, hyperbilirubinemia and pneumonia.

†Favours greater trochanteric nailing.
study revealed that a statistically greater number of patients undergoing retrograde nailing than antegrade nailing experienced knee pain. The etiology of this pain has been attributed to events such as concomitant patellar or ligamentous injury from the initial trauma, sepsis of the knee joint, distal locking screws, quadriceps atrophy, or protruding nails. This may also explain the finding of Murray and colleagues, who showed that both knee function and ROM were significantly lower in patients treated with retrograde nailing. None of the studies had long enough follow-up to show an increased incidence of knee osteoarthritis (OA) with retrograde nailing. In the absence of a prominent nail within the knee joint or septic arthritis, the risk of knee OA is likely minimal; however, the long-term incidence of OA following retrograde nailing remains unknown. It is important to note that none of the studies reviewed in this meta-analysis reported any occurrence of septic arthritis.

Whereas Ostrum and colleagues and Tornetta and Tiburzi reported no significant differences between antegrade and retrograde nailing in terms of blood loss, Ricci and colleagues found levels of estimated blood loss to be significantly lower in patients treated with retrograde than antegrade nails. They attributed this finding to the use of a tourniquet during retrograde nail insertion; however, tourniquet usage was not mentioned in the other included studies.

![Fig. 3. Trials comparing knee pain in patients treated with antegrade or retrograde nailing of the femur. CI = confidence interval; M-H = Mantel-Haenszel.](image)

![Fig. 4. Trials comparing hip/thigh pain in patients treated with antegrade or retrograde nailing of the femur. CI = confidence interval; M-H = Mantel-Haenszel.](image)

![Fig. 5. Trials comparing heterotopic ossification around the hip in patients treated with antegrade or retrograde nailing of the femur. CI = confidence interval; M-H = Mantel-Haenszel.](image)
studies. Additional studies have also shown retrograde nailing to be associated with minimal blood loss, which may be a result of reduced operative duration and soft tissue dissection. Another important finding among studies in this comparison was the greater presence of HO around the hip in patients treated with antegrade than retrograde nailing. This has been attributed to the requirements of additional muscle dissection and reamings from the femoral canal deposited in the soft tissues around the hip. However, only 1 study reported on symptoms caused by the HO, and none of the studies reported that patients required excision of HO. Therefore, the increase in HO with antegrade femoral nailing is not likely to be clinically significant. Furthermore, antegrade nailing frequently causes injury to the gluteus medius and minimus muscles and the superior gluteal nerve, causing abduction weakness. Weak abductors may be easily fatigued when challenged, consequently resulting in pain and a Trendelenburg gait. This is a possible explanation for the statistically greater numbers of patients experiencing hip pain in the antegrade than the retrograde nailing group and the finding of a Trendelenburg gait in all patients treated with antegrade nails in the study by Ostrum and colleagues.

No differences in union, delayed/nonunion, malalignment or femoral shortening were observed between antegrade and retrograde nailing. Previous studies evaluating retrograde nailing also showed rates of healing that were comparable to those of antegrade nailing. Differences in other complications were found not to be significant. However, this could be attributed to the small sample size and the fact that not all authors reported the same complications.

Our analysis showed differences in operative duration between trochanteric and piriformis nailing treatment groups, and 1 level-I study showed significant differences in hip ROM, favouring trochanteric nailing. Cadaver studies have shown that nailing through the piriformis fossa penetrated muscles and tendons of the hip abductors and external rotators, including the gluteus medius muscle. Replacement of these contractile fibres in living patients can have consequences for muscle function, and choosing a more lateral entry point, such as the greater trochanter, may be beneficial both for hip function and ease of access for the surgeon.

Limitations

Our study had several limitations. In order to reduce bias and heterogeneity in the results, it would have been best to use only level-I studies or RCTs. However, there is a paucity of such trials examining viable entry points for femoral nailing, perhaps owing to the difficulty in performing these studies in acute orthopaedic trauma patients. Although several of the included studies were randomized, blinding or randomization was often inadequate and included a relatively small number of patients. Combining the results of RCTs and lower level studies, as presented here, greatly reduces the external validity of the pooled analysis. Moreover, the studies examined different outcomes of interest and often reported these outcomes differently, which made it difficult to statistically pool data and decreased the available sample size for each outcome. There was also variation among studies in terms of surgical technique, which may have contributed to heterogeneity and bias. Finally, 8 of the 15 studies had a loss to follow-up greater than 10%. Despite these pitfalls, we were able to elucidate some key findings from the included studies, which may be a helpful starting point for more methodologically rigorous studies.

CONCLUSION

Our meta-analysis did not confirm superiority of either antegrade over retrograde nailing, or trochanteric over piriformis entry in IM nailing of the femur. The 15 included studies varied in quality and outcomes reported, and thus higher-quality studies are required to clearly establish any recommendations. We suggest that surgeons use their best judgment as to the choice of entry point based on surgeon comfort with the technique and on patient and fracture characteristics.

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Contributors: N. Hussain, E. Schemitsch, A. Sternheim and P. Kuzyk designed the study. N. Hussain, F. Hussain, C. Sermer and P. Kuzyk acquired the data, which all authors analyzed. N. Hussain, F. Hussain, C. Sermer, H. Kamdar and P. Kuzyk wrote the article, which all authors reviewed and approved for publication.

References

Analysis of contributing factors influencing thromboembolic events after total knee arthroplasty

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Background: Venous thromboembolic events (VTE) are a known and well-described complication following total knee arthroplasty (TKA). We sought to validate the American College of Chest Physicians thromboprophylaxis recommendations after elective TKA, paying special attention to our dose adjustments for weight, and their impact on VTE in our population.

Methods: We retrospectively investigated risk factors in patients undergoing TKA, focusing mainly on symptomatic VTE occurrence rates from deep vein thrombosis (DVT) or pulmonary embolism (PE). The anticoagulation protocol consisted of starting low molecular weight heparin (LMWH) therapy, with dalteparin administered 12 h after surgery in patients who received general anesthesia or 24 h later in patients who received single-dose regional anesthesia.

Results: Data from 346 patients (mean age 66.8 [range 24–91] yr) who underwent primary or revision TKA depicted an overall symptomatic VTE rate of 15%. The proximal DVT rate was 1.7%, and the nonfatal PE rate was 0.9%. The mean time to VTE diagnosis was 5.6 days. The first dalteparin dose was administered 19.5 (range 10–48) h after surgery in patients without VTE and 22.6 (range 11.5–52) h after surgery in patients with VTE (p = 0.003). With a first dose of dalteparin administered 12 h postoperatively, patients presented significantly lower DVT and PE rates than if it was administered 24 h postoperatively (8.5% v. 16.3%, p = 0.048).

Conclusion: Delayed administration of LMWH has deleteriously impacted the VTE rate after TKA at our institution. Prompt initiation of LMWH (≤ 12 h after surgery) is appropriate, without increasing the risk of major bleeding.

Contexte : Les événements thromboemboliques veineux (ETV) sont une complication connue et bien décrite de la chirurgie pour prothèse totale du genou (PTG). Nous avons voulu valider les recommandations de l’American College of Chest Physicians en matière de thromboprophylaxie après la PTG non urgente en portant une attention particulière à l’ajustement des doses selon le poids et à leur impact sur les ETV dans notre population.

Méthodes : Nous avons analysé de manière rétrospective les facteurs de risque chez des patients soumis à une PTG en nous attardant principalement aux taux d’ETV symptomatiques sous forme de thrombose veineuse profonde (TVP) ou d’embolie pulmonaire (EP). Le protocole d’anticoagulation prévoyait l’administration d’une héparine de bas poids moléculaire (HBPM), la dalteparine, 12 h après la chirurgie chez les patients ayant reçu une anesthésie générale ou 24 h après chez les patients ayant reçu une anesthésie locorégionale à dose unique.

Résultats : Les données provenant de 346 patients (âgés en moyenne de 66,8 ans [éventail 24-91 ans]) ayant subi une PTG primaire ou une révision de PTG ont révélé un taux d’ETV symptomatiques globaux de 15 %. Le taux de TVP proximal a été de 1,7 % et le taux d’EP non fatale a été de 0,9 %. Le temps moyen avant le diagnostic d’ETV a été 5,6 jours. La première dose de dalteparine avait été administrée 19,5 h (éventail 10–48 h) après la chirurgie chez les patients n’ayant pas présenté d’ETV et 22,6 h (éventail 11,5–52 h) après la chirurgie chez les patients ayant manifesté un ETV (p = 0.003). Avec une première dose de dalteparine administrée 12 h après l’intervention, les patients ont présenté des taux de TVP et d’EP significativement moindres que si elle leur avait été administrée 24 h après l’intervention (8,5 % c. 16,3 %, p = 0.048).

Conclusion : L’administration retardée de l’HBPM a produit des effets défavorables pour ce qui est des taux d’ETV après la PTG dans notre établissement. L’instauration rapide de l’HBPM (≤ 12 h après la chirurgie) est appropriée et n’accroît pas le risque d’hémorragie majeure.
The occurrence of venous thromboembolic events (VTE) following total knee arthroplasty (TKA) is a known and well-described complication. Without thromboprophylaxis, the rate of symptomatic and asymptomatic deep vein thrombosis (DVT) detected by venography following reconstructive knee surgery is 41%–84%, with proximal events presenting 5%–22% of the time. Pulmonary embolism (PE) is less frequent, with rates of 1.5%–10%, but it is associated with a mortality of 0.1%–1.7%. With appropriate thromboprophylaxis, the rate of symptomatic and asymptomatic DVT detected by venography or Doppler ultrasonography is 25.6%–38.1%, and the rate of proximal events is 1.3%–5.7%. With prophylaxis and considering only symptomatic VTE, the event rate is low but will not reach zero; the incidence of symptomatic VTE usually varies between 0.6% and 5.7%, that of DVT proximal to the knee varies between 0.33% and 2.1%, and that of PE varies between 0% and 1%. Previous studies present a wide range of disparity in the nature of the thromboprophylactic agent used, the hospital length of stay, the rehabilitation protocol and the duration of thromboprophylaxis.

Practice guidelines have been proposed by different scientific societies. The American College of Chest Physicians (ACCP) recommended that all patients undergoing TKA have thromboprophylaxis (low molecular weight heparin [LMWH], fondaparinux, or adjusted-dose vitamin K antagonist) for a minimum of 10 days after surgery. When using LMWH, the ACCP suggests giving the first dose either before or after surgery. On the other end of the spectrum, the American Academy of Orthopaedic Surgeons (AAOS) recommends thromboprophylaxis only if the patient is at risk for PE (previous VTEs, hereditary thrombophilia, hypercoagulable state or late mobilization after surgery). Acetylsalicylic acid (ASA), LMWH, fondaparinux, warfarin or no agents are among the choices recommended by the AAOS according to risk levels.

The present study was conducted to validate the ACCP thromboprophylaxis recommendations after elective TKA, paying special attention to our dose adjustments for weight, and their impact on VTE in our population compared with current literature. We also sought to identify risk factors specific to our patient characteristics, the thromboprophylaxis used and the surgical technique used.

**METHODS**

All patients undergoing elective primary TKA or revision TKA at our university-affiliated hospital between May 1, 2008, and Apr. 30, 2010, were potentially eligible to participate in the study. All patients who received thromboprophylaxis with dalteparin at a prophylactic dose for a period of 14 days after surgery in the reconstructive orthopaedic surgery unit constituted the study population. However, in patients heavier than 100 kg, the LMWH dose has been historically, but not systematically, increased by 50% in certain individuals at our institution, depending on the pharmacist’s opinion. Patients with a therapeutic dose of dalteparin (200 units/kg/d) or taking warfarin, fondaparinux, danaparoid, lepirudin, argatroban or other LMWH were excluded. The study received institutional approval and was conducted without contacting patients.

The primary outcome of the study was the rate of occurrence of symptomatic VTE, whether a DVT or PE, confirmed by objective testing during the 90-day postoperative period. DVT was diagnosed by means of Doppler ultrasonography, and PE was diagnosed with CT angiography and/or lung ventilation/perfusion scans. A retrospective systematic chart review was conducted to gather patient characteristics (age, sex, weight, height), thromboprophylaxis protocol (dosage of dalteparin, the anti-Xa levels when measured, the time between surgery and first dose of dalteparin) and surgical data (presence and duration of tourniquet, surgical technique, anesthesia type, the use of tranexamic acid in the perioperative period, primary v. revision TKA, blood transfusion of more than 2 units of packed red blood cells [PRBCs], a decrease of more than 2 g/dL in hemoglobin [Hb]). Specific risk factor assessment included a previous history of VTE, hormone therapy before surgery, active cancer in the last 6 months, thrombophilia and the interruption of LMWH before the 14th postoperative day. We collected the number of Doppler, CT angiography or lung ventilation/perfusion scans performed in the first 3 postoperative months in our centre. No routine screening tests for asymptomatic DVT or PE were performed at hospital discharge over the course of the study period.

Since 2007, thromboprophylaxis used at our institution following TKA has been almost exclusively dalteparin. The first dalteparin dose was administered 12 h after surgery in patients undergoing general anesthesia and 24 h later when single-dose regional anesthesia was preferred, or as otherwise specified by the orthopedic surgeon after closing the wound, mostly pertaining to subjective bleeding risks. The dalteparin treatment may have been interrupted over the 14 postoperative days in the presence of active bleeding, knee hemarthrosis, acute drop (> 2 g/dL) in Hb, or abnormal wound drainage, as defined at the discretion of the surgeon. A universal dalteparin dosage of 5000 units/d was prescribed with a downward or upward adjustment when body weight did not reach 45 kg or exceeded 100 kg. Anti-Xa level after the third dose of dalteparin was customarily assessed to make dosage adjustments when required under the supervision of the hospital pharmacist.

**Statistical analysis**

The aim of the study was to calculate the rate of occurrence of a symptomatic VTE in our population and to
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identify patient, pharmacological, surgical, or thrombo-
prophylaxis characteristics that were predictive of VTE.
Baseline quantitative variables are described using means
and standard deviations (SD) and compared using Stu-
dent t tests. Baseline categorical variables were analyzed
using $\chi^2$ or Fisher exact tests, as required. When assessing
results, we compared the variables of patients with and
without VTE using $\chi^2$, Fisher exact, or Student t test, as
required. Logistic regression analysis was used to evaluate
the association between VTE and predictor variables of
interest. These variables are reported as odds ratios (OR)
with associated 95% confidence intervals (CI). For all
analyses, differences were considered significant at $p <
0.05$. Statistical analysis was performed using SPSS ver-
sion 11.0 (SPSS Inc.). Data are expressed as means ± SD,
unless otherwise specified.

RESULTS

Between May 1, 2008, and Apr. 30, 2010, 371 patients
underwent primary and revision TKA, of whom 25 were
excluded for meeting 1 or more of the exclusion criteria
(Fig. 1), leaving 346 patients for inclusion in the study.
The mean age at surgery was 66.8 ± 10.2 (range 24–91)
years, most patients (216; 62%) were women, and the
mean body mass index (BMI) was 32.3 ± 6.3 (range
18–56). Patient characteristics are found in Table 1. The
number of patients with a known history of thrombo-
philia or active cancer in the last 6 months has not been
analyzed, given the small number of patients involved.

The multivariate analysis between age, sex and body
weight in patients experiencing a VTE did not highlight
any associations. Data on Anti-Xa level were available for
88 of 346 patients; 0% (0 of 12 patients) in the VTE

Fig. 1. Venous thromboembolic events (VTE) among patients in the study. DVT = deep vein thrombosis; PE = pul-
monary embolism; TKA = total knee arthroplasty; VT = vein thrombosis.
our service. No thromboembolic events were noted in patients receiving tranexamic acid \((n = 12)\) during TKA surgery. The application and duration of the tourniquet did not influence the incidence of VTE in either group \((p = 0.46\) and \(p = 0.68\)).

