First Canadian experience with donation after cardiac death simultaneous pancreas and kidney transplants

Results and limitations of outpatient and overnight stay laminectomies for lumbar spinal stenosis

The usefulness and costs of routine contrast studies after laparoscopic sleeve gastrectomy for detecting staple line leaks

Improving spine surgical access, appropriateness and efficiency in metropolitan, urban and rural settings

**SPONSORS**

Canadian Association of General Surgeons
Canadian Society of Surgical Oncology
Canadian Association of Thoracic Surgeons
Department of Surgery, Dalhousie University
James IV Association of Surgeons
Department of Surgery, University of Toronto

Department of Surgery, University of Calgary
Département de chirurgie, Université de Sherbrooke
Department of Surgery, McMaster University
Département de chirurgie, Université de Montréal
Department of Surgery, Western University
Q. WHAT IS HS?
A. Hidradenitis Suppurativa (HS) is a chronic, painful, inflammatory skin disease which affects 1-4% of the general adult population. It is characterized by boils usually occurring where certain sweat glands are located, such as under the breasts, buttocks and inner thighs. The boils can develop and connect, forming draining sinuses which discharge foul-smelling pus.

Q. WHAT CAUSES HS?
A. The cause of HS is unclear. It is thought that certain genetic markers and defects within hair follicles are at the root of the disease. Risk factors include smoking and obesity. About one-third of patients report a family history of HS. HS has been reported to co-occur with several comorbid conditions—mostly, inflammatory bowel disease.

Q. HOW DOES HS IMPACT QUALITY OF LIFE?
A. HS is often undiagnosed or misdiagnosed. It interferes with social interactions, job performance and intimate relationships—often leading to isolation. It is painful and causes embarrassment.

Q. DO PEOPLE SUFFERING FROM HS GO TO THE ER FOR TREATMENT?
A. People with HS come to the emergency room in severe pain and discomfort requiring assistance with the draining of the boils during a flare-up. It’s not unusual for patients to go home undiagnosed.

Q. IS THERE A CURE FOR HS?
A. There is currently no cure for HS. Early diagnosis and proper management is important for a patient’s quality of life. The first step for those with HS is to speak to their dermatologist to get an accurate diagnosis.

Q. HOW CAN HS BE TREATED?
A. Medical treatments for HS have included antibacterial washes, topical clindamycin, various systemic antibiotics, hormonal therapies, systemic retinoids, laser treatment, intralesional steroid injections and biologics. Surgical de-roofing or wide excision procedures have long been the definitive treatment for severe HS. There is no guarantee that HS will not recur in the previously excised areas.

References:
<table>
<thead>
<tr>
<th>Page</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>292</td>
<td>Doctors caught in Feds’ crosshairs — again</td>
<td>E.J. Harvey</td>
</tr>
<tr>
<td>293</td>
<td>Les médecins dans la mire du fédéral — encore une fois</td>
<td>E.J. Harvey</td>
</tr>
<tr>
<td>294</td>
<td>Continuing a long tradition: the Canadian Journal of Surgery at 60</td>
<td>V.C. McAlister, E.J. Harvey</td>
</tr>
<tr>
<td>296</td>
<td>Calgary, Edmonton and the University of Alberta: the extraordinary medical mobilization by Canada’s newest province</td>
<td>M.P. Da Cambra, V.C. McAlister</td>
</tr>
<tr>
<td>300</td>
<td>Role for laparoscopy in the management of bile duct injuries</td>
<td>V. Gupta, S. Jayaraman</td>
</tr>
<tr>
<td>316</td>
<td>Intraoperative ultrasonography of the biliary tract using saline as a contrast agent: a fast and accurate technique to identify complex biliary anatomy</td>
<td>A. Chandra, V. Gupta, R. Rahul, M. Kumar, A. Maurya</td>
</tr>
<tr>
<td>329</td>
<td>Results and limitations of outpatient and overnight stay laminectomies for lumbar spinal stenosis</td>
<td>D. Yen, A. Albargi</td>
</tr>
<tr>
<td>335</td>
<td>The usefulness and costs of routine contrast studies after laparoscopic sleeve gastrectomy for detecting staple line leaks</td>
<td>D. Terterov, P.H.-Y. Leung, L.K. Twells, D.M. Gregory, C. Smith, D. Boone, D. Pace</td>
</tr>
<tr>
<td>342</td>
<td>Improving spine surgical access, appropriateness and efficiency in metropolitan, urban and rural settings</td>
<td>M. Zarrabian, A. Bidos, C. Fanti, B. Young, B. Drew, D. Puskas, R. Rampersaud</td>
</tr>
<tr>
<td>349</td>
<td>Regional consolidation of orthopedic surgery: impacts on hip fracture surgery access and outcomes</td>
<td>S.A. Kreindler, L. Siragusia, E. Bohm, W. Rudnick, C.J. Metge</td>
</tr>
</tbody>
</table>
DISCUSSIONS IN SURGERY
DISCUSSIONS EN CHIRURGIE

355 Toward late career transitioning: a proposal for academic surgeons

© 2017 Joule Inc. ISSN 0008-428X. For information on permission to reproduce material from the Canadian Journal of Surgery (CJS) see canjsurg.ca.
All editorial matter in CJS represents the opinions of the authors and not necessarily those of the publisher. We assume no responsibility or liability for damages arising from any error or omission or from the use of any information or advice contained in CJS, including articles, editorials, reviews, letters and advertisements. All reproduction rights are reserved.
Printed by The Lowe-Martin Group, Ottawa. Appears in February, April, June, August, October and December.
Return undeliverable Canadian copies to the CMA Member Service Centre, 1870 Alta Vista Dr, Ottawa ON K1G 6R7 (email cmamsc@cma.ca).

We believe in open access to research
To ensure continued worldwide free access to all CJS content, articles submitted for publication as of Jan. 1, 2014, are subject to a submission fee of $100 (Canadian funds). Submission fees will be waived for corresponding authors affiliated with CJS sponsors. Accepted Research, Review and Continuing Medical Education articles are subject to a publication fee of $700, and Commentaries and Discussions are subject to a publication fee of $500, payable on acceptance in Canadian funds.

Benefits of open access
• For researchers and institutions: increased visibility, usage and impact for their work
• For government: a better return on investment for funding research
• For society: efficient, effective patient care resulting in better outcomes
CJS articles are available free of charge on the journal website (canjsurg.ca) and in PubMed Central.
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.

Le Journal canadien de chirurgie vise à dispenser une éducation médicale continue efficace aux spécialistes en chirurgie au Canada, et fournir aux chirurgiens un mécanisme efficace pour diffuser les constatations de la recherche clinique, fondamentale et éducative. Les lecteurs trouveront en direct le JCC à l’adresse canjsurg.ca.