Delay of dalteparin administration after surgery was a significant risk factor for VTE in our study. The delay before receiving the first dose of dalteparin was 19.5 (range 10–48) hours in patients with no events and was 22.6 (range 11.5–52) hours among patients affected by a VTE \((p = 0.003)\). This delay in receiving the first dalteparin dose could be explained by surgeons’ prescription specifications without documented explanation. No clerical errors from the nursing staff were identified as a possible cause of delays in medication administration during the study period. The subgroup of patients who received their first dose of dalteparin within 12 h after surgery experienced a significantly lower rate of DVT and PE than the subgroup who received their first dose 24 h or more after surgery (8.5\% v. 16.3\%, \(p = 0.048\)). Table 3 shows that administering dalteparin 24 h after surgery did not decrease the risk of major bleeding. The subgroup of patients who had LMWH dose adjustments according to their body weight did not experience more bleeding events (Table 4) and experienced 50% fewer VTE (8.7\% v. 16.3\%; Table 1).

**DISCUSSION**

There is a wide disparity of thromboprophylaxis practices after orthopedic surgery, including variants in pharmaceutical drugs, mechanical devices, or a combination of both. Differences between thromboprophylaxis protocols

<table>
<thead>
<tr>
<th>Table 1. Demographic and clinical characteristics of study patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Characteristics</td>
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<tr>
<td>---------------------------------------------------------------</td>
</tr>
<tr>
<td>Characteristics</td>
</tr>
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<td>Dalteparine dosage/weight, units/kg</td>
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<td>Dalteparine interruption</td>
</tr>
</tbody>
</table>

BMI = body mass index; CI = confidence interval; HRT = hormone replacement therapy; LOS = length of stay in hospital; SD = standard deviation; TKA = total knee arthroplasty; VTE = venous thromboembolic event.

*Odds ratio 2.4.
make studies on the subject difficult to compare directly. Our study highlights that LMWH given for 14 days after primary and revision TKA was safe and led to a proximal DVT rate of 1.7% and a nonfatal PE rate of 0.9%. Furthermore, LMWH dose adjustment according to body weight less than 45 kg or exceeding 100 kg proved safe, as this did not increase bleeding risks. The continuation of hormone replacement therapy until surgery and the dalteparin administration 24 h after surgery instead of within 12 h of surgery potentially increased the risk for VTE in our cohort.

Few studies have reported higher than average VTE rates. Guan and colleagues\textsuperscript{12} obtained a 20% incidence of symptomatic VTE, while Kerr and Linkins\textsuperscript{6} reported a 4.6% incidence of PE. The incidence of symptomatic VTE at 3 months observed in our study (15%) was significantly higher than that reported in other studies,\textsuperscript{1,10} although it approached the VTE rate described by Guan and colleagues.\textsuperscript{12} However, it should be noted that our incidence of PE (0.9%) and our proximal DVT rate (1.7%) were well within the values usually reported in studies of VTE post-TKA. The main difference in the literature consulted was that the incidence of DVT (12.7%) consisted mostly of distal DVT (11.0%). Only 1 other study\textsuperscript{13} has an incidence of DVT as high after reviewing 310 cases of orthopedic surgery, 92 of which were TKA. Although the rate of distal DVT post-TKA was higher than that observed at our centre (22.8% v. 11.0%), our rate of proximal DVT was lower than theirs, but to a lesser extent (3.2% v. 1.7%).\textsuperscript{15}

Delaying the administration of postsurgical thromboprophylaxis increased the risk of VTE significantly in our cohort ($p = 0.003$). The subgroup of patients who received their first dose of dalteparin within 12 h after surgery presented with a significantly lower rate of DVT and PE than the subgroup who received their first dose 24 h or more after surgery ($p = 0.048$). Our VTE rate of 15% may have been influenced by the fact that thromboprophylaxis was administered a mean of 20 h after surgery. The actual time of LMWH administration after surgery is rarely reported, making comparisons among studies difficult. The mean delay in LMWH administration of 9 h after surgery in the study by Schiff and colleagues\textsuperscript{13} resulted in a DVT rate of 26% and no PE. The incidence of VTE was much lower (5.7%) in a study by Kerr and Linkins\textsuperscript{6} with an interval of 24 h between the first 2 doses.\textsuperscript{16} This did not increase bleeding risks. The continuation of hormone replacement therapy until surgery and the dalteparin administration 24 h after surgery instead of within 12 h of surgery potentially increased the risk for VTE in our cohort.

Table 2. Venous thromboembolic events characteristics, $n = 346$

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>No. (%) of patients or mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>VTE incidence</td>
<td>52 (15.0)</td>
</tr>
<tr>
<td>VTE type</td>
<td></td>
</tr>
<tr>
<td>Superficial vein thrombosis</td>
<td>7 (2.0)</td>
</tr>
<tr>
<td>DVT*</td>
<td>44 (12.7)</td>
</tr>
<tr>
<td>Distal*</td>
<td>38 (11.0)</td>
</tr>
<tr>
<td>Proximal</td>
<td>6 (1.7)</td>
</tr>
<tr>
<td>PE†</td>
<td>3 (0.9)</td>
</tr>
<tr>
<td>Nonfatal</td>
<td>3 (0.9)</td>
</tr>
<tr>
<td>Fatal</td>
<td>0</td>
</tr>
<tr>
<td>Delay in VTE detection, d post-op</td>
<td></td>
</tr>
<tr>
<td>Global</td>
<td>5.6 ± 3.9</td>
</tr>
<tr>
<td>Superficial vein thrombosis</td>
<td>10.0 ± 6.7</td>
</tr>
<tr>
<td>DVT</td>
<td>5.0 ± 2.9</td>
</tr>
<tr>
<td>PE</td>
<td>4.0 ± 0</td>
</tr>
<tr>
<td>Investigation for VTE</td>
<td></td>
</tr>
<tr>
<td>Doppler ultrasonography</td>
<td>120 (34.7)</td>
</tr>
<tr>
<td>Positive finding (out of 120)</td>
<td>51 (42.5)</td>
</tr>
<tr>
<td>Angio-CT or ventilation/perfusion lung scan</td>
<td>8 (2.3)</td>
</tr>
<tr>
<td>Positive finding (out of 8)</td>
<td>3 (37.5)</td>
</tr>
</tbody>
</table>

\# CT = computed tomography; DVT = deep vein thrombosis; PE = pulmonary embolism; SD = standard deviation; VTE = venous thromboembolic event.*Includes 2 patients with PE.
†Diagnosed by lung ventilation/perfusion scans; 1 patient had CT pulmonary angiography for confirmation.

Obesity is a risk factor identified in the literature,\textsuperscript{1,17} and a BMI above 30 is associated with a higher rate of DVT in the postoperative period.\textsuperscript{18} Obesity did not play a role in our study, nor in that of Samama and colleagues,\textsuperscript{5} but has been reported by Memtsoudis and colleagues\textsuperscript{19} and Guan and colleagues.\textsuperscript{12} The mean weight of 86 kg and mean BMI of 32 in our cohort are similar to those reported in other studies on TKA.\textsuperscript{8} A fixed dose of dalteparin is usually recommended for DVT prophylaxis, regardless of weight or BMI, in contrast to the doses prescribed for the treatment of DVT. Kucher and colleagues\textsuperscript{20} support this recommendation unless the patient has a BMI above 40. The 2008 ACCP guidelines suggest a dose based on weight for obese patients receiving LMWH prophylaxis or therapy (Grade
Although not standardized, the practice in our centre is to increase the dose of dalteparin empirically by 50% when body weight is greater than 100 kg (i.e., 7500 units instead of the standard 5000 units of dalteparin). This may in itself explain why obesity was not identified as a risk factor in our patients. The fact that our obese patients did not experience more VTE and bleeding events may support this practice and help downplay the risk of thromboembolism in this subpopulation.

Limitations

The main limitation of this study was its retrospective design looking at risk factors gathered in a set of selected TKA patients. No patients were contacted to cross-reference risk factors, comorbidities or VTE possibly diagnosed after leaving the hospital. Therefore, the accuracy of evaluating nonstandard events, such as bleeding events, was diminished. The patients with complete data for inclusion in the study were those undergoing treatment in 1 of 3 local hospitals; a small but unknown number of patients may have been excluded from our analysis owing to incomplete data because they presented elsewhere with a VTE. In a larger study with a similar design and conducted in the same city, 1540 patient records were evaluated to confirm that no patients presented with a VTE at a different hospital than the one where the original surgery took place.22 We therefore assumed the patient flow would be similar in our cohort. Patients requiring long-term ASA were not analyzed in our study. In the context of such limitations, our results have to be interpreted with caution.

Conclusion

Although thromboprophylaxis with LMWH was systematically prescribed and administered routinely to patients undergoing TKA in this cohort, the observed VTE rate was 15%. Delaying the administration of LMWH may have a deleterious impact on the VTE rate after TKA. A prompt initiation of LMWH (≤12 h after surgery) is more appropriate and does not increase the risk of major bleeding. Increasing the LMWH thromboprophylaxis dose in patients heavier than 100 kg was safe with comparable bleeding and VTE risks. New anticoagulants, such as rivaroxaban, apixaban and dabigatran, can represent another avenue to reduce the incidence of VTE in our patients admitted for elective primary and revision TKA. The influence of thromboprophylaxis administration timing after surgery must be considered in future analyses, ideally in a prospective study.

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Competing interests: None declared.

Contributors: S. Plante, D. Fréchette and J. Lefebvre designed the study. S. Plante and D. Fréchette acquired the data, which all authors analyzed. S. Plante, E. Belzile and D. Fréchette wrote the article, which all authors reviewed and approved for publication.

References

Innovative practice model to optimize resource utilization and improve access to care for high-risk and BRCA+ patients

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Background: Bilateral prophylactic mastectomy (BPM) has shown breast cancer risk reduction in high-risk/BRCA+ patients. However, priority of active cancers coupled with inefficient use of operating room (OR) resources presents challenges in offering BPM in a timely manner. To address these challenges, a rapid access prophylactic mastectomy and immediate reconstruction (RAPMIR) program was innovated. The purpose of this study was to evaluate RAPMIR with regards to access to care and efficiency.

Methods: We retrospectively reviewed the cases of all high-risk/BRCA+ patients having had BPM between September 2012 and August 2014. Patients were divided into 2 groups: those managed through the traditional model and those managed through the RAPMIR model. RAPMIR leverages 2 concurrently running ORs with surgical oncology and plastic surgery moving between rooms to complete 3 combined BPMs with immediate reconstruction in addition to 1–2 independent cases each operative day. RAPMIR eligibility criteria included high-risk/BRCA+ status, BPM with immediate, implant-based reconstruction, and day surgery candidacy. Wait times, case volumes and patient throughput were measured and compared.

Results: There were 16 traditional patients and 13 RAPMIR patients. Mean wait time (days from referral to surgery) for RAPMIR was significantly shorter than for the traditional model (165.4 v. 309.2 days, p = 0.027). Daily patient throughput (4.3 v. 2.8), plastic surgery case volume (3.7 v. 1.6) and surgical oncology case volume (3.0 v. 2.2) were significantly greater in the RAPMIR model than the traditional model (p = 0.003, p < 0.001 and p = 0.015, respectively).

Conclusion: A multidisciplinary model with optimized scheduling has the potential to improve access to care and optimize resource utilization.

Contexte : La mastectomie prophylactique bilatérale (MPB) donne lieu à une réduction du risque de cancer du sein chez les patientes à risque élevé/BRCA+. Toutefois, la priorité accordée aux cancers évolutifs alliée à une utilisation inefficace des ressources dans les blocs opératoires pose des défis lorsqu’il est question d’offrir la MPB sans retard. Pour relever ces défis, un programme d’accès rapide à la mastectomie prophylactique et à la reconstruction immédiate (RAPMIR) a été mis de l’avant. Le but de cette étude est d’évaluer le programme du point de vue de l’accès aux soins et de l’efficience.

Méthodes : Nous avons passé en revue de manière rétrospective tous les cas de patientes à risque élevé/BRCA+ ayant subi une MPB entre septembre 2012 et août 2014. Les patientes ont été scindées en 2 groupes : 1 groupe a été soumis au modèle thérapeutique standard et l’autre, au modèle RAPMIR. Le modèle RAPMIR met à contribution 2 blocs opératoires fonctionnant concomitamment où l’oncologie chirurgicale et la chirurgie plastique alternent entre les salles pour réaliser 3 MPB concurremment avec des reconstructions immédiates, en plus d’un ou 2 autres cas distincts à chaque journée opératoire. Les critères d’admissibilité à RAPMIR incluaient : risque élevé/BRCA+, MPB avec reconstruction immédiate à l’aide d’implants et admissibilité à la chirurgie d’un jour. On a mesuré et comparé les temps d’attente, les volumes de cas et le nombre de patientes.

Résultats : L’étude a regroupé 16 patientes soumises au modèle standard et 13 au modèle RAPMIR. Le temps d’attente moyen (nombre de jours entre la consultation et la chirurgie) pour RAPMIR a été significativement plus bref que pour le modèle standard (165,4 v. 309,2 jours, p = 0,027). Le nombre de patientes/jour (4,3 v. 2,8), le volume des cas de chirurgie plastique (3,7 c. 1,6) et le volume des cas d’oncologie chirurgicale (3,0 c. 2,2) ont été significativement plus élevés avec le modèle RAPMIR qu’avec le modèle classique (p = 0,003, p < 0,001 et p = 0,015, respectivement).

Conclusion: Un modèle multidisciplinaire reposant sur une synchronisation optimisée a le potentiel d’améliorer l’accès aux soins et l’utilisation des ressources.
There is a strong body of evidence supporting the use of bilateral prophylactic mastectomy (BPM) as a means of reducing the risk of breast cancer in moderate- to high-risk women, including those with \( \text{BRCA1} \) and \( \text{BRCA2} \) mutations (\( \text{BRCA} \)).\(^1\) Although there are no randomized trials, a 2010 Cochrane review found that BPM was effective at reducing both the incidence of, and death from, breast cancer.\(^3\) In their retrospective review, Hartmann and colleagues\(^1\) found a risk reduction of 89.5% and 90% for the moderate- and high-risk groups, respectively.\(^1\) Risk reductions of approximately 90% for BPM in patients with \( \text{BRCA} \) mutations have been noted in other literature as well.\(^1\) Schrag and colleagues\(^6\) leveraged Markov modelling\(^7\) and estimated that a 30-year-old woman carrying a \( \text{BRCA} \) mutation would gain 2.9–5.3 years of life expectancy from prophylactic mastectomy.

In 2007, the Society for Surgical Oncology issued a position statement addressing prophylactic mastectomy.\(^7\) The potential indications for BPM are a known mutation of \( \text{BRCA1} \) or \( \text{BRCA2} \) (or other susceptibility genes), strong family history (multiple first-degree relatives), or high-risk histology (atypical ductal hyperplasia [ADH], atypical lobular hyperplasia, or lobular carcinoma in situ [LCIS]).\(^7\) There may also be an indication for BPM in other high-risk groups, such as women with non-\( \text{BRCA} \) hereditary breast cancer syndromes (e.g., Li–Fraumeni syndrome) or in women who received mantle radiation in the context of Hodgkin lymphoma treatment.\(^8\)

**Interest and satisfaction with prophylactic mastectomy**

The rate of contralateral prophylactic mastectomy (CPM) has been increasing in the United States and Canada in recent years.\(^9\)–\(^12\) The National Cancer Institute Surveillance, Epidemiology, and End Results (SEER) registry began tracking CPM in 1998. Between 1998 and 2003 the CPM rate increased 150% for patients with invasive breast cancer treated surgically.\(^11\) Using the American College of Surgeons’ National Cancer Database, Yao and colleagues\(^13\) reported a comparable increase, where the rate of CPM increased from 0.7% in 1998 to 4.7% in 2007. However, since national cancer databases do not collect information on healthy women without breast cancer, it is challenging to accurately elicit the trends of BPM.\(^8\) In their review of the New York state cancer registry, McLaughlin and colleagues\(^12\) found that 1196 women without a diagnosis of cancer received BPM between 1995 and 2005; interestingly, the rate increased only slightly over the study period. Recent reviews addressing prophylactic mastectomies\(^6\) note that the rate of BPM has likely increased secondary to increased awareness of genetic breast cancer, increased genetic testing and improvements in mastectomy and reconstruction techniques.