Doctors caught in Feds’ crosshairs — again

The views expressed in this editorial are those of the author and do not necessarily reflect the position of the Canadian Medical Association or its subsidiaries.

It is already hard to practise medicine in Canada. Patient care seems to be slipping daily. New resources are drying up, or current ones are being rolled back. Provincial governments are vilifying the medical profession. Our own representatives seem to be in disarray, as evidenced by the situation in Ontario, among other provinces, over the last couple years. The federal government now has seen fit to start meddling with health care at multiple levels instead of performing meaningful governance in federal affairs. First, they entered the debate on private versus public health care through the back door. Now they are attacking the way physicians, dentists and all other small business owners run their businesses by threatening incorporation of medical practices. Under the proposed measures, business owners will no longer be allowed to “income split” or to benefit from deferred corporate income.

Physicians and dentists are slightly worse off than many other types of small business owners, because they cannot increase their income to offset the added expenses brought down with this proposed change; physician salaries are locked by provincial governments. The federal government claims it is not fair that not everyone can incorporate, but most employees have some kind of package or pension plan. Under a scenario in which physician—business owners would no longer be able to defer taxes, their ability to save for the future would be limited. If what is rumored comes true, then the federal government plans to overtax, so that the corporation owners — who assume all the risks of their small businesses — will pay more tax than the employees. Is that fair or desirable? Many dentists are ready to throw in the towel, shutter their practices and become associates at larger companies. This will put many dental practices out of business. The same will occur on the medical side, where independent practices now run on a break-even basis.

Don’t underestimate the malice of this legislation. It is an attack on future livelihood and Canada’s economy. Usually, with most small corporations, the starting years are typically an attempt to make a footprint in the community. Almost all money is invested back into the business — hiring people, purchasing and renting real estate and equipment, paying for consumables. Over the subsequent decade, the business becomes more stable and, barring downturns in the real estate market or a disaster at home or work, there is more money that can be left in the corporation, and the owner can plan for retirement or sending the kids to school. During retirement, the owner of the corporation assets will now pay tax at the same rate as other Canadians on the salary they pull from their investment portfolio. This is a tax deferral of money invested in Canada until the corporation owner’s retirement — not tax avoidance. The government wants that money immediately. And the federal government plans to typically increase the dividend tax by up to 700% — a cash grab that will threaten to bankrupt our retirees.

Say goodbye to risk-takers and innovators. It is now the smart thing to enter the workforce looking for a government job with a salary guarantee and a pension (plus other benefits, such as the employer’s pension plan, paid vacation and statutory holidays, and paid sick days). It used to be that government jobs paid less salary to offset the pension available on retirement. Now those jobs pay more than those in private industry, and the benefits are increasing all the time. There will come a time when most people will work for the government directly — a sign of a dystopian democracy.

Edward J. Harvey, MD
Coeditor, Canadian Journal of Surgery

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

DOI: 10.1503/cjs.013417

References


Les médecins dans la mire du fédéral — encore une fois

Les opinions exprimées dans cet éditorial sont celles de l’auteur et ne représentent pas nécessairement celles de l’Association médicale canadienne ou ses filiales.

Il est déjà difficile de pratiquer la médecine au Canada. La qualité des soins aux patients semble se détériorer de jour en jour. Les nouvelles ressources se font attendre, ou les ressources actuelles sont supprimées. Les gouvernements provinciaux diabolisent la profession médicale. Nos propres représentants semblent désœuvrés, comme en témoigne entre autres la situation en Ontario depuis quelques années. Aujourd’hui, le gouvernement fédéral juge à propos de se mêler de multiples aspects de la santé plutôt que de s’atteler à bien gérer ce qui relève de sa compétence. Il s’est d’abord immisqué en douce dans le débat public-prive, et voilà maintenant qu’il s’en prend à la façon dont les médecins, les dentistes et tous les autres petits entrepreneurs gèrent leurs affaires en mettant en péril la constitution en société. Les chefs d’entreprise n’auront plus le droit de fractionner leur revenu ni de reporter le paiement de l’impôt de leur société1.

La situation des médecins et des dentistes est en fait légèrement plus perçue que celle de beaucoup d’autres petits entrepreneurs parce qu’ils ne peuvent pas accroître leurs revenus pour compenser les dépenses supplémentaires engendrées par les changements proposés; les salaires des médecins sont plafonnés par les provinces. Le gouvernement fédéral affirme qu’il est injuste que tout le monde ne puisse pas se constituer en société, mais la plupart des employés ont accès à des avantages sociaux ou à un régime de retraite. Dans un scénario où les médecins entrepreneurs ne pourraient plus reporter leurs impôts, leur capacité à économiser pour l’avenir serait limitée. Si la rumeur se confirme, le gouvernement fédéral pourrait surimposer les propriétaires d’entreprise — qui prennent tous les risques associés à la conduite de leurs affaires — de sorte qu’ils soient plus lourdement taxés que leurs employés. En quoi est-ce juste ou souhaitable? De nombreux dentistes sont prêts à lancer la serviette, à mettre la clé sous la porte et à devenir partenaires dans de grandes entreprises. Les fermetures de cliniques dentaires se multiplieront. La même chose se produira en médecine, où les cliniques indépendantes fonctionnent aujourd’hui au seuil de la rentabilité.

Ne sous-estimez pas les effets pervers de cette législation. Dites adieu aux innovateurs prêts à prendre des risques. Il est plus sage maintenant de chercher un emploi au gouvernement, qui vient avec un salaire garanti et un régime de retraite (en plus d’autres avantages sociaux, comme le régime de retraite de l’employeur, les vacances, les jours fériés et les congés de maladie payés). Autrefois, la fonction publique versait un salaire moindre pour compenser les prestations versées à la retraite. De nos jours, il est plus payant de travailler dans le secteur public que dans le secteur privé, et les avantages sociaux ne cessent de se bonifier. Un de ces jours, la plupart des gens travailleront directement pour le gouvernement — un signe de démocratie « dystopique ».

Edward J. Harvey, MD
Corédacteur, Journal canadien de chirurgie

Intérêts concurrents: E.J. Harvey est médecin hygiéniste en chef de Greybox Healthcare (Montréal) et président du Conseil d’administration de NXT-Sens Inc. (Montréal).

DOI: 10.1503/cjs.013717

Références

© 2017 Joule Inc. or its licensors
Continuing a long tradition: the *Canadian Journal of Surgery* at 60

Vivian C. McAlister, MB  
Edward J. Harvey, MD

Accepted Sept. 11, 2017

**Correspondence to:**  
V. McAlister  
University Hospital  
London ON N6A 5A5  
vmcalist@uwo.ca

DOI: 10.1503/cjs.013817

**SUMMARY**

As 2017 marks the 60th anniversary of the *Canadian Journal of Surgery*, its editors in chief take a look back at the history leading to the creation of the journal and at how *CJS* maintains its original partnerships in order to continue its mission. Organized surgery has existed in Canada for more than 3 centuries. The *CJS* is the longest surviving of more than 20 journals reporting surgical endeavours. The editors rededicate its mission to the highest standard possible.

More than 3 centuries ago, Michel Sarrazin, surgeon to the King’s troops in the colony of New France, performed a mastectomy on 37-year-old Marie Barbier of Ville Marie at the Hotel-Dieu in Quebec City.1 Sarrazin’s record of the operation is maintained at the hospital. The specimen was shipped to Paris, where it is kept by the Muséum national d’Histoire naturelle. Sarrazin sent many reports to the Académie royale des sciences, presumably on medical and botanical matters, but only his method for making maple syrup made it into the academy’s publication. Sarrazin began a tradition of transparent inquiry and excellence in surgery in Canada, which we have inherited. Sister Barbier, dite de l’Assomption, survived the mastectomy operation and lived another 39 years, becoming the superior of her congregation.

In 1824, Dr. François-Xavier Tessier started the *Quebec Medical Journal*. Tessier envisioned the bilingual journal as a way for physicians to keep up to date with the medical literature of France and England and to provide a forum for Canadian writing. Tessier was aware of Canada’s advantage of having both French and English. In 1827, he titled his translation of Louis-Jacques Bégin’s textbook on therapeutics *The French Practice of Medicine*, and he appended a section that he wrote on the treatment of diseases found in North America. He intended to follow up with a French language periodical on natural philosophy, “since that language is, among modern languages, the only one that is appropriate to all the sciences.”2 Tessier advocated for the creation of a medical school in Quebec, and he was a founder of the Quebec Medical Society. He died young, probably of smallpox, having set up a vaccination clinic in his home. The *Quebec Medical Journal* lasted only 2 years.

The medical school was McGill University’s first functioning academic unit and Canada’s first medical school, established in 1829. Fifteen years later, fearful of competition, the faculties at the Montreal General Hospital and McGill excluded several prominent physicians and surgeons. The excluded group banded together to set up a rival bilingual medical school, the Montreal School of Medicine and Surgery. They published the *Montreal Medical Gazette*, edited by Drs. Francis Badgley and William Sutherland, which became the *British American Journal of Medical and Physical Science* and lasted from 1844 to 1852. Interestingly, the group was also prominent in establishing the Montreal Medico-Chirurgical Society. Francis Badgley, editor of the journal and secretary of the society, proposed an association with the Quebec Medical Society and the other medical societies of British North America. That proposal is considered the original for the Canadian Medical Association, which came into being.
20 years later in 1867. With the demise of the British American Journal of Medical and Physical Science, Dr. William Wright founded the Montreal Monthly Journal of Medicine & Surgery in 1853. He edited it for 7 years. Notably, when Wright graduated from McGill at the age of 20, he was British North America’s first black doctor. He had a 30-year career as a teacher at McGill, where he was a professor of pharmacology and therapeutics.

In the 2 centuries since Tessier started the Quebec Medical Journal, more than 20 periodicals dedicated to surgery and medicine were published in what is now Canada. Many of these journals were local publications that sought to share knowledge published elsewhere, originally Europe and later the United States, either by reprinting articles or by abstracting them. Locally authored articles, which tended to be case reports or case series, were often written versions of presentations made by the authors to local medical societies. The republished material was evenly balanced between medicine and surgery; whereas most of the local articles were surgical. Many of the descriptions were innovative, such as those by the surgical pioneer, Abraham Groves.

Andrew MacPhead, a faculty member at McGill and editor of the Montreal Medical Journal, best described the interdependence of medical societies and their journals when he argued in 1907 for the founding of the Canadian Medical Association Journal (CMAJ) that without a journal to express its views and record its proceedings, the association would have little impact. In 1911, CMAJ was founded by amalgamating the Montreal Medical Journal with the Maritime Medical News. The dominance of surgery in medical writing continued until the end of the First World War. The balance in favour of medical topics then developed so that by the 1950s the need for a journal dedicated to surgery was evident. This was an important time for Canadian surgery, as the Hospital Insurance and Diagnostic Act of 1957 gave the federal government authority to enter into an agreement with the provinces to establish a comprehensive, universal plan covering acute hospital care, laboratory and radiology diagnostic services. That year, the Canadian Journal of Surgery (CJS) was founded through a collaboration of the Royal College of Physicians and Surgeons of Canada, the Canadian university chairs of surgery and the Canadian Medical Association. Its first editor was Robert Janes, President of the Royal College and head of surgery in Toronto. The first editorial board consisted of the heads of surgery from each Canadian university.

Today, the CJS is 60 years old with this issue. It is the longest published surgical journal in 3 centuries of surgeons writing in Canada. Canadian surgery has thrived by combining the best of surgical traditions, first from Britain and France and later from each side of the Atlantic, an advantage recognized 2 centuries ago by François-Xavier Tessier. It is an advantage that could make Canadian surgery the best in the world. There is no reason for its journal of record to accept any other goal.

Affiliation: Co-editors in chief, CJS.
Competing interests: E.J. Harvey is the Chief Medical Officer of Greybox Healthcare (Montreal) and Chairman of the Board of NXT-Sens Inc. (Montreal). None declared by V.C. McAlister.
Contributors: Both authors contributed substantially to the conception, writing and revision of this article and approved the final version for publication.

References
Calgary, Edmonton and the University of Alberta: the extraordinary medical mobilization by Canada’s newest province

Mark P. Da Cambra, MD, MSc
Vivian C. McAlister, MB

The views expressed in this paper are those of the authors and do not constitute the views or policies of the Canadian Armed Forces.

Accepted for publication Aug. 25, 2017

Correspondence to:
M. Da Cambra
Royal Canadian Medical Service
7 High Park Gardens
Toronto ON M6R 1S8
mdacambra@gmail.com

DOI: 10.1503/cjs.012117

The Canadian contribution of medical services to the British Empire during the First World War was a national endeavour. Physicians from across the country enlisted in local regiments to join. No other region provided more physicians per capita than the newly formed province of Alberta. Largely organized through the Medical School of the University of Alberta, the No. 11 Canadian Field Ambulance out of Edmonton and the No. 8 Canadian Field Ambulance out of Calgary ultimately enlisted between one-third and half of the province’s doctors to the war campaign. Many individuals from this region distinguished themselves, including LCol J.N. Gunn from Calgary, who commanded the No. 8 Canadian Field Ambulance; Maj Heber Mosher, one of the founders of the School of Pharmacy at the University of Alberta; and Dr. A.C. Rankin, who would go on to be the first Dean of Medicine at the University of Alberta. These Canadian heroes, and the many others like them who served with the No. 8 and 11 Field Ambulances, personify the sacrifice, strength and resilience of the medical community in Alberta and should not be forgotten.