There is a growing body of literature documenting the long-term patient perspective on BPM and immediate reconstruction.\(^14\)–\(^16\) Geiger and colleagues\(^15\) found that most (84%) women were satisfied at long-term follow-up after receiving BPM; there was no difference in quality of life between those who received BPM and those who did not in a risk-matched cohort. With an average follow-up of 14.5 years, Frost and colleagues\(^14\) found that 70% of women were satisfied following BPM, with notable reductions in emotional concern about breast cancer developing and favourable psychological outcomes.

**Timing for reconstruction after mastectomy**

Compared with therapeutic mastectomy in the context of active breast cancer, BPM is an elective procedure and gives the patient the option of the timing of reconstruction (delayed or immediate).\(^17\) There was initially some resistance to immediate reconstruction, with some authors contending that patients who do not live with a mastectomy deformity are less likely to appreciate the esthetics of the reconstruction.\(^18\)\(^19\) More recently, however, evidence has emerged that suggests that immediate reconstruction provides better esthetic results and greater patient satisfaction than delayed reconstruction.\(^20\)\(^21\) With all other factors held constant, with more of the native breast skin available to envelop the reconstructed breast, immediate breast reconstruction typically yields superior esthetic results than delayed reconstruction.\(^20\) Further, immediate breast reconstruction has been found to have materially lower incidence of psychological morbidity than delayed reconstruction.\(^16\)\(^22\)\(^23\) The patient is able to wake from mastectomy surgery with a reconstructed breast mound and avoids having to live with a full mastectomy deformity. In their retrospective study, Al-Ghazal and colleagues\(^23\) found that patients receiving immediate reconstruction had significantly greater body image and self-esteem and felt significantly less anxiety and depression than patients receiving delayed reconstruction. There are also cost benefits to immediate reconstruction. Khoo and colleagues\(^24\) found the costs of delayed reconstruction to be 62% higher than those of immediate reconstruction. The lower overall costs were attributed to lower overall operating room (OR) time and fewer inpatient hospital days resulting from reducing the number of surgeries from 2 operations to 1.\(^24\)

**The rapid access prophylactic mastectomy and immediate reconstruction program**

Given the demonstrated cancer risk reduction and advantages of immediate reconstruction, there is a strong demand among high-risk breast cancer patients and carriers of the \( \text{BRCA1} \) and \( \text{BRCA2} \) mutations for BPM with immediate reconstruction. Unfortunately, given limited OR resources and active cancer taking priority, there can be long wait
times for patients who wish to undergo prophylactic procedures. Boyd and colleagues\(^2\) found that women seeking reconstruction at the time of mastectomy with no active cancer (benign and high-risk) waited an average of 242 days, compared with 43 days for those with ductal carcinoma in situ and 40 days for those with invasive cancer.

Presently, there are no pan-Canadian wait time targets for cancer surgery; targets are mandated and monitored provincially.\(^2\) In Ontario, for example, Cancer Care Ontario (CCO) sets targets based on the urgency of the malignancy; aggressive, invasive and indolent tumours have target wait times of 14, 28 and 84 days from readiness to treat to operation, respectively.\(^2\) Further, the mandated wait time for elective general surgery procedures is 182 days.\(^2\) As a result of the mandated cancer surgery wait times, patients without cancer often find themselves low on surgical wait lists and experience long wait times, which regularly exceed the 182-day target. The mandated cancer surgery wait time targets in Ontario have affected patients of other specialties who do not have cancer in a similar way. Cancer could develop in high-risk or \(BRCA1\) or \(BRCA2\) women while they await elective procedures, thus a solution to this problem is necessary.

To address these challenges, a rapid access prophylactic mastectomy and immediate reconstruction (RAPMIR) practice model was created. Leveraging an outpatient hospital, the goal of the program was to increase access to BPM with immediate reconstruction among high-risk and \(BRCA^+\) women. The purpose of this study is to describe and evaluate this program with regards to access to care and surgeon efficiency.

**METHODS**

**Rapid access prophylactic mastectomy and immediate reconstruction program**

Prior to the introduction of the RAPMIR program, patients who wished to undergo BPM with reconstruction were scheduled through a traditional model and triaged relative to the urgency of other surgical cancer cases. Scheduling was coordinated for surgical oncology and plastic surgery to perform a combined case at the main inpatient hospital. In this traditional model, prophylactic patients and patients with cancer were included on the same wait list for access to surgery. In November 2013, the RAPMIR practice model was implemented at a tertiary care outpatient hospital in Ottawa, Ont., Canada. In this new practice model, the prophylactic patients were included on an independent wait list, thus their wait times were no longer affected by those of patients with cancer.

The OR suite of the outpatient hospital consists of 5 ORs in a freestanding ambulatory centre with an annual case volume approaching 9000. The RAPMIR program runs 1 day each month and involves dedicated operating time for patients eligible for the program. To be eligible for treatment in the RAPMIR program a patient is required to be high-risk or a \(BRCA1\) or \(BRCA2\) carrier; to desire BPM with immediate, implant-based reconstruction (implant or tissue expander); and to be an acceptable candidate for day surgery (e.g., no comorbidities that would necessitate extended postanesthetic observation). Patients not eligible for inclusion or with confirmed surgery dates are managed through the traditional model.

To optimize scheduling, RAPMIR runs 2 ORs concurrently, with surgical oncology and plastic surgery teams alternating rooms (Fig. 1). In room 1, the surgical oncology team begins with the mastectomy portion of the first combined case. Once they complete the first BPM, they begin the second BPM in room 2 as the plastic surgery team begins reconstruction in room 1. Continuation of this pattern makes 3 BPMs with immediate reconstruction possible in 1 operative day (7:50–3:30). The surgical oncology and plastic surgery teams each complete 1–2 independent cases in the remaining time, for a daily total of 5–6 patients. The aforementioned timetable represents scheduling under optimal conditions; under circumstances

![Fig. 1. Optimized operating room schedule of the rapid access prophylactic mastectomy and immediate reconstruction practice model. BPM = bilateral prophylactic mastectomy; PS = plastic surgery; SO = surgical oncology.](image-url)
where there are fewer than 3 patients available for BPM, the remaining time is scheduled with alternative cases.

The postoperative protocol involves Steri-Srips (3M) left on the incisions until they fall off or until they are removed after a maximum of 2 weeks. Patients are instructed to shower within 24 h after surgery and to wear a supportive garment 24 h per day for 6 weeks. Drains are left in place until output is less than 30 mL/d for 2 consecutive days. Patients are prescribed a 7-day course of cephalexin (500 mg orally 4 times per day).

Retrospective chart review

This study was performed at The Ottawa Hospital, a tertiary breast cancer centre in Ottawa, Ont., Canada, where approximately 850 breast cancers are treated annually. Following ethics approval, we initiated a retrospective chart review. The senior author’s (K.U.B.) complete electronic medical records were reviewed for all patients who had received breast reconstruction between September 2012 and August 2014. Diagnostic and operative data were reviewed to identify all patients who were high-risk or had BRCA mutations and who received a prophylactic mastectomy. A patient was considered to be high-risk if she met 1 of the following inclusion criteria: 2 or more first- or second-degree relatives with breast or ovarian cancer, family history of breast cancer occurring before the age of 50 years, family history of both breast and ovarian cancer, or 1 or more relatives with 2 cancers (breast and ovarian cancer or 2 independent breast cancers). Patients with active cancer at the time of their mastectomy were excluded from the chart review.

We reviewed clinic notes for preoperative demographic data, and operative notes and anesthetic records were reviewed to document mastectomy type (nipple-sparing, skin-sparing), reconstruction (implant, tissue expander) and perioperative data. We retrieved referral and appointment dates from hospital records. All clinic notes following surgery were reviewed to document incidences of postoperative complications. The OR schedule for each day was retrieved to document case volume.

Patients were divided into 2 groups: those managed through the traditional model and those managed through the RAPMIR model. The RAPMIR group was composed of all patients who met the aforementioned RAPMIR program eligibility criteria after the program’s initiation. The traditional group was composed of all patients who received BPM with immediate, implant-based reconstruction before the RAPMIR program’s initiation and all patients who were not eligible for the RAPMIR program (e.g., medically unfit for day surgery) after the program’s initiation.

Statistical analysis

Assuming a type I error rate of 5% and a desired statistical power of 0.8, 13 participants were required in each group to show a 10% reduction in wait times25 with the RAPMIR program.29 We compared wait times (referral to consult, consult to surgery, referral to surgery) and surgeon productivity (case volume) between groups. Statistical analysis was performed using Pearson χ², Fisher exact and independent t tests using SPSS software version 21.0 (IBM Corp).

RESULTS

The charts of 343 patients were included for review. A total of 29 patients were identified who were either high-risk or BRCA+ and who had prophylactic mastectomy with immediate reconstruction during the study period. During this time period, 5 different surgical oncologists performed the mastectomies, and 1 plastic surgeon performed all of the reconstructions. Sixteen patients were treated with the traditional model and 13 were treated through the RAPMIR model. Mean age for all patients at the date of surgery was 46.6 (range 26–67) years. Mean follow-up for all patients was 497.6 (234–1018) days. The baseline preoperative demographic data are shown in Table 1. The majority of patients were BRCA+ (n = 27), with 1 patient in each group qualifying because of their high-risk status in the absence of a BRCA mutation (n = 2). There were no significant differences in age, body mass index, weight, breast dimensions, or cup size between the RAPMIR and traditional groups. There were no active smokers in either group.

The perioperative and postoperative data are shown in Table 2. All patients had either a skin- or nipple-sparing mastectomy. The decision for nipple-sparing mastectomy was based on body habitus, ptosis and patient preference. Patients with large, ptotic breasts were considered ineligible for nipple-sparing mastectomy. When compared with nipple-sparing mastectomies, skin-sparing mastectomies were more common in the RAPMIR group (84.6%) than the traditional group (50%), but this difference was not significant. Both groups had comparable postoperative complications. The most common complication in both the traditional and the RAPMIR groups was cellulitis requiring treatment with antibiotics (25.0% and 23.1%, respectively). Of the patients with postoperative cellulitis, 2 (28.6%) had type 2 diabetes mellitus, both of whom were in the traditional group. One patient in the RAPMIR group required reoperation for a deflated tissue expander, whereas 4 patients in the traditional group required reoperation for tissue expander deflation (n = 1), hematoma (n = 1), skin flap necrosis (n = 1), or seroma (n = 1). There were no differences in the duration of surgery, mastectomy weight, implant size, estimated blood loss, postoperative complications, or rate of unplanned reoperation between the groups.

The total wait time from referral to surgery was 47% shorter for the RAPMIR group compared with the traditional group (165.4 v. 309.2 d). This difference was driven by a significantly shorter time from consult to surgery in
Table 1. Preoperative patient demographic characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>RAPMIR (n = 13)</th>
<th>Traditional (n = 16)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age at time of surgery, yr</td>
<td>47.2 ± 12.0</td>
<td>46.1 ± 10.8</td>
<td>0.79*</td>
</tr>
<tr>
<td>Risk status</td>
<td></td>
<td></td>
<td>&gt; 0.99†</td>
</tr>
<tr>
<td>BRCA+</td>
<td>12 (92.3)</td>
<td>15 (83.8)</td>
<td></td>
</tr>
<tr>
<td>High-risk</td>
<td>1 (7.7)</td>
<td>1 (6.2)</td>
<td></td>
</tr>
<tr>
<td>Body mass index</td>
<td>25.8 ± 4.4</td>
<td>27.0 ± 7.8</td>
<td>0.62*</td>
</tr>
<tr>
<td>Weight, kg</td>
<td>72.1 ± 13.5</td>
<td>69.8 ± 17.2</td>
<td>0.70*</td>
</tr>
<tr>
<td>Type 2 diabetes mellitus</td>
<td>0 (0)</td>
<td>2 (12.5)</td>
<td>0.49†</td>
</tr>
<tr>
<td>Sternal notch to nipple distance, cm</td>
<td>24.7 ± 3.0</td>
<td>24.0 ± 3.4</td>
<td>0.56*</td>
</tr>
<tr>
<td>Nipple to inframammary fold distance, cm</td>
<td>8.5 ± 2.7</td>
<td>8.6 ± 2.0</td>
<td>0.96*</td>
</tr>
<tr>
<td>Breast width, cm</td>
<td>12.7 ± 1.2</td>
<td>12.4 ± 2.0</td>
<td>0.56*</td>
</tr>
<tr>
<td>Breast cup size</td>
<td></td>
<td></td>
<td>0.96‡</td>
</tr>
<tr>
<td>A</td>
<td>1 (7.7)</td>
<td>2 (12.5)</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>3 (23.1)</td>
<td>5 (31.3)</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>3 (23.1)</td>
<td>8 (50.0)</td>
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<tr>
<td>D</td>
<td>5 (38.5)</td>
<td>0 (0)</td>
<td></td>
</tr>
<tr>
<td>DD</td>
<td>1 (7.7)</td>
<td>1 (6.3)</td>
<td></td>
</tr>
</tbody>
</table>

RAPMIR = rapid access prophylactic mastectomy and immediate reconstruction; SD = standard deviation.
*Independent t test.
†Fisher exact test.
‡Pearson χ² test.

Table 2. Preoperative and perioperative patient characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>RAPMIR (n = 13)</th>
<th>Traditional (n = 16)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of mastectomy</td>
<td></td>
<td></td>
<td>0.11†</td>
</tr>
<tr>
<td>Nipple-sparing</td>
<td>2 (15.4)</td>
<td>8 (50.0)</td>
<td></td>
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<tr>
<td>Skin-sparing</td>
<td>11 (84.6)</td>
<td>8 (50.0)</td>
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<td>Mastectomy, g</td>
<td>489.6 ± 323.5</td>
<td>404.1 ± 220.5</td>
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<tr>
<td>Type of reconstruction</td>
<td></td>
<td></td>
<td>&gt; 0.99†</td>
</tr>
<tr>
<td>Implant</td>
<td>9 (69.2)</td>
<td>10 (62.5)</td>
<td></td>
</tr>
<tr>
<td>Tissue expander</td>
<td>4 (30.8)</td>
<td>6 (37.5)</td>
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</tr>
<tr>
<td>Acellular dermal matrix placement</td>
<td></td>
<td></td>
<td>0.49†</td>
</tr>
<tr>
<td>AlloDerm placement</td>
<td>13 (100)</td>
<td>14 (87.5)</td>
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<tr>
<td>No AlloDerm placement</td>
<td>0 (0)</td>
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</tr>
<tr>
<td>Implant size, g</td>
<td>396.1 ± 133.4</td>
<td>362.0 ± 91.4</td>
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</tr>
<tr>
<td>Duration of surgery, min</td>
<td>176.2 ± 40.5</td>
<td>166.8 ± 34.5</td>
<td>0.51*</td>
</tr>
<tr>
<td>Estimated blood loss, mL</td>
<td>151.5 ± 46.3</td>
<td>118.8 ± 81.4</td>
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</tr>
<tr>
<td>Total postoperative complications</td>
<td></td>
<td></td>
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<tr>
<td>Cellulitis (requiring treatment with antibiotics)</td>
<td>3 (23.1)</td>
<td>4 (25.0)</td>
<td></td>
</tr>
<tr>
<td>Seroma</td>
<td>2 (15.4)</td>
<td>2 (12.5)</td>
<td></td>
</tr>
<tr>
<td>Hematoma</td>
<td>0 (0)</td>
<td>1 (6.3)</td>
<td></td>
</tr>
<tr>
<td>Implant or tissue expander deflation</td>
<td>1 (7.7)</td>
<td>1 (6.3)</td>
<td></td>
</tr>
<tr>
<td>Nipple, T-junction, or flap necrosis</td>
<td>1 (7.7)</td>
<td>3 (18.8)</td>
<td></td>
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<tr>
<td>Unplanned reoperation for complication</td>
<td>1 (7.7)</td>
<td>4 (25.0)</td>
<td>0.34†</td>
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<tr>
<td>Seroma</td>
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<td>1 (6.3)</td>
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<tr>
<td>Hematoma</td>
<td>0 (0)</td>
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<td>1 (7.7)</td>
<td>1 (6.3)</td>
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</tr>
<tr>
<td>Nipple, T-junction, or flap necrosis</td>
<td>0 (0)</td>
<td>1 (6.3)</td>
<td></td>
</tr>
</tbody>
</table>

RAPMIR = rapid access prophylactic mastectomy and immediate reconstruction; SD = standard deviation.
*Independent t test.
†Fisher exact test.
the RAPMIR group compared with the traditional group (127.4 v. 284.1 d), as there was no significant difference between the time from referral to consultation. The summary of patient wait times is shown in Table 3.