Summary

Health care personnel from all over Canada were mobilized in support of the British Empire war effort during the First World War. No other region in Canada provided more physicians proportionately than Alberta and Western Canada. It is estimated that about 30% of all practising physicians from the Prairies enlisted. A report from the Edmonton Bulletin on May 31, 1916, declared, “Third of City’s Medical Men on Military Duties.” It stated that from Edmonton alone 35 out of the city’s 112 (31%) physicians had enlisted. By October 1918, 216 out of an estimated 400 (54%) physicians from the province of Alberta, who had joined the Confederation of Canada only 13 years prior, had joined the cause.1

Physicians who volunteered in the Canadian Army Medical Corps (CAMC) were assigned a military rank and attached to a battalion. Albertans were the main source of 2 deployed medical units. The No. 8 Canadian Field Ambulance from Calgary was created in December 1915, and the No. 11 Canadian Field Ambulance was created in 1916 and comprised members from the University of Alberta Faculty of Medicine and the Manitoba Medical College.2 Although some physicians remained in Canada performing enlistment medicals and providing care at military bases, the majority were sent out to the Western Front together with nurses, ambulance drivers and stretcher bearers. Each field ambulance operated immediately behind the regimental first aid stations. Their role was to receive, triage and stabilize casualties. Patients treated at the field ambulance would then often be sent to a dressing station, casualty clearing station, or a field hospital.3

The No. 8 Field Ambulance was organized in Calgary in December 1915 under the command of LCol S.W. Hewetson. It had a strength of 10 officers and 182 men of other ranks. They set sail from Halifax on Apr. 1, 1916, aboard the S.S. Adriatic, arriving in England 8 days later.2,4 Members of the No. 8 Field Ambulance made it to the front line in France on May 8, 1916, as
part of the 3rd Canadian Division. The No. 8 rotated through the Front along with the No. 9 (from Montreal) and the No. 10 (from Winnipeg) Canadian Field Ambulances on 1-month cycles throughout their 3 years in the war. The No. 8 saw 14 separate battles throughout the war, including multiple mass casualty scenarios involving mustard gas attacks. The No. 8 Field Ambulance was present at some of the greatest battles in Canadian history. During the Battle of Vimy Ridge, it handled more than 2000 casualties in a single day (April 1917) and it handled 3300 casualties at Passchendaele (October 1917). There is an account of 12 fractured femurs awaiting a single doctor’s attention. On one occasion, the No. 8 even came under direct fire, during which it lost 23 men and 80 others were wounded. LCol Hewetson ultimately died of an infection during the war, and the second commanding officer, LCol J.N. Gunn, was appointed. LCol Gunn was born in Ontario in 1879 and trained in medicine at the University of Toronto. He moved to Calgary in 1907, where he practised as an eye specialist. For his service with the No. 8 Field Ambulance, he was awarded the Distinguished Service Order. Unfortunately, his tenure was cut short, as he suffered trench fever twice and was forced to leave his command on Feb. 27, 1917. His obituary stated that LCol Gunn was among the first to suggest blood transfusions as a means of saving life early in the war. The initial concept of transfusing patients in hemorrhagic shock on the battlefield with fresh whole blood was pioneered by other Canadian physicians, such as Drs. L. Bruce Robertson in the First World War and Norman Bethune in the Spanish Civil War, both also University of Toronto medical school alumni. This breakthrough would subsequently be recognized as “the most important medical advance to come from the First World War” by the Royal Army Medical Corps.

The No. 8 Canadian Field Ambulance was one of the very few that returned as a complete unit in March of 1919. At the end of the War, 100 officers and 2000 men, mostly from Alberta, had become part of the No. 8. LCol Gunn talked in a speech about the very high code of honour among stretcher bearers in his unit: “None considered any risk too great or any task too hard if it meant relief for some stricken man. Their duty was not over until every man had been picked up.”

---

Fig. 1. Soldiers from the No. 8 Canadian Field Ambulance, C section, reading the English periodical Bystander, Lille, France, 1918 (Glenbow Muesuem Archives NA-4400-1).

Fig. 2. LCol John Nisbet Gunn of the No. 8 Canadian Field Ambulance, Calgary, Alberta, circa 1919 (Glenbow Museum Archives NA-4002-26).
During their time in France, the No. 8 Canadian Field Ambulance had acquired a Distinguished Service Order, a Distinguished Conduct Medal, 5 Military Crosses and 20 Military Medals.3,9

The No. 11 Field Ambulance was organized simultaneously in Edmonton and Winnipeg in March 1916 under the command of LCol J.D. McQueen. The mobilization of medical personnel was under the control of a committee of civilians composed of the presidents of the University of British Columbia, University of Alberta, University of Saskatchewan and University of Manitoba. It had a strength of 10 officers and 179 men of other ranks. Members of the No. 11 departed Halifax on May 22, 1916, aboard the S.S. Adriatic and arrived in England a week later.2,10 They ultimately ended up near the front line in France on Aug. 11, 1916, as part of the 4th Canadian Division. Dr. Heber H. Moshier, Professor of Physiology and one of the founders who helped establish the School of Pharmacy at the University of Alberta in 1915, went on to command the No. 11 (Western Universities) Canadian Field Ambulance.10 This unit is closely associated with the University of Alberta, because when it left for the Front in March 1916, it included numerous faculty members,

![Fig. 3. Dr. H.H. Moshier, commander of the No. 11 Canadian Field Hospital, and one of the founders who helped establish the School of Pharmacy at the University of Alberta in 1915 (The Canadian Letters and Images Project).](image)

![Fig. 4. Canadian advanced dressing station in the German Line, east of Arras, France, September 1918 (Library and Archives Canada).](image)

![Fig. 5. LCol Allan C. Rankin of No. 1 Canadian General Hospital (Montreal) and first Dean of Medicine of the University of Alberta, circa 1918 (D.M. Gilchrist. 100 Years of Medicine, University of Alberta, 2006).](image)
15 medical students and 6 theology students. Maj Moshier was killed in action on Aug. 29, 1918, while moving forward to assess the best location for a new advanced dressing station near Arras, France.1

Although many Albertan physicians joined local regiments, some elected to explore opportunities in larger centres. Bacteriologist Dr. Allan Coats Rankin, who came from Bangkok, was the Director of the Provincial Laboratory in Edmonton. He and Dr. J.C. Fyshe, superintendent of the Royal Alexandra, Strathcona and Isolation Hospitals in Edmonton, went off to join the No. 1 Canadian General Hospital in Montreal. Rankin’s distinguished military career began with his work to suppress the 1914 outbreak of cerebrospinal meningococcal encephalitis in Britain’s largest military training camp at Salisbury Plain. There were 399 cases in the Canadian Expeditionary Force, and 219 died. Subsequently, he went door-to-door searching and vaccinating Belgians for typhoid fever, averting another epidemic.

He was then transferred to a mobile laboratory unit in France, where he and LCol G.G. Nasmith confirmed the first German chlorine gas attack and researched the best gas masks to prepare for future attacks.1 Later, Dr. Rankin went on to describe trench fever in the *Lancet*1,11 and confirmed that troops from India had brought malaria with them to the Western Front. He was ultimately awarded a Companion of the Order of St. Michael and St. George by King George V and, in 1920, he became the first Dean of Medicine of the University of Alberta.

The contribution of medical care to the British Empire coalition by the Province of Alberta during the First World War cannot be overestimated. The extraordinarily high enlistment levels of physicians from the Prairies (30%–50%) compared with the rest of the country (10%), combined with the increasing influx of casualties being repatriated to Canada from theatre, resulted in a severe shortage of physicians at home. At one point there were only 3 professors (Drs. Revell, Collip and Jamieson) and 7 part-time lecturers and demonstrators remaining in the School of Medicine at the University of Alberta.2 The fact that the School could continue to function at all with this staffing level for prolonged periods of time is a testament to the commitment and determination of the faculty. These Canadian heroes, and the many others like them who served with the No. 8 and No. 11 Canadian Field Ambulances, personify the sacrifice, strength and resilience of the medical community in Alberta and should not be forgotten.

Affiliations: From the Royal Canadian Medical Service, Toronto, Ont. (Da Cambra, McAlister); and the Division of General Surgery, Western University, London, Ont. (McAlister).

Competing interests: None declared.

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

References
Role for laparoscopy in the management of bile duct injuries

Common bile duct (CBD) injury is the most serious complication of laparoscopic cholecystectomy. Recently, laparoscopic techniques have been used in the management of postoperative bile leak and CBD injury; this literature has not been reviewed. We reviewed the literature on CBD injury, the approach to its diagnosis and management, and reports of laparoscopic management techniques. We combined this review with our experience in laparoscopic methods to highlight diagnostic and therapeutic options. Laparoscopic techniques can be used to prevent, diagnose and treat CBD injuries. Intraoperatively, CBD injury can be prevented in the case of short cystic duct with the use of a loop ligature or transfixing suture, and it can be diagnosed using intraoperative cholangiography or other visualization techniques. When CBD injury is suspected postoperatively, repeat laparoscopy can be used to control sepsis with abdominal washout; as a diagnostic tool to guide management; and, in some settings, as a therapeutic tool for suturing small duct leaks, drain insertion and postoperative endoscopic retrograde cholangiopancreatography with sphincterotomy. Definitive laparoscopic repair is possible when certain criteria are met. Open surgery should be considered when the CBD is small, the injury occurred more than 72 hours previously, injury or anatomy are complex, port positioning is awkward for repair, or local experience is limited with laparoscopic management. There is an emerging role for laparoscopy in the management of CBD injuries. More case reports and series are needed to show the safety and efficacy of this technique, encourage its wider adoption, and allow outcomes assessment on a larger scale.

La lésion du canal cholédoque est la plus grave complication de la cholécystectomie laparoscopique. Récemment, des techniques laparoscopiques ont été utilisées pour traiter les fuites biliaires postopératoires et les lésions du canal cholédoque; la littérature à ce sujet n’a pas été passée en revue. Nous avons donc entrepris de faire une revue de la littérature publiée sur les lésions du canal cholédoque, les approches diagnostiques et thérapeutiques les concernant, ainsi que des rapports sur les approches thérapeutiques laparoscopiques. Nous avons combiné cette revue à notre expérience des méthodes laparoscopiques pour mettre en lumière les options diagnostiques et thérapeutiques. Il est possible d’utiliser des techniques laparoscopiques pour prévenir, diagnostiquer et traiter les lésions du canal cholédoque. Durant une intervention, on peut prévenir la lésion du canal cholédoque, dans le cas d’un canal cystique court, en recourant à des boucles de fil préformées ou à des sutures par transfixion; et la lésion peut être diagnostiquée par cholangiographie ou autre technique d’imagerie per-opératoires. Lorsqu’on soupçonne une lésion du canal cholédoque en postopératoire, on peut répéter la laparoscopie pour vérifier la présence d’infection et procéder à un lavage abdominal, comme outil diagnostique pour guider le traitement et, dans certains contextes, comme outil thérapeutique pour suturer de petites fuites du canal cystique, insérer un drain ou procéder à une cholangiopancréatographie rétrograde endoscopique postopératoire avec sphinctérotomie. Il est possible de procéder à une réparation laparoscopique définitive en présence de certains critères. On envisagera la chirurgie ouverte si le canal cholédoque est petit, la lésion s’est produite plus de 72 heures auparavant, la lésion ou les caractéristiques anatomiques sont complexes, la réparation est rendue difficile par le positionnement du cathéter ou l’équipe locale a une expérience limitée du traitement laparoscopique. On constate le rôle émergent de la laparoscopie pour la prise en charge des lésions du canal cholédoque. Il faudra davantage de rapports et de séries de cas pour en démontrer l’innocuité et l’efficacité, en encourager l’utilisation plus répandue et permettre une évaluation de ses résultats à plus grande échelle.
Laparoscopic cholecystectomy is accepted as the gold standard in the surgical management of gallbladder disease.1 Despite the widespread application of this approach, the rate of common bile duct (CBD) injury is still reported to be 0%–2.7% for laparoscopic cholecystectomy versus 0%–0.5% for open cholecystectomy; however, this gap has narrowed as expertise with laparoscopic surgery has been gained.2

Bile duct injury is the most serious complication of laparoscopic cholecystectomy and can lead to sepsis, liver failure and even death. In this review, we focus on the role of laparoscopy to diagnose and manage CBD injury.

**DEFINITION**

For the purpose of this review, we consider CBD injury to include thermal injury, partial laceration or ligation, and complete transection with or without associated vascular injury. It manifests in the form of bile leakage, stricture formation, or complete occlusion.

**ETIOLOGY**

Common bile duct injury usually occurs intraoperatively. In some cases, it may present in a delayed fashion, such as in the case of thermal injury. The widely accepted approach to help prevent bile duct injury in laparoscopic cholecystectomy is achievement of the critical view of safety.1 Excess or incorrect traction on the gallbladder while exposing the Calot triangle can tent the CBD superiorly and expose it to injury. Misidentification of the correct anatomy may also occur when there is severe inflammation of the porta hepatis region, such as with acute cholecystitis, impacted stones in the Hartman pouch and Mirizzi syndrome.3 Furthermore, anatomic variations in bile duct anatomy or a short cystic duct (CD) also predispose to ductal injury.

**CLASSIFICATION**

Bismuth and colleagues4 classified 5 types of bile duct injury in 1982 according to location of the injury in the biliary tract, based on patterns that were seen more frequently with open cholecystectomy. In 1995, Strasberg and colleagues1 expanded the Bismuth classification to encompass injuries seen more commonly with laparoscopic cholecystectomy; the classification is summarized in Table 1.