There were 14 operative days completed under the traditional model and 6 under the RAPMIR model. Compared with the traditional model, RAPMIR operative days had significantly greater daily case volumes for plastic surgery and surgical oncology as well as a larger total number of patients undergoing operations — plastic surgery case volume was 131% greater (1.6 v. 3.7), surgical oncology case volume was 36% greater (2.2 v. 3.0), and the total number of patients operated on was 54% greater (2.8 v. 4.3). The summary of surgeon productivity is shown in Table 4.

**DISCUSSION**

In patients with **BRCA1** or **BRCA2** mutations or a strong family history of breast cancer, BPM has a demonstrated cancer risk reduction** and favourable long-term psychological outcomes**. In the context of mastectomy, there is also a strong body of evidence indicating that compared with delayed reconstruction, immediate reconstruction provides better aesthetic results**,** greater patient satisfaction**,** lower incidence of psychological morbidity**,** and lower costs to the health care system**. Taken together, BPM with immediate reconstruction in **BRCA** carriers or high-risk patients is beneficial. However, with active cancer taking priority over prophylactic operations, significant wait times exist for patients to receive BPM with reconstruction**. The RAPMIR practice model was innovated at The Ottawa Hospital to improve patients’ (high-risk or **BRCA**+) access to BPM with immediate reconstruction while concurrently optimizing the use of scarce OR resources.

The RAPMIR program leveraged 2 concurrently running ORs at an outpatient hospital 1 day each month with an independent wait list for the high-risk and **BRCA**+ women. The surgical oncology and plastic surgery teams moved between rooms in order to complete 3 combined BMPs with immediate reconstruction each operative day. The implementation of the program improved access to care for patients. Compared with the traditional approach, patients treated through the RAPMIR model had a 47% reduction in wait time; from referral to surgery RAPMIR patients had a mean wait time of 165.4 days compared with 309.2 days through the traditional model. Notably, implementation of the RAPMIR model decreased wait times to within the mandated CCO target of 182 days (Fig. 1).28

Wait times for BPM among patients without an active cancer diagnosis are not commonly reported. However, wait times in the context of active breast cancer form a meaningful point of comparison. In the United States, using the National Cancer Database, Liederbach and colleagues30 reported on the wait times for breast surgery in 819175 patients from 2003 to 2011. In 2011, the mean wait time for mastectomy and reconstruction was 42 days, which had increased materially from 33 days in 2003.30 Less advanced staging was associated with increased wait times, with carcinoma in situ having the longest wait times.30 Similarly, in a Canadian study of wait times for patients seeking breast reconstruction between 2001 and 2004, Boyd and colleagues25 found mean wait times of 43 days and 40 days for ductal carcinoma in situ (DCIS) and invasive cancer pathology, respectively. They also reported a mean wait time of 242 days from

### Table 3. Patient wait times and surgeon productivity

<table>
<thead>
<tr>
<th>Measure</th>
<th>Group; mean ± SD</th>
<th>p value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time from referral to plastic surgery consultation, d</td>
<td>RAPMIR (n = 13)</td>
<td>Traditional (n = 16)</td>
</tr>
<tr>
<td>Time from plastic surgery consultation to surgery, d</td>
<td>38.2 ± 105.8</td>
<td>25.1 ± 36.4</td>
</tr>
<tr>
<td>Time from plastic surgery referral to surgery, d</td>
<td>127.4 ± 82.1</td>
<td>284.1 ± 177.7</td>
</tr>
<tr>
<td>Time from referral to surgery, d</td>
<td>165.4 ± 144.8</td>
<td>309.2 ± 178.4</td>
</tr>
</tbody>
</table>

RAPMIR = rapid access prophylactic mastectomy and immediate reconstruction; SD = standard deviation.

*Independent t test.

### Table 4. Surgeon productivity and patient throughout

<table>
<thead>
<tr>
<th>Measure</th>
<th>Group; mean ± SD</th>
<th>p value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operations/d (plastic surgery)</td>
<td>RAPMIR (n = 6)</td>
<td>Traditional (n = 14)</td>
</tr>
<tr>
<td>Operations/d (surgical oncology)</td>
<td>3.7 ± 0.8</td>
<td>1.6 ± 0.6</td>
</tr>
<tr>
<td>No. of patients/d receiving BPM with immediate reconstruction</td>
<td>2.3 ± 0.5</td>
<td>1.1 ± 0.3</td>
</tr>
<tr>
<td>Total no. of patients operated/d (BPM and non-BPM (“throughput”))</td>
<td>4.3 ± 0.8</td>
<td>2.8 ± 0.8</td>
</tr>
</tbody>
</table>

BPM = bilateral prophylactic mastectomy; RAPMIR = rapid access prophylactic mastectomy and immediate reconstruction; SD = standard deviation.

*Independent t test.
referral to surgery for high-risk patients or benign disease, which offers perhaps the best benchmark to compare the wait times found in the present study.

The Fraser Institute is an independent research organization that has tracked wait times in Canada since 1988. In a recent report by the Fraser Institute, the median wait time in Canada from general practitioner plastic surgery referral to treatment had increased from 14.2 weeks (99.4 d) in 1993 to 27.1 weeks (189.7 d) in 2014. This wait time was composed of 12.2 weeks elapsing between general practitioner referral and plastic surgery consultation and 14.9 weeks elapsing between plastic surgery consultation and definitive treatment. Interestingly, the 165.4-day wait time observed with the RAPMIR program is shorter than the 189.7-day median wait time reported by the Fraser Institute, whereas the original 309.2-day wait of the traditional model was materially longer.

Implementation of the RAPMIR program also offered a significant improvement in surgeon productivity. The greater case volume from both surgeons naturally yielded a significant increase in the total number of patients undergoing operations each day (referred to as “throughput”), which rose by 54% under the RAPMIR model. These improvements in access and productivity were accomplished with no significant differences in complications or unplanned reoperations. Notably, the complication rates of 38.5% and 37.5% for the RAPMIR and the traditional groups, respectively, are comparable to the Stage I results of the BREASTrial, which reported an overall complication rate of 36.2% with the use of acellular dermal matrix in breast reconstruction.

Throughput is an important metric in OR planning and monitoring. Throughput, defined as the number of patients operated on over a given period of time, has implications for both patient wait times and health care costs. Throughput is inversely related to wait times, whereby increasing the number of patients treated each day reduces wait times for all of the patients within the system. Furthermore, given that a significant portion of OR costs are fixed costs, increasing throughput has a beneficial impact on costs and resource utilization. As throughput increases in a system with significant fixed costs, the cost per surgical case is reduced as those fixed costs are spread across a greater number of operations. Simply put, more is accomplished with a comparable amount of resources. Taken together, the increased patient throughput of the RAPMIR program provides advantages to patients in the form of improved access as well as to the health care system through optimization of scarce OR resources.

Limitations

There are some limitations to this study and its conclusions. First, it was a small retrospective cohort study designed to validate the impact of the RAPMIR program. The small size of each study group can be partially attributed to the low prevalence of BRCA1 and BRCA2 carriers, which is estimated at 0.07%–0.09% and 0.14%–0.22%, respectively. Second, in the context of prophylactic procedures there are confounding factors impacting wait times. For example, patients from each group elected to delay surgery to accommodate their preference of date as opposed to having their operation at the earliest possible time. As this occurred to an uncertain degree in both groups, all patients who were eligible for study inclusion were included for analysis in an effort to minimize potential bias. Third, given the retrospective nature of the study design, patient satisfaction and quality of life metrics were not captured; this would be an interesting outcome measure to investigate in a future prospective study.

CONCLUSION

Although it is early in the lifecycle of the RAPMIR program, the findings from this study suggest that a multidisciplinary model with optimized OR scheduling has the potential to improve access to BPM with immediate reconstruction for high-risk or BRCA+ patients. Importantly, the program accomplishes this in a manner that increases patient throughput and consequently optimizes scarce hospital resources and surgeon time. Although RAPMIR was originally implemented at an outpatient hospital, the basic structure and principles of the program would be suitable for implementation at either an inpatient or an outpatient facility for other non-cancer procedures.

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Affiliations: From the Faculty of Medicine, University of Ottawa, Ottawa, Ont. (Head); the Division of General Surgery, Department of Surgery, University of Ottawa, Ottawa, Ont. (Nessim); and the Division of Plastic Surgery, Department of Surgery, University of Ottawa, Ottawa, Ont. (Boyd).

Competing interests: K. Usher Boyd is a paid consultant for LifeCell. In this role, she has received honoraria for speaking about the use of acellular dermal matrix and she has had expenses for travel covered to attend meetings regarding the same. This does not pose a conflict for the present study, as the products are not mentioned in the article, nor do they influence the topic. No other competing interests declared.

Contributors: All authors designed the study and acquired the data, which L. Head and C. Nessim analyzed. L. Head wrote the article, which all authors reviewed and approved for publication.

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29. Canadian Institute for Health Information. Target wait times for cancer surgery in Ontario; 2006.


Impact of trauma centre designation level on outcomes following hemorrhagic shock: a multicentre cohort study

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Pier-Alexandre Tardif, MA, MSc
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Madiba Omar, MSc
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Background: Hemorrhagic shock is responsible for 45% of injury fatalities in North America, and 50% of these occur within 2 h of injury. There is currently a lack of evidence regarding the trajectories of patients in hemorrhagic shock and the potential benefit of level I/II care for these patients. We aimed to compare mortality across trauma centre designation levels for patients in hemorrhagic shock. Secondary objectives were to compare surgical delays, complications and hospital length of stay (LOS).

Methods: We performed a retrospective cohort study based on a Canadian inclusive trauma system (1999–2012), including adults with systolic blood pressure (SBP) < 90 mm Hg on arrival who required urgent surgical care (< 6 h). Logistic regression was used to examine the influence of trauma centre designation level on risk-adjusted surgical delays, mortality and complications. Linear regression was used to examine LOS.

Results: Compared with level I centres, adjusted odds ratios (and 95% confidence intervals [CI]) of mortality for level III and IV centres were 1.71 (1.03–2.85) and 2.25 (1.08–4.73), respectively. Surgical delays did not vary across designation levels, but mean LOS and complications were lower in level II–IV centres than level I centres.

Conclusion: Level I/II centres may offer a survival advantage over level III/IV centres for patients requiring emergency intervention for hemorrhagic shock. Further research with larger sample sizes is required to confirm these results and to identify optimal transport time thresholds for bypassing level III/IV centres in favour of level I/II centres.
emorrhagic shock following injury is responsible for 45% of injury fatalities in the United States, and 50% of these deaths occur within 2 h of injury. Surgical or angiographic interventions are standard treatments for hemorrhagic injuries, and time to intervention is an important marker of quality of care for these patients. A delay to definitive care of more than 1 h is associated with a 3-fold increase in the odds of death, and every additional minute of prehospital time increases those odds by 5%. For this reason, time to definitive care has guided the development of trauma systems.

Organized trauma systems are associated with a 15% reduction in trauma-related mortality in North America. This is mainly owing to the highly specialized care available in level I/II centres and to the reduced time to definitive care associated with more appropriate prehospital triage and interfutility transfer protocols. Trauma patients are transported to the nearest trauma centre for initial stabilization, although prehospital triage protocols dictate bypassing regional trauma centres for major traumatias when direct transport to the nearest level I/II centre is possible. However, because of the time-sensitive nature of hemorrhagic injuries and because all trauma centres theoretically have the capacity to provide definitive surgical care to patients in hemorrhagic shock with no other serious injuries, these patients are often taken to the nearest trauma centre, regardless of the designation level. There is currently a lack of evidence regarding the potential benefit of level I/II care for these patients.

The primary objective of the present study was to compare mortality across trauma centre designation levels for patients in hemorrhagic shock. Secondary objectives were to compare surgical delays, complications and hospital length of stay (LOS). We hypothesized that mortality is lower in level I centres than level IV centres owing to higher volume, greater surgical expertise and the availability of high-technology resources. We also hypothesized that level I centres have shorter delays to definitive hemorrhagic control than level IV centres as surgical teams are already on site.

METHODS

Study setting and population

This retrospective, multicentre cohort study is based on the fully inclusive, mature trauma system in the province of Quebec, Canada. The system consists of 57 adult trauma centres, including 3 level I, 4 level II, 22 level III and 28 level IV centres covering a territory of 1.6 million km². Trauma centre designation levels are revised periodically according to American College of Surgeons criteria. Trauma care services in Quebec are based on transfer agreements between hospitals and a no-refusal transfer policy. Level I/II centres are large, urban hospitals with 24/7 surgical coverage, while level IV centres are mostly small rural hospitals.

Our study population comprised adults (age ≥ 16 yr) with a systolic blood pressure (SBP) < 90 mm Hg on arrival at the definitive care trauma centre who were undergoing intervention for hemorrhage control (i.e., surgery or angio-intervention within 6 h). Relevant Canadian Classification of Health Interventions (CCI) codes for hemorrhagic control were selected by clinical experts. We excluded patients who were coded dead on arrival or who arrived with no vital signs and died within 30 min from all analyses. Patients in hemorrhagic shock on arrival who died within 6 h were included for analyses on mortality if they had major thoracoabdominal injury (Abbreviated Injury Scale [AIS] score ≥ 4) and had a maximum AIS for head injuries ≤ 2. The study was approved by the Research Ethics Committee of the CHU de Québec and by the Ethics Committee of Research of Université Laval.

Study data

Data were extracted from the Quebec trauma registry. Each provincial trauma centre is mandated to contribute to the registry according to the following patient inclusion criteria: death following injury, admission to the intensive care unit, hospital stay of 3 days or longer, or transfer from another hospital. Medical archivists extract data from patient files based on protocols proposed by the American College of Surgeons. Anatomic injuries are coded using the AIS. Interventions are coded using the CCI. Different mechanisms are used to ensure data quality: yearly ongoing training, 3 meetings per year with key stakeholders, an electronic forum of coding queries and supervision by a data coordinator.

Outcomes

The primary outcome of interest was in-hospital mortality. Secondary outcomes were in-hospital surgical delay, occurrence of at least 1 complication during the hospital stay and hospital LOS. Surgical delay was calculated in hours from arrival in the emergency department (ED) to the initiation of surgery or angio-intervention and dichotomized using a 1-h cut-off. Complications, including postadmission death, were conditions potentially related to care according to expert consensus, described in detail elsewhere. We calculated LOS as the number of days from admission to discharge from the definitive acute care hospital.

Statistical analysis

To characterize trajectories of care, we described designation levels of first receiving and definitive care centres, the median time to definitive care, the median surgical delay...
(from the ED to the operating table), the proportion of patients with a surgical delay longer than 1 h, and the ratio of angio-interventions to surgery.

Mortality, surgical delay longer than 1 h and complications were compared across trauma centre designation levels using odds ratios (ORs) derived from multivariate logistic regression models. We compared LOS using geometric mean ratios (GMRs) obtained from a multivariate log-linear regression model based on data from patients who were discharged alive. We adjusted the GMRs, ORs and 95% confidence intervals (CIs) for sex; age; presence of cardiopathies and/or coagulopathies; SBP on arrival; Glasgow Coma Scale (GCS) score; maximum AIS of injuries to the trunk, the extremities and the head; and presence of penetrating injuries. Adjustments for cardiopathies included congestive heart failure, cardiac arrhythmias, valvular disease and any coagulopathies, which are all components of the Elixhauser Comorbidity Index.21

Missing data on surgical delay (3.4%), SBP (1.5%) and GCS (15%) were simulated using multiple imputation with the Markov Chain Monte Carlo method using 10 imputed data sets for each missing data value. The imputation models included the same independent and dependent variables as the analysis models. All analyses were conducted using the 10 imputed data sets, and results were combined using the MIANALYZE procedure in SAS software version 9.4.

**Sensitivity analyses**
Analyses were repeated excluding 1) patients with missing data, 2) patients with a severe head injury (head AIS ≥ 3) and 3) patients who received only angio-interventions. We also repeated analyses using a 2- and 4-h cut-off to define emergency surgery.

All statistical analyses were performed using SAS software. All tests were 2-sided. Statistical significance was set at 5%.