**DIAGNOSIS**

**Intraoperative identification**

If a bile duct injury is identified intraoperatively, it allows the possibility of immediate repair or triage toward appropriate nonoperative therapy. If an injury is suspected, intraoperative cholangiography can be beneficial in determining the extent of the problem and can help guide definitive repair. Repair (laparoscopic or open) should be attempted only by surgeons with adequate training in biliointerectic reconstruction. Video-recording cases can be helpful in identifying injuries during postoperative review if a patient presents with complications.

**Postoperative presentation**

The preoperative presentation of a patient with a CBD injury can vary. Subjectively, these patients often report abdominal pain or distension, nausea, fever and malaise. Objectively, they may show evidence of obstructive jaundice, sepsis, or documented bile leakage.1,2,5 For patients with bile peritonitis, it is important to implement a rigorous workup, including cholangiography via magnetic resonance cholangiopancreatography (MRCP), percutaneous transhepatic cholangiography (PTC), or endoscopic retrograde cholangiopancreatography (ERCP). Likewise, control of bilomas or bile peritonitis is imperative.

**Investigations**

The well-known radiologic and endoscopic modalities available to investigate biliary disease each have advantages; these are summarized in Figure 1.

**Intraoperative**

Intraoperative cholangiography is typically used on a selective basis when there is a question of common duct stones, when anatomy is difficult to delineate, or when ductal injury is suspected and confirmation for location is desired.6 Intraoperative cholangiography can be highly accurate in the diagnosis of bile duct injuries where there is intraoperative suspicion. In our practice, we routinely position the patient and the surgical bed to permit easy introduction of the C-arm for fluoroscopic cholangiography should the need arise.

**Postoperative**

The role of exploratory laparoscopy in the diagnosis and treatment of bile leak in the postoperative period following laparoscopic surgery is increasingly being used. The diagnostic accuracy and feasibility of this procedure has been reported by several authors.3,4,7-11 In a systematic review, Rodriguez et al.12 reported that laparoscopic exploration has a sensitivity, specificity, and accuracy of 76%, 82%, and 80%, respectively. The role of laparoscopic exploration following laparoscopic cholecystectomy is controversial, with some surgeons using it as a routine part of their practice, while others reserve it for specific indications.13-16

**Table 1. Strasberg et al.1 classification of bile duct injury**

<table>
<thead>
<tr>
<th>Type</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Cystic duct leak or leak from small liver bed duct</td>
</tr>
<tr>
<td>B</td>
<td>Occlusion of part of the biliary tree</td>
</tr>
<tr>
<td>C</td>
<td>Transection without ligation of aberrant right hepatic ducts</td>
</tr>
<tr>
<td>D</td>
<td>Lateral injuries to major bile ducts</td>
</tr>
<tr>
<td>E1</td>
<td>Low on common hepatic duct, with stump &gt; 2 cm</td>
</tr>
<tr>
<td>E2</td>
<td>Proximal on common hepatic duct, with stump &lt; 2 cm</td>
</tr>
<tr>
<td>E3</td>
<td>Involves hilum but spares hepatic ductal confluence</td>
</tr>
<tr>
<td>E4</td>
<td>Disruption of left and right hepatic ducts</td>
</tr>
<tr>
<td>E5</td>
<td>Any injury involving an aberrant right sectoral hepatic duct</td>
</tr>
</tbody>
</table>

Can J Surg, Vol. 60, No. 5, October 2017
laparoscopic cholecystectomy has increasingly been reported in the literature.\textsuperscript{5-9} Returning to the operating room early following surgery allows for the drainage of a biloma or intra-abdominal collection, clipping of any accessory ducts or an insecure cystic duct, inspection of the biliary anatomy with potential treatment (i.e., releasing a clipped CBD), or placement of a drain to control the leak conservatively. We discuss this topic in further detail below, in the management section.

Another option as an adjunct to the above is performing “drain tube cholangiography” through a tube placed percutaneously or intraoperatively for conservative management of a bile leak. This can be useful in identifying whether a persistent opening remains in the biliary tree, indicated by extraductal extravasation of contrast.

\section*{Management of CBD Injuries}

The presence of a CBD injury has important short- and long-term implications for the patient. Fortunately, there are several management strategies available to help these patients. Although conservative measures, such as ERCP, CBD stenting or abdominal drainage, can be useful, we focus on the laparoscopic techniques that can be applied in this situation.

Laparoscopic techniques may play a role in 3 settings for the management of CBD injuries: in the initial operation to confirm a suspected injury, in the postoperative period when the patient presents with a symptomatic leak, and when the diagnosis is established and definitive repair is planned.

\subsection*{Initial operation}

Intraoperatively during any cholecystectomy, active effort should be made to avoid a CBD injury. The “critical view of safety” should be established before clips are deployed in the Calot triangle. Failure to identify the anatomy or achieve the critical view may be an indication for conversion to open surgery; however, subtotal cholecystectomy with removal of all stones from the gallbladder is another method for definitively managing gallbladder inflammation and preventing an injury.

The presence of a short cystic duct can be particularly challenging. In our experience, this scenario is addressed well with the use of a transfixing suture or loop ligation to achieve secure closure of the cystic duct stump. Some surgeons use endomechanical staplers in this setting; however, we feel the aforementioned techniques allow better tissue control and visualization when operating close to key biliary structures.\textsuperscript{6}

If a CBD injury is suspected intraoperatively, intraoperative cholangiography should be used to confirm the diagnosis. In cases of limited injury, we advocate leaving a drain in place with a view to treating the injury conservatively with a biliary stent. In all other cases, definitive repair is achieved with hepaticojejunostomy or hepatico-duodenostomy, discussed below. The hepatic arteries should be carefully visualized to ensure there is no vasculobiliary injury in every case.

\subsection*{Relaparoscopy}

When a patient presents in the postoperative period with evidence of bile leak or peritonitis, laparoscopy can be a useful diagnostic and therapeutic tool.\textsuperscript{9}

The first step at relaparoscopy is to perform extensive washout of the abdominal cavity to help control and treat the sepsis and to allow for identification of the source of the bile leak.\textsuperscript{5,7} Although the most likely

\begin{itemize}
  \item \textbf{Suspected bile leak}
  \begin{itemize}
    \item \textbf{Intraoperatively}
      \begin{itemize}
        \item Intraoperative cholangiography
          \begin{itemize}
            \item Diagnostic accuracy
            \item May prevent injury progression
          \end{itemize}
      \end{itemize}
    \item \textbf{Postoperatively}
      \begin{itemize}
        \item MRCP
          \begin{itemize}
            \item Diagnostic accuracy
          \end{itemize}
        \item ERCP
          \begin{itemize}
            \item Therapeutic advantage
          \end{itemize}
        \item CT abdomen
          \begin{itemize}
            \item Detection of distant collection
          \end{itemize}
        \item Drain tube cholangiography
          \begin{itemize}
            \item Can monitor effectiveness
          \end{itemize}
      \end{itemize}
  \end{itemize}
\end{itemize}

\textit{Fig. 1. Investigation options and advantages for suspected bile leak. CT = computed tomography; ERCP = endoscopic retrograde cholangiopancreatography; MRCP = magnetic resonance cholangiopancreatography.}
source is somewhere in the biliary tree, the small bowel and, in particular, the duodenum should be inspected to rule out inadvertent injury there, which could give rise to a similar presentation.