**RESULTS**

**Study population**
The Quebec trauma registry included 7855 adult patients with SBP < 90 mm Hg on arrival at the trauma centre between 1998 and 2014. Of those patients, 732 had an intervention for hemorrhagic control within 6 h of their arrival in the ED. An additional 190 patients (total 922 patients) arrived with a major extracranial injury (head AIS ≤ 2 and trunk AIS ≥ 4) and died without receiving an intervention 30 min to 6 h following arrival (Fig. 1 and Table 1).

**Patient trajectories**
The majority of patients in hemorrhagic shock (n = 493, 67.3%) received definitive care in a level I or level II trauma centre (Table 2), of whom 83.2% were transported

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**Fig. 1.** Selection of the study population. AIS = Abbreviated Injury Scale; SBP = systolic blood pressure.
directly. Only 50 (6.8%) patients received definitive care in a level IV centre. Crude median surgical delay for patients directly admitted to a level IV centre (1.9 h) was similar to that of patients directly admitted to a level III (1.7 h) or level I/II centre (1.8 h). Anglo-intervention was used in 118 (23.9%) patients in level I/II centres, whereas

<table>
<thead>
<tr>
<th>Table 1. Demographic and injury characteristics of the study population according to designation level of the definitive care trauma centre*</th>
</tr>
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<tbody>
<tr>
<td>Characteristic</td>
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<tr>
<td>---------------------------------------------------------------</td>
</tr>
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<tr>
<td>55–64</td>
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<tr>
<td>≥ 75</td>
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<tr>
<td>Mechanism of injury</td>
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<td>Motor vehicle collision</td>
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<tr>
<td>Fall</td>
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<tr>
<td>Penetrating Injury</td>
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<td>Blunt object and others</td>
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<td>SBP, mm Hg†</td>
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<tr>
<td>&lt; 50</td>
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<td>50–75</td>
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<tr>
<td>76–89</td>
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<tr>
<td>GCS score†</td>
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<td>3–8</td>
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<td>9–12</td>
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<td>Body region of the most severe injury</td>
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<tr>
<td>Head</td>
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<td>Thorax</td>
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<tr>
<td>Abdomen</td>
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<tr>
<td>Spine</td>
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<tr>
<td>Extremities</td>
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<tr>
<td>Maximum AIS to the trunk, neck and limbs</td>
</tr>
<tr>
<td>1–2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5–6</td>
</tr>
<tr>
<td>Maximum AIS to the head</td>
</tr>
<tr>
<td>1–2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5–6</td>
</tr>
<tr>
<td>Cardiopathies and coagulopathies</td>
</tr>
<tr>
<td>Residential remoteness†</td>
</tr>
<tr>
<td>Metropolitan‡</td>
</tr>
<tr>
<td>Other regions§</td>
</tr>
<tr>
<td>Agglomerations¶</td>
</tr>
<tr>
<td>Small town and rural areas**</td>
</tr>
</tbody>
</table>

AIS = Abbreviated Injury Scale; GCS = Glasgow Coma Scale; SBP = systolic blood pressure.
*Data simulated using multiple imputation
†Data missing for 57 patients
‡Population size ≥ 1 000 000
§Population size 100 000–1 000 000
¶Population size 10 000–100 000
**Population size < 10 000
only 3 patients (6.0%) had nonsurgical hemorrhagic control in level IV centres (Table 2).

Outcomes

Overall, 190 patients (20.6%) died within 6 h of arrival before intervention, and a further 147 patients (15.9%) died after surgery or angio-intervention. Patients treated in a level III trauma centre had an adjusted odds of dying that was 70% higher than those treated in a level I centre, whereas the odds for patients treated at level IV centres was 2.3 times higher (Table 3).

The adjusted odds of a surgical delay longer than 1 h were higher in level II, III and IV centres than level I centres, but observed differences did not reach statistical significance (Table 3).

Overall, 53.0% (388 of 732) of eligible patients experienced at least 1 complication following surgery or angio-intervention. The most common complications were hospital-acquired pneumonia and surgical site infection (Fig. 2). The adjusted odds of complications for patients receiving definitive care in level II, III and IV centres was less than half that observed for patients treated in a level I centre (Table 3).

Observed mean LOS in survivors was 29.3 (median 18) days. Patients who received definitive care in a level II, III, or IV centre had a mean LOS 26%, 50% and 72% shorter, respectively, than patients who were admitted to a level I centre (Table 3).

Sensitivity analyses

The significantly lower odds of risk-adjusted mortality, higher odds of complications and longer LOS observed in the complete study population remained stable when we restricted analyses to patients with no missing data and to patients with no major head injury. The odds of death were reduced when we excluded patients who received exclusively angio-intervention from our analysis. Odds ratios for mortality were 1.1, 1.1, and 1.2, for level II, III and IV centres, respectively, compared with level I centres. Conclusions remained unchanged when we used a 2- or 4-h cut-off instead of a 6-h cut-off to define emergency surgery.

DISCUSSION

In this multicentre cohort study, patients treated for hemorrhagic shock in a level IV trauma centre had a risk-adjusted

<table>
<thead>
<tr>
<th>Table 2. Trajectories of patients according to the designation level of first receiving and definitive trauma centres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor; first receiving centre level*</td>
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<tr>
<td>-------------------------------------</td>
</tr>
<tr>
<td>Non designated</td>
</tr>
<tr>
<td>Delay definitive care</td>
</tr>
<tr>
<td>Surgical delay</td>
</tr>
<tr>
<td>Surgical delay &gt; 1 h</td>
</tr>
<tr>
<td>Angio-intervention/surgery</td>
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<tr>
<td>Level IV</td>
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<tr>
<td>Delay definitive care</td>
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<tr>
<td>Surgical delay</td>
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<tr>
<td>Surgical delay &gt; 1 h</td>
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<tr>
<td>Angio-intervention/surgery</td>
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<tr>
<td>Level III</td>
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<tr>
<td>Delay definitive care</td>
</tr>
<tr>
<td>Surgical delay</td>
</tr>
<tr>
<td>Surgical delay &gt; 1 h</td>
</tr>
<tr>
<td>Angio-intervention/surgery</td>
</tr>
<tr>
<td>Level II / I</td>
</tr>
<tr>
<td>Delay definitive care</td>
</tr>
<tr>
<td>Surgical delay</td>
</tr>
<tr>
<td>Surgical delay &gt; 1 h</td>
</tr>
<tr>
<td>Angio-intervention/surgery</td>
</tr>
<tr>
<td>Total</td>
</tr>
<tr>
<td>Delay definitive care</td>
</tr>
<tr>
<td>Surgical delay</td>
</tr>
<tr>
<td>Surgical delay &gt; 1 h</td>
</tr>
<tr>
<td>Angio-intervention/surgery</td>
</tr>
</tbody>
</table>

IQR = interquartile range.
*First centre in which the patient is admitted.
†Centre in which the patient is admitted for definitive hemorrhagic control.
odds of death 2.3 times that of patients treated in a level I centre. The OR for level III centres was 70% higher. The proportion of patients receiving an intervention for hemorrhagic control more than 1 h after their arrival was higher in level II, III and IV centres than in level I centres, but the difference did not reach statistical significance. Finally, complications and mean LOS were significantly greater in level I centres than in level II, III and IV centres.

Only 1 out of 4 patients received their intervention for hemorrhagic control within 1 h of arrival. These data suggest that trajectories for patients with hemorrhagic shock within our trauma system are suboptimal.

The increase in mortality for level IV centres observed in this study is consistent with those reported in the literature. Several studies have observed higher mortality in level IV centres than level I centres in integrated trauma systems for general injury admissions and for traumatic brain injury.\(^{5,22}\)

Previous studies have reported that as hospital volume increases, the odds of dying decreases for general injury admissions and specifically for patients in hemorrhagic shock.\(^{21,24}\) The increase in mortality observed in our study is clinically important and could be explained by higher surgical volume, greater expertise and availability of resources, such as imagery and angio-intervention.\(^{10,31}\) This hypothesis is supported by the reduction in mortality when patients who received only angio-interventions were excluded from the sensitivity analysis. Observed increases in complication rates for level I/II centres have also been observed for general injury admissions\(^{25}\) and could be due to the higher intensity of care in these centres, greater exposure to hospital-acquired infections or to under-reporting of complications in level IV centres owing to lack of systematic screening practices (e.g., screening for deep vein thrombosis). Our results of longer LOS in trauma centres with a higher designation level also corroborate previous studies in general injury admissions\(^{26}\) and may again be explained by higher intensity of care in higher level centres or to difficulty accessing postdischarge care facilities in urban areas where patients are also more likely to be affected by social deprivation, restricting access to natural caregivers.\(^{27}\) The longer LOS observed in level I centres may also be related to their higher incidence of complications.

### Strengths and limitations

Since participation in the provincial trauma registry is mandatory for all trauma centres and more than 90% of major trauma is treated within the trauma system, this study provides excellent representation of patients with hemorrhagic shock who survive transport to a trauma centre.\(^{28}\) Other strengths include the availability of extensive clinical information for risk adjustment and the simulation of missing data, which enabled us to include all eligible patients.

This study does have limitations, which should be considered in the interpretation of our results. First, despite the use of 16 years of data in a province-wide inclusive trauma system, we had limited statistical power to detect clinically significant differences in surgical delays across trauma centre designation levels. Given the low frequency of patients in hemorrhagic shock requiring emergency intervention, sufficient sample sizes would require data across several centres. 

### Table 3. Adjusted* odds ratios for death, surgical delay > 1 h and complications and geometric mean ratios for length of hospital stay, by trauma centre designation level

<table>
<thead>
<tr>
<th>Outcome: trauma centre level</th>
<th>No. (%) or mean ± SD</th>
<th>Crude OR or GMR (95% CI)</th>
<th>Adjusted OR or GMR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death (n = 922)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>83 (26.0)</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>II</td>
<td>76 (26.8)</td>
<td>1.39 (0.96-2.01)</td>
<td>1.35 (0.83 – 2.17)</td>
</tr>
<tr>
<td>III</td>
<td>132 (46.6)</td>
<td>2.49 (1.77-3.50)</td>
<td>1.71 (1.03 – 2.85)</td>
</tr>
<tr>
<td>IV</td>
<td>46 (28.3)</td>
<td>3.11 (1.91-5.07)</td>
<td>2.25 (1.08 - 4.73)</td>
</tr>
<tr>
<td>Surgical delay &gt; 1 h (n = 732)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>195 (68.4)</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>II</td>
<td>165 (79.3)</td>
<td>1.89 (1.22–2.86)</td>
<td>1.52 (0.94–2.44)</td>
</tr>
<tr>
<td>III</td>
<td>141 (74.6)</td>
<td>1.35 (0.89–2.04)</td>
<td>1.19 (0.74–1.92)</td>
</tr>
<tr>
<td>IV</td>
<td>38 (76.0)</td>
<td>1.45 (0.73–2.94)</td>
<td>1.15 (0.53–2.50)</td>
</tr>
<tr>
<td>Complications (n = 732)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>175 (61.4)</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>II</td>
<td>111 (53.4)</td>
<td>1.03 (0.77–1.39)</td>
<td>0.48 (0.31 – 0.74)</td>
</tr>
<tr>
<td>III</td>
<td>85 (44.9)</td>
<td>0.71 (0.53–0.96)</td>
<td>0.48 (0.30 – 0.75)</td>
</tr>
<tr>
<td>IV</td>
<td>14 (28.0)</td>
<td>0.41 (0.27–0.64)</td>
<td>0.32 (0.15 – 0.70)</td>
</tr>
<tr>
<td>LOS, d (n = 583)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>25.5 ± 2.5</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>II</td>
<td>19.7 ± 2.5</td>
<td>0.78 (0.63–0.95)</td>
<td>0.74 (0.62 – 0.90)</td>
</tr>
<tr>
<td>III</td>
<td>12.1 ± 3.1</td>
<td>0.48 (0.39–0.58)</td>
<td>0.50 (0.41 – 0.61)</td>
</tr>
<tr>
<td>IV</td>
<td>5.95 ± 2.7</td>
<td>0.23 (0.17–0.32)</td>
<td>0.28 (0.21 – 0.39)</td>
</tr>
</tbody>
</table>

CI = confidence interval; GMR = geometric mean ratio; LOS = length of stay; OR = odds ratio; SD = standard deviation.

*Adjusted for sex, systolic blood pressure, age, cardiopathies and coagulopathies, Glasgow Coma Scale score, maximum Abbreviated Injury Scale score to the trunk, limbs and head and penetrating injuries.

![Fig. 2. Frequency of complications.](image-url)
health care systems, leading to significant heterogeneity in trajectories of care. This highlights the fact that patients in hemorrhagic shock represent only a small proportion of major trauma admissions and that undue emphasis should not be placed on this patient group in the organization of Canadian trauma systems. Second, we used SBP < 90 mm Hg and intervention within 6 h or less as a proxy for hemorrhagic shock requiring emergency surgery in the absence of more comprehensive information. This may have led to selection bias that would have caused an underestimation of the influence of trauma centre designation level on outcomes in these patients. Third, a large proportion of patients had missing data on SBP, GCS or surgical delay. We simulated missing data using multiple imputation, which relies on the postulate that data are missing at random (i.e., the probability of being “missing” depends only on available data). However, we are confident that information on patient demographics, injury characteristics and trajectories of care explains the missing data mechanism well, a hypothesis supported by our sensitivity analyses and the validity of parameter estimates based on multiple imputation in simulation studies of trauma registry data.29–31 Fourth, trauma registries are subject to data quality problems, which may have led to misclassification of outcome variables, possibly leading to an underestimation of ORs or GMRs. Suboptimal data quality may also have led to misclassification of adjustment variables, which could lead to residual confounding and an over- or underestimation of ORs or GMRs. Notably, comorbidities are notoriously under-reported in clinical registries, and coagulopathies are particularly difficult to identify. However, quality control of the registry data described previously ensures the extent of this bias is limited, and previous data quality checks suggest that data accuracy in the trauma registry compared with complete patient charts is greater than 95%. Nevertheless, this applies only to information reported in the chart. Fifth, the results of the present study are likely to generalize well to trauma systems with similar proportions of penetrating trauma and geographical challenges, such as Australia and large, rural US states, but may not generalize well to urban US trauma systems where the frequency of penetrating injury is much higher. Finally, the majority of deaths following hemorrhagic injury occur at the scene of the accident, and future research should aim to integrate information on prehospital deaths to further advance knowledge on optimal trauma system configuration for these patients.

Conclusion

The results of this multicentre cohort study suggest that level I and II centres may offer a survival advantage over level III and IV centres for patients requiring emergency intervention for hemorrhagic shock. Factors explaining this advantage require further investigation but may include shorter surgical delays (clinically but not statistically significant), volume expertise and technical availability (i.e., imagery and angio-intervention). Further research with larger sample sizes is required to confirm these results and to identify optimal transport time thresholds for bypassing level III/IV centres in favour of level I/II centres.

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Affiliations: From the Population Health and Optimal Health Practices Research Unit, Trauma, Emergency, Critical Care Medicine, CHU de Québec, Université Laval Research Centre, Québec, Que., (Dufresne, Moore, Tardif, Omar, Boutin); the Department of Social and Preventive Medicine, Université Laval, Québec, Que., (Dufresne, Moore, Tardif, Omar, Boutin); the Department of Surgery, McGill University, Montreal, Que., (Razek); and the Department of Surgery, Université Laval, Québec, Que. (Clément).

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Competing interests: None declared.

Contributors: P. Dufresne, L. Moore and J. Clément designed the study. L. Moore and J. Clément acquired the data, which all authors analyzed. P. Dufresne, L. Moore and J. Clément wrote the article, which all authors reviewed and approved for publication.

References

The cost of screening radiographs after stable fracture fixation

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Background: Currently up to 58% of Canadian surgeons would forego screening radiographs after stable fracture fixation. It is therefore expected that reducing screening radiographs will be well accepted, provided that patient safety is not compromised, resulting in a cost reduction. The study objective was to measure the savings of a simplified radiographic protocol for well-fixed fractures and establish feasibility for a noninferiority trial that proves patient safety.

Methods: Patients were randomized after fixation. The control group received screening radiographs immediately after fixation and at 2 weeks. The experimental group received radiographs only when clinically indicated. At 6 weeks all patients received radiographs. The cost of imaging, time spent in clinic and patient satisfaction was measured. A blinded reviewer documented adverse events, either detected or missed.

Results: Of the 90 patients screened, 39 were randomized and 26 had complete follow-up. The mean cost of radiographs over the first 6 weeks was $44.51 (95% confidence interval [CI] 38.64–50.38) per patient in the experimental group, and $129.23 (95% CI 120.23–138.23) in the control group (p < 0.001). The mean time spent in clinic at 2 weeks was 46 min (95% CI 32–60) per patient for the experimental group and 68 min (95% CI 55–81) for the control group (p = 0.018). Two complications occurred in the experimental group. Both were detected clinically and did not qualify as missed events.

Conclusion: Implementing a simplified radiography protocol after stable fracture fixation saves time and money. Additionally, no adverse events were missed with the study protocol. Recommendations are made toward a noninferiority trial to establish protocol safety.

Contexte: À l’heure actuelle, jusqu’à 58 % des chirurgiens canadiens renonceraient aux radiographies de contrôle après la fixation d’une fracture stable. On s’attend donc à ce qu’une réduction du nombre de radiographies de contrôle soit bien acceptée, à la condition que la sécurité des patients ne soit pas compromise, et à ce que cela contribue à diminuer les coûts. Les objectifs de l’étude étaient de mesurer les économies générées par un protocole radiographique simplifié pour les fractures bien fixées et d’établir la faisabilité d’un essai de non-inferiorité visant à confirmer que la sécurité des patients n’est pas compromise.

Méthodes : L’assignation aléatoire des patients s’est faite après la fixation. Le groupe témoin était soumis à une radiographie de contrôle immédiatement après l’intervention, et 2 semaines plus tard. Dans le groupe expérimental, les radiographies étaient faites uniquement lorsqu’elles étaient cliniquement indiquées. Au bout de 6 semaines, tous les patients étaient soumis à une radiographie. Le coût de l’imagerie, le temps passé à la clinique et la satisfaction des patients ont été mesurés. Un examinateur a documenté à l’aveugle les effets indésirables détectés ou passés inaperçus.

Résultats : Parmi les 90 patients pressentis pour la sélection, 39 ont été assignés aléatoirement et 26 ont fait l’objet du suivi complet. Le coût moyen des radiographies pour les 6 premières semaines a été de $44,51 (intervalle de confiance [IC] de 95% 38,64–50,38) par patient dans le groupe expérimental, et de $129,23 (IC de 95% 120,23–138,23) dans le groupe témoin (p < 0,001). Le temps passé à la clinique pour la radiographie après 2 semaines a été de 46 minutes (IC de 95% 32–60) par patient dans le groupe expérimental, et de 68 minutes (IC de 95% 55–81) dans le groupe témoin (p = 0,018). Deux complications sont survenues dans le groupe expérimental. Les deux ont été détectées à l’examen clinique et ne répondaient pas aux critères d’événements passés inaperçus.

Conclusion : L’application d’un protocole radiographique simplifié après fixation d’une fracture stable permet d’épargner du temps et de l’argent. De plus, aucun effet indésirable n’est passé inaperçu avec le protocole expérimental. Nous recommandons la conduite d’un essai de non-infériorité afin d’en confirmer la sécurité.
A recent survey\(^1\) noted that anywhere from 31% to 49% of Canadian orthopedic surgeons do not acquire screening or check radiographs in the first 6 weeks after fracture fixation. The numbers vary depending on the type of fracture and fixation construct as well as on the timing of the radiograph. When asked, many of those who do screen with radiographs said they would consider a change in practice.\(^2\) Such a change is further supported by a review of the literature. There is a paucity of studies that reported screening with imaging successfully led to a change in patient management.\(^2\)–11 A change in clinical practice therefore appears reasonable and would likely produce savings for both patients and the health care system. The magnitude of savings and ultimately the safety of a modified postfracture fixation protocol for acquiring radiographs remain unknown and are worth investigating.

A simplified postoperative radiography protocol for fracture patients may therefore exclude screening radiographs, but include obtaining radiographs when warranted by the surgeon’s examination and clinical judgment. The objective of this study was to compare the savings, both in terms of cost and time, of a simplified postfracture fixation radiography protocol, which asks surgeons to base their requests for radiographs on their clinical examinations. The secondary objective was to calculate the sample size required for a noninferiority trial to establish the safety of such a protocol. I hypothesized that using a simplified protocol would save money and time and that the sample size for a noninferiority trial would be large given the expectation of a low adverse event rate.

**METHODS**

Randomization for this study occurred after fracture fixation, allowing patients to be screened in the operating room at the time of their procedure. Surgeons were asked to consider inclusion and exclusion criteria and record these on the screening form (Appendix 1, available at canjsurg.ca). The inclusion and exclusion criteria are listed in Table 1. The simplified protocol was not meant to be restrictive for surgeons and patients. To this end, surgeons were allowed to exclude patients who had just completed fracture fixation and in whom screening radiographs were warranted based on suboptimal quality of the construct or bone. Surgeons were also allowed to exclude patients with factors not accounted for in the exclusion criteria. A research assistant collected the screening form daily, and patients were approached once they had fully recovered from the anesthetic for consent to participate and for randomization. Randomization was completed using a computerized random number generator in blocks of 10.

Based on a prospective database maintained by the group of surgeons, it was estimated that 100 patients with the fracture types listed in Table 1 would be available for inclusion into the study over a 6-month period. The study and research support staff were therefore funded for 6 months.

Once enrolled patients were randomized to the control group or the experimental group. Patients in the control group received screening radiographs in hospital on the first or second day after surgery, at the 2-week follow-up visit in clinic and at the 6-week follow-up visit in clinic. The 2- and 6-week visits are typical follow-up times at our institution. Patients in the experimental group did not receive screening radiographs on the first or second day after surgery nor at the 2-week follow-up visit in clinic. They received screening radiographs at the 6-week follow-up visit. At each time point, surgeons were asked what they noted on the radiographs, if anything, and whether a change in patient management was implemented. Importantly, for the simplified protocol group, surgeons were permitted to obtain radiographs, but were asked what clinical findings directed them to request the radiographs. These questions were asked on the study follow-up forms (Appendix 1).

To measure the cost of imaging for the 2 groups, the actual cost of each specific set of images acquired over the study period was tabulated and totaled. The average cost, including materials and labour, per set of images for the fracture types included was $41.19 CAD at the time of the study. The individual cost per radiograph for each fracture type is listed in Table 2.

To measure the time associated with obtaining screening versus indicated radiographs, time in hospital and time in clinic were tabulated. Time in hospital was measured from the time the patient left the operating room, which is part of the computerized record maintained by the operating room circulating nurse, to the time the patient left the ward, which is noted by the ward nurse in the patient chart. Time in clinic was measured from the time the research assistant recorded when the patient presented to the clinic clerk to the time the patient left the clinic and at the 6-week follow-up visit in clinic. The 2- and 6-week visits are typical follow-up times at our institution.

**Table 1. Inclusion and exclusion criteria**

<table>
<thead>
<tr>
<th>Inclusion criteria</th>
<th>Exclusion criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Mid-shaft femur fracture treated with intramedullary nailing</td>
<td>- Age &lt; 18 yr, or open growth plates</td>
</tr>
<tr>
<td>- Mid-shaft tibia fracture treated with intramedullary nailing</td>
<td>- Multiple fractures</td>
</tr>
<tr>
<td>- Forearm fractures treated with standard compression technique</td>
<td>- History of osteoporosis or osteopenia</td>
</tr>
<tr>
<td>- One or both bones fractured</td>
<td>- Age &gt; 50 yr</td>
</tr>
<tr>
<td>- Simple fracture or presence of single butterfly fragment treated with lag screw</td>
<td>- Dialysis patients</td>
</tr>
<tr>
<td>- Humeral shaft fractures treated with standard compression technique</td>
<td>- Surgeon feels patient should be excluded</td>
</tr>
<tr>
<td>- Ankle fractures treated with standard compression technique</td>
<td></td>
</tr>
<tr>
<td>- Clavicle fractures treated with standard compression technique</td>
<td></td>
</tr>
<tr>
<td>- Olecranon fractures treated with standard compression technique</td>
<td></td>
</tr>
</tbody>
</table>
the time the patient finished the encounter and presented once again to the clerk to obtain the next appointment.

To record adverse events that were either identified or missed by the screening radiographs, the following definitions were used. Controls in whom a surgeon identified a radiographic finding that led to a change in management noted on the follow-up form (Appendix 1) were deemed to have experienced a major event appreciated through the use of screening radiographs. Those cases where findings were identified on the radiograph, but did not require a change in management were deemed minor events. Patients in the experimental group in whom a radiographic change was identified on the final 6-week radiograph compared with the intraoperative fluoroscopy image were deemed to have experienced major events when accompanied by a complication or a change in management noted at the 6-week follow-up. Cases when a complication or a change in management was not noted or required were deemed minor events. Patients in the experimental group for whom surgeons were led to acquire a radiograph owing to clinical concerns are discussed in the results section.

Patient satisfaction was measured using the University of Leeds satisfaction survey, which was administered at the 2-week clinic visit (Appendix 1). This survey was designed for the outpatient setting in a musculoskeletal clinic (rheumatology clinic) and has previously demonstrated both reliability and internal stability.12 It was provided to both the control and experimental groups at the beginning of their visit. Satisfaction scores were compared between the 2 groups.

RESULTS

Of the 90 patients screened for the study, 39 consented to participate in the study and were randomized to the control or experimental group. The distribution of fracture type among study patients is illustrated in Table 3. Between 30 and 36 of the patients had data available for analysis for the immediate, in-hospital time point and for the 2-week time point. Twenty-six patients had data available for the 6-week time point. Patients in whom data were lacking for the 2-week time point. Twenty-six patients had data available for the 6-week time point and for the 2-week time point. Twenty-six patients had data available for analysis for the immediate, in-hospital time point and for the 2-week time point. Twenty-six patients had data available for the 6-week time point. Patients in whom data were lacking for the 2- and 6-week time points had missed the designated window of time for those follow-up visits. Table 4 lists patient data available at each time point.

Table 3. Patients enrolled, by anatomic location of fracture

<table>
<thead>
<tr>
<th>Anatomic location of fracture</th>
<th>No. of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Femur shaft</td>
<td>5</td>
</tr>
<tr>
<td>Tibia shaft</td>
<td>2</td>
</tr>
<tr>
<td>Ankle</td>
<td>16</td>
</tr>
<tr>
<td>Humerus shaft</td>
<td>1</td>
</tr>
<tr>
<td>Forearm</td>
<td>7</td>
</tr>
<tr>
<td>Clavicle shaft</td>
<td>3</td>
</tr>
<tr>
<td>Olecranon</td>
<td>5</td>
</tr>
</tbody>
</table>

There was a difference in mean cost of radiographs. The cost was $44.51 (95% confidence interval [CI] 38.64–50.38) in the experimental group, and $129.23 (95% CI 120.23–138.23) in the control group (p < 0.001). There was also a difference in the mean time in clinic at 2 weeks. Patients in the experimental group spent 46 min in clinic (95% CI 32–60), while those in the control group spent 68 min (95% CI 55–81, p = 0.018). There was no difference between the groups in the time spent in hospital immediately after surgery, in the time spent in clinic at 6 weeks, or in patient satisfaction measured in clinic (Table 4).

There were no major events missed in the experimental group by eliminating screening radiographs. There were no major events identified in the control group by using screening radiographs. Two complications occurred, both in the experimental group. These were diagnosed based on patient presentation and clinical findings and did not qualify as events as they were not missed. One patient with olecranon fracture fixation reported pain at the 2-week mark, which prompted radiographs. Early heterotrophic ossification was identified. One patient with an olecranon fracture had a repeat major trauma event within the first 6 weeks after surgery and presented with substantial pain and swelling, which prompted radiographs. Loss of fixation was identified and revised surgically.

These results were used to estimate the sample size for a noninferiority trial that would satisfactorily support the safety of omitting screening radiographs as described in this protocol. There were no major events missed. For the calculation, a low major event rate of 2%, which is close to zero, is proposed for convenience. It is also assumed that tolerance would be close to zero for missing a statistical difference between groups. As such, a 2% difference at most is proposed as acceptable classification as “no difference” in the analysis. Therefore, estimating a major event rate of 2% and accepting a no more than 2% difference as “no difference,” the sample size required for a noninferiority trial would be 1212 (power = 0.80, α = 0.05).

DISCUSSION

The present study measured cost savings of 65% and time savings of 30% through the reduction of screening radiographs. There was a difference in mean cost of radiographs. The cost was $44.51 (95% confidence interval [CI] 38.64–50.38) in the experimental group, and $129.23 (95% CI 120.23–138.23) in the control group (p < 0.001).

There were no major events missed in the experimental group by eliminating screening radiographs. There were no major events identified in the control group by using screening radiographs. Two complications occurred, both in the experimental group. These were diagnosed based on patient presentation and clinical findings and did not qualify as events as they were not missed. One patient with olecranon fracture fixation reported pain at the 2-week mark, which prompted radiographs. Early heterotrophic ossification was identified. One patient with an olecranon fracture had a repeat major trauma event within the first 6 weeks after surgery and presented with substantial pain and swelling, which prompted radiographs. Loss of fixation was identified and revised surgically.

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radiographs after fracture fixation. Screening radiographs are still broadly used by orthopedic surgeons, and as such, the projected savings would be considerable. While the average cost per radiograph is $41.19 in Manitoba, this appears to be representative of the cost in a sample of other provinces. The average cost per radiograph when considering Manitoba, Saskatchewan, Alberta, British Columbia and Ontario, is very similar at $39.21 (Appendix 1). As such, study findings appear applicable to other parts of Canada.

**Limitations**

Although randomized and prospective, the present study was small. The projection for patients available for enrollment was accurate; however, fewer patients consented to participate than anticipated, despite the noninvasive nature of the study. Although there is no clear reason for the low enrollment rate, enrolling patients postoperatively is a departure from other studies in our centre. This is the only potential cause identified for low enrollment. The study sample was further limited by the imposition of strict time windows for the 2- and 6-week follow-up visits, which were missed by a number of patients.

**Conclusion**

A noninferiority trial to identify the safety of omitting early screening radiographs would require a large number of patients and, therefore, substantial funding and likely multicentre involvement. Nevertheless, based on the present study, the collection of data is expected to be simple, as there are few data points of interest. Additionally, the duration of follow-up in the present study was brief compared with most prospective studies. The rigidity of the timing for patient follow-up significantly decreased the sample size for this study. Increasing the follow-up windows would rectify this issue. Additionally, screening and enrolling patients preoperatively may increase participation. Although this is not entirely clear, the protocol would not suffer if changed accordingly. Finally, the literature suggests that hip fractures and distal radius fractures could also be included in the protocol.2–5 As such, opening the study to more fracture types would not only increase the sample size, but also the generalizability of findings. Taking all this together, it appears possible to complete a noninferiority trial to speak to the safety of the protocol and to provide definitive proof supporting a change in practice.

**Affiliations:** From the Department of Surgery, University of Manitoba, Winnipeg, Man.

**Competing interests:** None declared.

**References**


Table 4. Comparison of results for the experimental and control groups

<table>
<thead>
<tr>
<th>Result</th>
<th>Group; mean (95% CI) or no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of radiographs over first 6 wk (n = 26), Canadian dollars</td>
<td>Experimental group 44.51 (38.64–50.38) Control group 129.23 (120.23–138.23) p value* &lt; 0.001</td>
</tr>
<tr>
<td>Time in clinic at 2-week follow-up (n = 36), min</td>
<td>46 (32–60) 68 (55–81) p = 0.018</td>
</tr>
<tr>
<td>Time in clinic at 6-week follow-up (n = 26), min</td>
<td>69 (55–84) 61 (47–74) p = 0.38</td>
</tr>
<tr>
<td>Time to hospital discharge (n = 35), h</td>
<td>53 (27–78) 92 (43–141) p = 0.22</td>
</tr>
<tr>
<td>Patient satisfaction score (n = 30)</td>
<td>3.0 (2.8–3.1) 2.8 (2.6–3.0) p = 0.12</td>
</tr>
<tr>
<td>No. minor missed events (no change in management required; n = 26)</td>
<td>2 0 χ² = 0.8586</td>
</tr>
<tr>
<td>No. major missed events (change in management required; n = 26)</td>
<td>0 0</td>
</tr>
</tbody>
</table>
Cost savings of outpatient versus standard inpatient total knee arthroplasty

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Background: With diminishing reimbursement rates and strained public payer budgets, a high-volume inpatient procedure, such as total knee arthroplasty (TKA), is a common target for improving cost efficiencies.