In situations where bile is leaking from a small defect in the cystic duct, common hepatic duct, or CBD, laparoscopic peritoneal lavage is often the only surgical intervention needed to control the spillage and prevent severe sepsis.\textsuperscript{5,7} Endoscopic retrograde cholangiopancreatography and sphincterotomy, with or without biliary stenting, can help to ensure low pressure in the biliary tract, which will allow the defect to seal itself with time. There are several reports of leaks from small ducts in the gallbladder bed, the duct of Luschka, or small accessory hepatic ducts being successfully controlled with laparoscopic suturing.\textsuperscript{8,9}

An option during this procedure is to place a drain, which can help to control or prevent the progression of sepsis. This method can be used to treat the injury conservatively, or to stabilize the patient while definitive repair is planned.

At this point of the procedure, the surgeon must make a judgment call on whether to proceed with immediate repair or to delay repair of the injury, depending on the location and extent of injury, the patient’s overall stability and local expertise. Although treatment of CBD injury at a tertiary centre is not an absolute recommendation in our opinion, it is a very reasonable option.

**Definitive repair**

Bilioenteric anastomosis in the form of hepaticojejunostomy or hepaticoduodenostomy is the definitive treatment for a severe CBD injury and has shown good long-term results.\textsuperscript{10}

In the index operation, if a bile leak is found intraoperatively, the source should first be elucidated through careful inspection and the use of suction and irrigation to examine the gallbladder fossa for accessory ducts, the liver surface for any tears, and the extrahepatic biliary tree for inadvertent injury. The diagnosis can be confirmed with intraoperative cholangiography. The arterial supply to the duct should be examined; an injury there often requires open reconstruction if there has been minimal delay between identification of the injury and repair.

If the leak is from a very small CBD lesion, it may be amenable to conservative management with a Jackson–Pratt drain to achieve a controlled leak. Postoperative ERCP with sphincterotomy can be used as an adjunct to ensure low pressure in the biliary system and to promote healing. In selected cases of an aberrant or liver bed bile duct leak where the duct orifice is very small (\( \leq 2–3 \) mm) and cholangiography shows it to be draining only a small section of the liver, that duct orifice may be simply ligated.\textsuperscript{8} The criteria for laparoscopic repair are the same as those used for open repair. If the injury is fresh (\( \leq 72 \) h), we prefer early repair with laparoscopic bilioenteric anastomosis. We prefer an open approach if the duct is small (\( < 3 \) mm), if anatomy or injury complexity precludes straightforward repair, or if port positioning is awkward for laparoscopic repair. Any free bile should be suctioned and the abdomen irrigated to control sepsis. A surgical drain is not always necessary, but it is our practice to leave one routinely.

In situations where the operating surgeon does not feel comfortable performing the repair, the CBD can be stented or cannulated and an abdominal drain placed to stabilize the patient and control sepsis while they are transferred to a tertiary care centre for delayed repair. In this setting, laparoscopic repair is feasible if inflammation in the porta hepatitis is not too extensive.

If there is a healthy duct with good arterial blood supply, we perform an end-to-side bilioenteric anastomosis. If there is any concern regarding the blood supply, a side-to-side repair incorporating the anterior wall of the bile duct near the biliary bifurcation is favored.

**CONVERTING TO OPEN SURGERY**

Up to 15% of laparoscopic cholecystectomy cases are converted to open laparotomy. This conversion may be done when an injury is recognized intraoperatively but is not amenable to laparoscopic management or when the operating surgeon is not comfortable repairing the injury laparoscopically. Common bile duct injuries repaired with minimal delay have a much more favourable outcome; performing timely repair should be prioritized over delay for laparoscopic repair.\textsuperscript{11}

During laparoscopic cholecystectomy, if a surgeon encounters bleeding that is not easily controlled, we recommend conversion to open surgery to prevent concomitant biliary and vascular injury. In most cases, bleeding that seems impossible to control laparoscopically is readily controlled during laparotomy. In challenging cases, conversion to laparotomy can prevent injury to the bile duct, duodenum, or other structures.

**CONCLUSION**

Laparoscopic techniques can be used to avoid, diagnose and treat CBD injuries, and early evidence shows this can be safe. In the initial operation, subtotal cholecystectomy can be useful in avoiding injury where there is severe inflammation or obscure anatomy. A bile leak or fresh injury can be assessed at the index operation to help plan for immediate versus delayed repair. In the postoperative period, relaparoscopy can allow for identification of CBD injury, drainage of intra-abdominal collection, and exclusion of injury to surrounding structures, which can guide the decision between conservative management and early or late definitive repair.
Affiliation: From the Division of General Surgery, University of Toronto, Toronto, Ont.

Competing interests: None declared.

Contributors: Both authors designed the study. V. Gupta acquired the data, which both authors analyzed. V. Gupta wrote the article, which both authors reviewed and approved for publication.

References


Changes in patient characteristics following cardiac transplantation: the Montreal Heart Institute experience

Nicola Vistarini, MD, MSc*
Anthony Nguyen, MD*
Michel White, MD
Normand Racine, MD
Louis P. Perrault, MD, PhD
Anique Ducharme, MD, MSc
Denis Bouchard, MD, PhD
Philippe Demers, MD
Michel Pellerin, MD
Yoan Lamarche, MD
Ismail El-Hamamsy, MD, PhD
Geneviève Giraldeau, MD
Guy Pelletier, MD
Michel Carrier, MD

*These authors contributed equally to this work.

Presented as an Oral Communication at 2015 Canadian Cardiovascular Congress

Accepted Jan. 24, 2017; Early-released Aug. 3, 2017

Correspondence to:
M. Carrier
Department of Cardiac Surgery
Montreal Heart Institute
5000 Belanger St
Montreal QC H1T 1C8
michel.carrier@icm-mhi.org

DOI: 10.1503/cjs.005716

Background: Heart transplantation is no longer considered an experimental operation, but rather a standard treatment; nevertheless the context has changed substantially in recent years owing to donor shortage. The aim of this study was to review the heart transplant experience focusing on very long-term survival (≥ 20 years) and to compare the initial results with the current era.