Methods: This prospective case–control study compared the cost-minimization of same day discharge (SDD) versus inpatient TKA. We examined if and where cost savings can be realized and the magnitude of savings that can be achieved without compromising quality of care. Outcome variables, including detailed case costs, return to hospital rates and complications, were documented and compared between the first 20 SDD cases and 20 matched inpatient controls.

Results: In every case–control match, the SDD TKA was less costly than the inpatient procedure and yielded a median cost savings of approximately 30%. The savings came primarily from costs associated with the inpatient encounter, such as surgical ward, pharmacy and patient meal costs. At 1 year, there were no major complications and no return to hospital or readmission encounters for either group.

Conclusion: Our results are consistent with previously published data on the cost savings associated with short stay or outpatient TKA. We have gone further by documenting where those savings were in a matched cohort design. Furthermore, we determined where cost savings could be realized during the patient encounter and to what degree. In carefully selected patients, outpatient TKA is a feasible alternative to traditional inpatient TKA and is significantly less costly. Furthermore, it was deemed to be safe in the perioperative period.

Contexte : Dans le contexte de budgets publics serrés et de taux de remboursement à la baisse, une intervention chirurgicale en service interne à volume élevé, comme l’arthroplastie totale du genou, est souvent ciblée pour améliorer le rapport coût–efficacité.

Méthodes : Cette étude cas–témoins prospective a fait une analyse de minimisation des coûts de l’arthroplastie totale du genou en chirurgie d’un jour et en service interne. Nous avons examiné si et où des économies peuvent être réalisées et l’ampleur des économies pouvant être obtenues sans compromettre la qualité des soins. Les variables dépendantes, notamment les coûts détaillés des cas, le taux de retour à l’hôpital et les complications, ont été documentées, puis comparées entre les 20 premiers cas de chirurgie d’un jour et 20 cas–témoins appariés de chirurgie en service interne.

Résultats : Pour chaque appariement cas–témoins, l’arthroplastie totale du genou en chirurgie d’un jour était moins coûteuse que la chirurgie en service interne et a généré des économies médianes d’environ 30 %. Les économies découlaient principalement des coûts associés à l’hospitalisation du patient tels que les coûts de l’unité de soins chirurgicaux, de la pharmacie et des repas du patient. Après 1 an, ni l’un ni l’autre des 2 groupes ne présentait de complications majeures, de retours à l’hôpital ou de réadmissions.

Conclusion : Nos résultats concordent avec les données antérieures publiées sur les économies associées à l’arthroplastie totale du genou pratiquée en chirurgie d’un jour ou en service interne de courte durée. Nous sommes allés plus loin en documentant également où les économies se situaient dans un modèle cas–témoins. De plus, nous avons déterminé les aspects de la rencontre avec le patient où des économies pourraient être réalisées et l’ampleur de ces économies. Chez des patients soigneusement choisis, l’arthroplastie totale du genou en chirurgie d’un jour est une solution de rechange envisageable à l’arthroplastie totale du genou traditionnelle en service interne et est beaucoup moins coûteuse. De plus, elle a été jugée sécuritaire en période périopératoire.
Total knee arthroplasty (TKA) is considered a highly cost-effective procedure, on par with procedures such as hemodialysis. There was an increase of 250,000 cases of TKA performed between 1991 and 2010 in the U.S. Medicare population, accounting for a 160% increase in volume. Similarly, in Canada the number of hip and knee replacements increased by 13% between 2006 and 2011 and by 87% in the 10 years preceding that. Diminishing third party payer reimbursement rates and strained public payer budgets have made procedures such as TKA a common target for improving cost efficiencies. Bundled payment programs are also providing substantial incentives to create more efficient TKA protocols, which include standardized care pathways in most major centres.

Since its establishment, inpatient hospital stay has been and continues to be the standard of care following TKA. However, within the past decade, the concept of outpatient TKA programs has been reported. Berger and colleagues showed promising results with an outpatient TKA program first in selected patients and then in an unselected cohort. In both studies, the authors showed successful discharges within 24 hours following TKA with low hospital readmission rates.

Given the demonstrated safety of outpatient TKA, there is great interest among health care providers and hospital administrators in characterizing its financial impact. The purpose of this study was to compare the cost minimization of a pilot outpatient same-day discharge (SDD) TKA program to that of standard inpatient TKA in matched patients. Specifically, we sought to determine both the nature and extent of any cost savings.

**METHODS**

This prospective case–control study was conducted in accordance with the Declaration of Helsinki with the aim to compare the cost minimization of outpatient versus inpatient TKA. Accordingly, we obtained institutional ethics approval before the study began. Outpatient, as described in the study, refers to discharge on the same day of surgery with no overnight stay (SDD). Data from both SDD and inpatient TKA cases from a single surgeon’s practice in a tertiary academic medical centre were prospectively collected between September 2012 and October 2013. Outcome variables, including detailed case costs, patient-centred satisfaction scores, return to hospital rates and 90-day complications, were documented and compared between the first 20 SDD cases and 20 matched inpatient controls.

**Patient selection**

Same-day discharge patients were selected preoperatively based on low age-adjusted Charlson Comorbidity Index (CCI), age younger than 75 years, stable medical health with a willing caregiver at home, and patient willingness to participate in the voluntary SDD TKA program. They also had to live within 45 minutes of the hospital and have access to standardized, government-funded home care. These patients were then matched to control patients from the same surgeon’s practice who were undergoing TKA at the same site in the same fiscal year and who were enrolled in the standard inpatient clinical pathway, which was a typical contemporary rapid rehabilitation program aiming for a length of stay (LOS) of 48 hours. Patients were matched based on fiscal year, age, sex, body mass index (BMI) and comorbid conditions according to the age-adjusted CCI.

**Clinical pathways**

The patients were placed and treated in their respective pathways following standardized patient care maps, which included patient physiotherapy starting on postoperative day (POD) 1 and standardized clinical follow-up. All patients attended a mandatory preoperative clinic assessment with multidisciplinary resources, including social work and physiotherapy, to educate them about their upcoming procedure and address pertinent questions. This assessment occurred 4–10 weeks before the scheduled surgery date and was distinct from the preoperative assessment with the nursing and anesthesia teams which occurred 2–4 weeks before surgery. At both visits, expectation on LOS was reinforced for outpatient and inpatient protocols. All patients received similar anesthetic regimens, including spinal anesthetic where possible and standardized postoperative analgesic and antiemetic treatments. Specifically, the SDD protocol was geared to the patient being discharged on the same day of surgery after receiving a second dose of intravenous cefazolin at 8 h or vancomycin (if there was a documented allergy to cefazolin) at 10 h postoperative. Patients also had to successfully complete a mobilization test with a physical therapist that included the use of stairs. The SDD protocol included a postoperative visit from a home care nurse for a wound dressing evaluation on POD 1 and standardized physiotherapy. In contrast, the inpatient group received daily physiotherapy starting on POD 1 and a wound dressing change. They were discharged once they were able to safely ambulate independently and remained stable medically with only oral analgesic requirements. Both groups had standardized follow-up clinic visits at 2 weeks, at which time the skin staples were removed, and at 6 weeks, 3 months and 1 and 2 years.

**Cost data**

We obtained detailed case costs, including comprehensive financial breakdown of direct, indirect and total costs, from the hospital’s finance department. Direct costs included all...
costs related directly to patient care, such as labour and supply costs; indirect costs comprised general operating expenses and overhead. A detailed description of the various cost components is provided in Appendix 1, available at canjsurg.ca. All hospital costs were collected in accordance with the Ontario Case Costing Initiative (OCCI), a standardized medical case costing system for Ontario hospitals based on Management Information Systems (MIS) and Ontario Healthcare Reporting Standards (OHRS) standards.8

Cost-centred outcomes

We compared median costs and differences among indirect, direct and total costs between SDD cases and matched inpatient controls. Any failure to discharge, with subsequent overnight stays or admission to hospital, and any return to hospital encounters within 90 days, regardless of whether the patient was admitted, were included into the patient’s cost. The cost of the home care visit from the nurse was also included in the SDD group. A home visit from physical therapy was provided to all patients in both groups as part of a rapid rehabilitation and discharge incentive program and was therefore considered cost-neutral.

Statistical analysis

Basic descriptive statistics (means and standard deviations for normalized data, and medians and ranges for skewed data) are reported as appropriate. For each variable, normality was assessed with a Shapiro–Wilk test, and non-parametric tests were used when necessary. We compared aggregate costs for both cohorts, including a breakdown of direct and indirect cost attributes. All statistical analyses were conducted using SPSS software version 22 (IBM).

RESULTS

Demographic characteristics of the study sample are presented in Table 1. There were no significant differences between the groups for age, sex, BMI or CCI, suggesting they were homogeneous comparison cohorts.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>SDD, n = 20</th>
<th>Inpatient, n = 20</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex, male:female</td>
<td>14:6</td>
<td>14:6</td>
<td>&gt; 0.99</td>
</tr>
<tr>
<td>Age, yr</td>
<td>58.5 ± 5.6</td>
<td>61.5 ± 5.9</td>
<td>0.40</td>
</tr>
<tr>
<td>BMI</td>
<td>29.0 ± 3.7</td>
<td>30.6 ± 5.3</td>
<td>0.27</td>
</tr>
<tr>
<td>CCI</td>
<td>2 (1–3)</td>
<td>2 (1–4)</td>
<td>0.30</td>
</tr>
<tr>
<td>LOS, d</td>
<td>0 (1–3)</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

BMI = body mass index; CCI = Charlson Comorbidity Index; IQR = interquartile range; LOS = length of stay; NA = not applicable; SD = standard deviation; SDD = same-day discharge.

The median LOS was 2.8 (range 1–5) days for the inpatient group, which was less than the median discharge times in 2012–2013 in the province of Ontario, in keeping with an accelerated inpatient protocol. All patients in the SDD group were discharged within 10 h of surgery as planned. In every case–control match, the SDD TKA procedure was less costly than the inpatient procedure and yielded a 30% median cost savings (Appendix 1 gives representative costing for an outpatient case). Specifically, the total hospital median costs for an inpatient case was $9643.06 (range $6458.54–$14 201.67) compared with $6487.50 (range $5168–$11 490.36) for the SDD group, for a difference in median costs of $3155.56 or 32.7%. This cost reduction was shared between both direct and indirect cost attributes (Fig. 1). A more specific cost breakdown of the various aspects of patient care between the 2 groups is shown in Figure 2. The inpatient group spent more time in the postanesthesia care unit (PACU) than the SDD group, leading to a significant difference in costs between the groups. This variable was negatively influenced for the inpatient group by hospital occupancy; inpatients typically had prolonged stays in the PACU while waiting for their beds on the ward owing to delayed discharges and hospital occupancy levels above capacity. This was not captured directly for this study, but it is important to note that medical discharge criteria from the PACU were identical for both cohorts. As expected, other significant contributing costs unique to the inpatient group included surgical floor care costs (mean $1869 per inpatient), pharmacy costs (mean $1026.50 per inpatient), and other hospitalization costs (mean $3759 per inpatient).
$543 per inpatient) and patient meals (mean $117 per patient). The high outlier SDD case was due to an additional augment component and a prolonged PACU stay corresponding to additional indirect cost inflation.

At 1 year, there were no major complications and no return to hospital encounters for either group and no readmissions. Minor complications included 2 patients within the first 10 cases in the SDD group with transient vasovagal episodes occurring on the day of surgery, which resolved with fluid resuscitation; no patients among the latter 10 SDD cases experienced complications. No patients failed discharge or returned to hospital.

**DISCUSSION**

While the merits of same day unicompartmental arthroplasty (UKA)\(^9,10\) are well documented and accepted, outpatient TKA has been much less frequently reported, likely owing to concerns of patient safety and questions surrounding its true cost minimization once societal costs have been factored in. Berger and colleagues\(^5\) reported a discharge rate within 24 hours of operation of 94% in an unselected cohort of patients undergoing same-day TKA. We have confirmed the safety of outpatient TKA and further demonstrated savings of 30% of the inpatient costs, which averaged approximately $3100 per patient in the Canadian system. There was a reduction in both direct and indirect costs with a majority of the savings coming from surgical floor care, patient meals and inpatient pharmacy costs and physiotherapy.

Our study also had no readmissions and no major complications in the outpatient cohort. Two outpatients (within the first 10 SDD cases) experienced vasovagal episodes postoperatively before discharge. There were no recurrences after modifications to the anesthetic and postoperative analgesia protocol, and neither episode prevented SDD. Although the study clearly showed a significant cost differential, it remains a pilot study and is underpowered to detect any added complication risk, specifically because the outpatient cohort was carefully selected preoperatively. The nursing visit was established to reassure patients and the surgical team that the wound dressing could be changed within 24 hours and that a general assessment could be performed for any medical concerns.

Our findings are on par with those of previous studies of outpatient arthroplasty patients. Lovald and colleagues\(^11\) performed a comparison in the US Medicare population of outpatient TKA versus short (1–2 d) inpatient stay, standard (3–4 d) inpatient stay, or extended (≥ 5 d) inpatient stay. There were mean cost savings of $8527 USD for the outpatient cases compared with the most common standard (3–4 d) LOS cohort.\(^11\) Similarly, Aynardi and colleagues\(^12\) compared...
the outcomes and cost-effectiveness of outpatient versus inpatient total hip arthroplasty (THA) on a selected patient population in a case-control study. Similar to our outcomes, they found a significantly decreased cost for the outpatient cohort compared with the inpatient cases ($24 529 v. $31 327, \textit{p} < 0.001), with no differences in complications or estimated blood loss between the groups.\textsuperscript{12} The trend in these studies is that patients in the outpatient group have a lower comorbidity profile. Conversely, our matched cohorts did not show any significant difference in age, BMI or comorbidity index. Furthermore the median LOS was closer to 3 days in keeping with younger, healthier patients. Our study also found no increased rates for readmission for the outpatient group, and they did not have an increased likelihood of complications—a fact likely attributed to the standardized patient pathway that included preoperative education, home nursing visits and modern occlusive dressings.

The financial benefits associated with outpatient THA can have an immense impact on the operating budgets of public hospitals. Health care spending in Canada has continued to grow since the inception of the \textit{Canada Health Act}. Currently, Canada spends approximately 11\% of its gross domestic product (GDP) on health care, a number that is expanding by approximately 2\% per year.\textsuperscript{11} In Ontario, approximately 42\% of tax dollars are allocated to health care, a number that is expected to rise if spending is not curtailed.\textsuperscript{14} Classically, hospitals were funded on a global budget, a provider-centric model based on nonmedical factors, including previous budgets, rates of inflation, capital investment decisions and lobbying. The Ontario government now has a new objective, evidence and health-based allocation model.\textsuperscript{15} Quality-based procedures (QBP), such as THA, are reimbursed a specific dollar figure based on the 40th percentile of the provincial average cost of the procedure, with hospital-specific multipliers for patient medical complexity. From a cost perspective, an outpatient THA program can create the opportunity for value in patient care, where value can be defined as providing an equivalent level of care at a reduced cost.\textsuperscript{16} The cost per case in this study came well under the QBP price paid by the provincial Ministry of Health, and helped to subsidize higher-cost revision cases. In fact, the cost per case may be further reduced now given the recently improved costing methods implemented in Ontario, as the year-to-year differences and the wide range of costs in this study would likely be eliminated. The concerns that some of the costs of outpatient surgery will be borne by the patient are also unfounded. For example, physiotherapy costs in the first 2 weeks are borne by the public health care system in the form of home care, regardless of whether the patient is an inpatient or outpatient. Furthermore, the advent of novel occlusive dressings that can be left on has already reduced the need for the nursing visits as a routine in our current practice,\textsuperscript{17} resulting in more savings.

\section*{Limitations}

The strengths of this study rely upon detailed hospital costing methodologies, which accurately portray the direct, indirect and total costs attributed to the care of both cohorts of patients. Furthermore, the groups were closely matched on patient demographics known to influence the cost of health care. The limitations of this pilot study lie in its small sample size, as it may have been underpowered to identify any added complication risks. Patient selection may also be perceived as a weakness as our patients were generally healthier and moderately younger than the average THA patient. This is, however, becoming more relevant as North American trends forecast continued growth in the percentage of patients younger than 65 years expected to receive THA, which is now well over 50\% and represents a major contributor to the absolute annual increases seen in both countries.\textsuperscript{18} The 30\% savings estimate approaches previously reported inpatient cost estimates for primary THA, where 28\% of total costs were allocated to the room and board and ward costs.\textsuperscript{2,19} As such, the costs incurred are likely representative of savings that other hospitals could realize given that the median LOS of 3 days in the inpatient cohort would be expected for similar patients in other settings.

\section*{Conclusion}

Outpatient THA is a safe and cost-effective alternative to inpatient THA in selected individuals. Savings were achieved largely from costs associated with the inpatient stay, including ward, pharmacy and meal costs. Future studies will be required to confirm the safety of this protocol in unselected patients, and efforts to enhance the safety of the pathway could make this a more mainstream alternative beyond the increasingly younger and healthier cohort of patients undergoing THA.

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\section*{Competing interests}

None declared.

\section*{Contributors}

A. Huang and G. Dervin designed the study. A Huang acquired the data, which all authors analyzed. All authors wrote and reviewed the manuscript and approved the final version for publication.
References

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Why wait until residency? Competency-based education in longitudinal integrated clerkships

John Quinn Gentles, BSc

This essay was selected as the winner of the 2015 Canadian Undergraduate Surgical Education Committee student essay competition. It was written in response to the prompt: “How is your school preparing you for residency — be it surgical or medical?”.

There is an increasing understanding at the University of British Columbia (UBC), Canada, and internationally of the importance of an integrated curriculum in undergraduate medical education. One of the ways UBC medicine is putting this theory into practice is through its integrated community clerkship programs. These programs are a model of third-year medical education better known as longitudinal integrated clerkships (LICs). Instead of the traditional rotation-based clerkship (RBC) approach in which students spend a set amount of time in single disciplines during their third year of medical school, the LIC program enables students with the desire and drive for a more self-directed experience to integrate their learning and define their own education. LIC students complete their core program objectives and clinical experiences in all disciplines simultaneously throughout their clerkship year. The result of this approach is that a student’s progression through an LIC program does not depend on the amount of time a student spends within a particular discipline, but rather the student’s competency within that discipline. As such, LICs represent an invaluable opportunity for the incorporation of competency-based medical education at the undergraduate level.

Benefits of this approach include greater appreciation for continuity of care, increased independence and responsibility in patient care, and enhanced participation in interprofessional teams. This is partly because throughout the LIC program students are encouraged to follow patients through different clinical contexts from the initial presentation of their disease and illness through its various treatment modalities and ultimate resolution. I will never forget the time I was working on a general surgery service and was consulted on a patient presenting with ascites. Two weeks later working in a gynecology clinic I saw that same patient in consultation for the ovarian cancer we had diagnosed. Through this exposure students are better able to appreciate continuity of care across health care disciplines and gain a better sense of independence in the care of patients. This level of integration and responsibility facilitates the progression of the clerk through the early stages of their clinical education to the point where they become the primary care provider all under the careful supervision of preceptors that have been working closely with them throughout their third year of medical school.

LIC experiences also provide longitudinal mentorship and assessment, which facilitates better acquisition of higher-level knowledge and clinical skills as compared with RBCs. Hauer and colleagues studied how the role of a clerk differs between LICs and RBCs and found that LIC students consistently take on more advanced clinical roles in the care of their patients earlier in their training and to a greater extent than their RBC peers. One study found that...
with respect to surgical training specifically, LIC students received more than 1.6 times as much operating room exposure, see 3 times as many surgical cases, and are the first assistant 4 times as often as their RBC peers. This increased expectation and opportunity is largely because students in LIC programs benefit from longitudinal relationships with both their clinical preceptors and their patients. At UBC, LIC students are paired with a family doctor with whom they will work on a weekly basis for their entire third year to facilitate this mentorship and training. Without the limitation of rotations that may involve working with multiple preceptors in just a few weeks, LIC clerks have the benefit of time to develop their competency and build a professional relationship with their preceptors. Once a preceptor knows a student well and has had the chance to personally assess their competence, they are better able to decide which clinical decisions and activities they can trust the student to perform independently. This longitudinal approach is not only ideal for giving trainees a gradual and holistic approach to increasing their clinical acumen and skill level, but also provides preceptors with a far greater ability to assess the strengths, weaknesses and, most importantly, the progress of their students.

It is well documented that LIC students achieve equivalent or better performance on standardized exams than their RBC counterparts; however, I would argue that the true strength of LICs is that they provide optimal preparation for competency-based training within residency. LICs already base the expectations and responsibilities of students on their competency, not on the amount of time they have spent within a particular discipline. As discussed, the longitudinal format of these clerkships provide the time necessary for preceptors to assess their students’ competency and trust that competency in the care of their patients. Hirsh and colleagues4 argued that providing “time to trust is necessary to realize competency-based education.” My question is why does this have to wait until residency? The answer is that it doesn’t. LICs already exemplify competency-based education at the medical undergraduate level. Both in their format and approach, LICs are far more congruent with competency-based postgraduate residency training than traditional rotation-based clerkships. What better preparation for residency can a clerk obtain than a training program that promotes the roles, responsibilities and assessment expected of a junior resident?

I feel incredibly fortunate to be part of an LIC program for my third year at UBC. I believe that the LIC model is preparing me for residency with a competency-based approach. I have the unique opportunity to guide my learning, gradually develop my clinical skills and understand the complexity and interdependence of services in the care of my patients — all with a level of preceptor continuity that is unparalleled. Completing a third year that pushes me beyond the role and responsibilities of a traditional clerk can be intimidating at times, but it is also tremendously exciting and gratifying. Already I serve a meaningful role as part of the health care team, I feel the sense of duty and responsibility that comes with following my own patients as they navigate their care, and I know that this approach is the best possible preparation for the challenges of residency and my future career.

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References

A new fixation-free 3D multilamellar preperitoneal implant for open inguinal hernia repair

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SUMMARY

Between September 2014 and December 2015, 32 patients with inguinal hernia were treated using a new 3D mesh in our department. This mesh is characterized by a multilamellar flower-shaped central core with a flat, large-pore polypropylene ovoid disk that has to be implanted preperitoneally. Compared with the traditional Lichtenstein procedure, we observed a shorter mean duration of surgery and a significantly lower mean visual analogue scale (VAS) postoperative pain score recorded immediately after the procedure in the 3D mesh group. The mean VAS score recorded after 4 and 8 postoperative days showed better results in the 3D mesh group than the control group. Moreover, there was reduced postoperative morbidity in the 3D mesh group than the control group, even if no patients experienced severe complications.

The use of a polypropylene mesh during a tension free repair of an inguinal defect represents the standard of care in the majority of centres. However, in the last few decades, prosthetic hernia techniques have been implemented through the use of different types of mesh, including those with 3D structures.

A deep fixation of the mesh is well accepted as a cause of many common complications, including chronic pain. Owing to these considerations, several types of mesh that eliminate the need for fixation have been produced and studied; one of these is the Freedom ProFlor Inguinal Hernia Implant (Insightra Medical Inc.), a large, porous polypropylene mesh that uses the flexible properties of polypropylene to form an additional multilamellar flower shape similar to a radial spring. This 3D mesh is characterized by a dual system that involves a synthetic and permanent polypropylene implant and a reusable dilation and deployment tool made from plastic tubing. Attached to the central core there is a flat, large-pore polypropylene ovoid disc measuring 8 × 10 cm that has to be implanted preperitoneally into the defect to protect the repair and stabilize the device.

Between September 2014 and December 2015, 32 patients with inguinal hernia were treated using the 3D mesh in our department. A 1:1 ratio retrospective case–control analysis was performed with a control group of patients treated with a traditional large-pore polypropylene mesh during the same period. The description of the study and our results are reported in Appendix 1, available at canjsurg.ca.

A Lichtenstein technique was used in all controls treated with standard polypropylene mesh. For the 3D mesh, 2 different sizes of central core were used (2.5 cm and 4 cm), depending on the width of the hernia opening. After the opening of the external oblique aponeurosis, the hernia sac was isolated from the spermatic cord. Then a careful and gentle dissection of parietal peritoneum from the posterior abdominal wall was performed using the specific device. In this phase accurate control of the hemostasis is a crucial step to place the mesh safely. The width of dissection has to be appropriate to achieve a preperitoneal free space large enough to allow
positioning of the implant’s disc. The mesh was then compressed and loaded into the tube system (Fig. 1A). Subsequently, the tube system was inserted into the hernia defect to release the mesh into the preperitoneal space (Fig. 1B). The tube was then pulled back, taking care that the polypropylene disc remained beyond the posterior abdominal wall. After delivery, the flower shape multilamellar core fully obliterated the hernia defect (Fig. 1C-D). In cases of indirect hernia, the mesh was placed from the internal inguinal ring, and the spermatic cord’s structures were not compressed by the lamellas (Fig. 1C). For direct hernias the mesh was directly placed into the preperitoneal space from the hernia opening (Fig. 1D). No stitches were necessary to stabilize the mesh or reduce the hernia opening. Closure of the external oblique fascia was routinely performed using absorbable running sutures. Skin closure was performed with separate intradermal monofilament absorbable stitches.

Even if the use of polypropylene mesh allows the development of a tension-free technique, a high level of postoperative discomfort and chronic pain is still described. Several studies developed a new type of implant to eliminate the necessity of fixation, improving scar tissue formation within the mesh.

Based on these considerations we moved to the use of this new type of mesh, reconsidering our standard technique with the polypropylene implant following the traditional Lichtenstein procedure.

In our experience, the use of this new fixation-free 3D multilamellar mesh substantially reduced the duration of surgery compared with traditional techniques, such as the Lichtenstein procedure. This result should be related to the absence of the fixation phase of the operation. The 3D mesh is placed in the preperitoneal space after the preparation of the layer that is facilitated by using the specific device. In our experience this procedure is easy and short to perform; furthermore, we speculate that the learning

Fig. 1. (A–B) The 3D mesh is inserted in the tube system and placed into the preperitoneal space. (C) For indirect hernias, the mesh is placed into the internal inguinal ring without compression on the spermatic cord. (D) For direct hernias, the mesh is placed directly from the hernia opening.
curve for this procedure would be short. Despite this report representing our first experience using this 3D mesh, no complications related to the technique were observed, highlighting the safety and feasibility of this procedure.

Our most important result was the substantially lower postoperative pain and discomfort recorded in the 3D mesh group than the Lichtenstein group. This was further confirmed after 4 and 8 postoperative days. These outcomes could be related to the absence of stitches needed to fix the mesh, which can be one of main causes of postoperative patient discomfort. Certainly every preperitoneal mesh is placed far from the nerve, reducing the possible risk of postoperative pain. Nevertheless, owing to its peculiar 3D structure, this type of mesh results in no dislodgement and apparently less or no pain and discomfort. However, the absence of recurrence and chronic pain in both groups shows the efficacy and validity of the traditional technique.

CONCLUSION

In our initial experience, the use of this new fixation-free 3D multilamellar mesh can be considered a safe and viable option for inguinal hernia repair, resulting in a shorter duration of surgery and substantially less postoperative pain and lower morbidity than traditional polypropylene mesh.

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Informed consent for surgery: risk discussion and documentation

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Informed consent for surgery has become a critical component of surgical practice. There are specific legal requirements for what has to be disclosed to patients and for the accompanying documentation. The hospital consent for surgery form with the patient’s signature is a small part of the process. A quality assurance review of the documentation of informed consent by our surgical group indicated major deficiencies and prompted this article (and its Appendix containing further information). Our intent was to inform surgeons about modern standards and to discuss particular challenges. Informed consent for surgery entails what surgeons communicate to their patients about the proposed surgery and is a key element in the trust patients have in surgeons. It is of increasing importance, and we must keep up to date with patient and legal expectations.

The Canadian Medical Protective Association reports that over a recent 5-year period, 65% of medical legal actions involving informed consent were surgical and only 21% of these cases were decided in favour of the surgeon.1 We examined the documentation of informed consent by general surgeons at the General Campus of the Ottawa Hospital and found it to be poor (Appendix 1, available at canjsurg.ca). We suspect this is not unique to our group.

Prior to obtaining consent for the proposed surgery, the surgeon must provide the patient with information about the nature of the surgery, the expected benefits, material risks and adverse effects, alternate treatments and the consequences of not having the surgery. Material risks include risks common to all surgery and risks specific for the proposed surgery, even if they are rare. Risks that may cause the patient to refuse surgery are especially important, and the specific circumstances for individual patients, such as work responsibilities, family issues, religious beliefs and insurance coverage, have to be considered. Because not all of the hundreds of conceivable risks for an operation can be discussed, surgeons have to use their clinical judgment in the discussion. Supporting documents can contribute to the discussion, but they are not a substitute for oral communication. Surgery without consent can be done only in emergency situations when the patient is not capable and no substitute decision-maker is available.

Challenges to obtaining informed consent may arise. Surgery produces anxiety in patients, and some display this stress more than others. Hearing their surgeon iterate a long list of things that can go wrong is frightening. Although patient autonomy includes the right to refuse necessary surgery and the “therapeutic privilege” of withholding information is outdated,4 we want to minimize patients’ fear and avoid anxiety-induced excess catecholamine release causing problems at administration of anesthesia. The surgeon’s calm, reassuring
demeanour goes a long way in relieving this stress. Family members can be helpful with the occasional patient who does not wish to hear about any potential complications.

Another challenge can be a language barrier when a friend or family member translates the surgeon’s explanations into brief sentences, with the patient receiving a fraction of the information provided. A hospital interpreter can be a valuable resource.

Part of the discussion requires surgeons to make reasonable attempts to answer the patients’ questions. The majority of these questions are straightforward, and a simple, clear response usually suffices to bring relief to the patient and their concerned family. With all the information available on the Internet, patients may wish to engage in an intensive, detailed discussion, and the surgeon must be patient while facilitating their understanding of the wealth of data they have acquired.

Proper documentation is the only objective measurement of what information was communicated to the patient and provides legal protection for the surgeon. The defence of “I cannot remember this particular patient but my usual practice is…” does not suffice. Although consent can be implied or expressed orally, consent for surgical procedures requires recorded documentation. The minimum recommended documentation is the date of the dialogue, who was involved, material and unique risks discussed, any special circumstances of the patient, the risk of not having the surgery and whether consent was obtained or refused.2 A frequent finding in our retrospective chart review was that the documentation of the informed consent discussion was found in the operating room (OR) report, dictated after completion of the procedure (Appendix 1). If a complication occurs in the OR, documentation after the fact about the discussion of that particular risk is of questionable value.

The following is an example of proper documentation of an informed consent discussion.

The patient was advised that laparoscopic cholecystectomy was indicated to prevent further episodes of pain and complications from the gall stones. The nature of the surgery and the risk of conversion to open laparotomy for unexpected bleeding, infection or injury to an organ during the operation was discussed with the patient and her husband. We talked about the postoperative course and potential complications, including wound infection and herniation. I advised them of common risks for all surgery, such as pneumonia and venous thrombosis. She understood and wished to proceed with surgery. The surgery will be delayed until after her daughter’s wedding.

Templates may facilitate proper documentation and serve to remind the surgeon of important details to include in the discussion with the patient, although the discussion and documentation have to be individualized for each patient. Audiovisual recording of the consent process is common in the United States and could be useful in Canada if the surgeon anticipates a very difficult, contentious process. The assistance of an experienced colleague and a legal professional would be prudent in such a situation.

The dialogue and documentation of informed consent for surgery have evolved from a brief chat and a quick signature into a major and sometimes complex component of surgical practice. We can anticipate more changes in the future in response to patient expectations regarding communication and information. It is important to keep up to date with and fulfill the medical legal requirements in the policies of the provincial regulatory authorities.

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