Methods: From April 1983 through April 1995, 156 consecutive patients underwent heart transplantation. Patients who survived 20 years or longer (group 1) were compared with patients who died within 20 years after surgery (group 2). To compare patient characteristics with the current era, we evaluated our recent 5-year experience (group 3; patients who underwent transplantation between 2010 and 2015), focusing on differences in terms of donor and recipient characteristics.

Results: Group 1 (n = 46, 30%) included younger patients (38 ± 11 v. 48 ± 8 yr, p = 0.001), a higher proportion of female recipients (28% v. 8%, p = 0.001) and a lower prevalence of ischemic heart disease (42% v. 65%, p = 0.001) than group 2 (n = 110, 70%). Patients in group 3 (n = 54) were older (52 ± 12 v. 38 ± 11 yr, p = 0.001), sicker (rate of hospital admission at transplantation 48% v. 20%, p = 0.001) and transplanted with organs from older donors (42 ± 15 v. 29 ± 11 yr, p = 0.001) than those in group 1.

Conclusion: Very long-term survival (≥ 20 yr) was observed in 30% of patients transplanted during the first decade of our experience. This outcome will be difficult to duplicate in the current era considering our present population of older and sicker patients transplanted with organs from older donors.

Contexte : De nos jours, la transplantation cardiaque n’est plus considérée comme une intervention expérimentale, mais bien comme une opération standard; mais le contexte a substantiellement changé ces dernières années en raison d’une pénurie de donneurs cardiaque, et plus particulièrement sur la survie à très long terme (≥ 20 ans), et de la comparer aux résultats initiaux.

Métodes : Entre avril 1983 et avril 1995, 156 patients consécutifs ont subi une greffe cardiaque. Les patients qui ont survécu 20 ans ou plus (groupe 1) ont été comparés aux patients décédés moins de 20 ans après l’intervention (groupe 2). Pour comparer les caractéristiques des premiers patients à celles des cas plus récents, nous avons fait un bilan des 5 années allant de 2010 à 2015 (groupe 3), en portant attention aux différences quant aux caractéristiques des donneurs et des receveurs.

Résultats : Le groupe 1 (n = 46, 30%) incluait des patients plus jeunes (38 ± 11 ans c. 48 ± 8 ans, p = 0,001), une proportion plus élevée de femmes (28 % c. 8 %, p = 0,001) et la prévalence de maladie cardiaque ischémique y était moindre (42 % c. 65 %, p = 0,001) comparativement au groupe 2 (n = 110, 70 %). Les patients du groupe 3 (n = 54) étaient plus âgés (52 ± 12 ans c. 38 ± 11 ans, p = 0,001), plus malades (taux d’hospitalisation au moment de la transplantation 48 % c. 20 %, p = 0,001) et ont reçu le cœur de donneurs plus âgés (42 ± 15 ans c. 29 ± 11 ans, p = 0,001) que ceux du groupe 1.

Conclusion : Une survie à très long terme (≥ 20 ans) a été observée chez 30 % des patients ayant reçu leur greffe au cours de la première décennie de notre expérience. Ce résultat sera difficile à reproduire de nos jours étant donné que notre population actuelle est constituée de receveurs plus âgés et plus malades, qui reçoivent le cœur de donneurs plus âgés.
Cardiac transplantation is the gold standard for patients with ischemic and nonischemic end-stage heart failure and is associated with a median survival exceeding 10 years. This remarkable achievement of modern medicine was made possible with substantial improvements in the field of immunosuppression, infection prophylaxis and surgical techniques. Today, heart transplantation is no longer considered an experimental operation, but rather a standard treatment; nevertheless the context has changed substantially in recent years owing to donor shortage.

With these concerns in mind, we decided to review the heart transplantation experience at the Montreal Heart Institute, focusing on patients who have experienced very long-term survival (≥20 yr). Our first objective was to determine the prevalence and characteristics of patients who achieved prolonged survival. The second objective was to compare these patients with those who had shorter survival in terms of recipient and donor characteristics. Finally, the third objective was to compare patient demographics in the first era with patients in our current practice, aiming to identify differences in terms of donor and recipient characteristics.

**Methods**

**Study population and study design**

From April 1983 through April 2015, 425 consecutive patients underwent heart transplantation at the Montreal Heart Institute. We first analyzed patients who experienced very long-term survival (≥20 yr). For this reason, only patients transplanted before April 1995 were considered. Consequently, the study population for the present analysis is the group of patients who received transplants between April 1983 and April 1995 (156 consecutive patients). Patients who underwent a second heart transplantation were included in the analysis. To compare the transplant results of our initial experience with our current practice, we evaluated our recent 5-year experience (2010–2015), focusing on differences in terms of donor and recipient characteristics.

We conducted a retrospective cohort study. Patients’ clinical charts were reviewed, and pre-, intra- and postoperative data were prospectively recorded in an electronic database. We considered the following relevant clinical information for analysis: demographic characteristics of both donors and recipients (age, sex, race), cause of heart failure (HF; idiopathic, ischemic, miscellaneous), ischemic time of the transplanted heart, clinical preoperative status (active working or studying, at home stable, admitted to hospital with pharmacological support, admitted with mechanical support), time on the waiting list, long-term complications and causes of death. Patient follow-up involved regular visits at the specialized transplant clinic, with echocardiographic and/or hemodynamic controls and planned biopsies and coronary angiographies. All patients provided informed consent, and the Montreal Heart Institute Research Centre Ethics Committee approved the study protocol.

**Statistical analysis**

Statistical analyses were performed using analyses of variance and Fisher least significant difference (LSD) tests for continuous variables among the 3 groups and with χ² tests for categorical variables. Rates of survival, freedom from acute rejection, infection, chronic rejection characterized by any coronary lesions documented at angiographies and cancer were calculated according to actuarial analyses using the NCSS (2012) statistical system. We used the log-rank test to study differences among the groups. Continuous variables are presented as means ± standard deviations, and categorical variables are reported as frequencies (percentages). We developed a Cox regression model to study donor and recipient variables associated with late survival. We considered results to be significant at p < 0.05.

**Results**


Preoperative characteristics of patients who underwent cardiac transplantation between 1983 and 1995 (n = 156) are shown in Table 1. Patients who survived 20 years or longer were included in group 1 (n = 46), whereas patients who died within 20 years of transplantation were included in group 2 (n = 110). Overall, 30% of patients transplanted during the first decade of our experience survived 20 years or more. The cumulative mean survival of the whole population was 35% ± 4% 20 years after transplantation, and the median survival was 15 years (Fig. 1).

All patients who underwent mechanical support in this era of our experience with left ventricular assist devices (LVAD) or total artificial hearts (TAH) waited in the hospital in status 4 (the most urgent status). Immunosuppression varied according to study periods, although the basic treatment was based on triple drug therapy including cyclosporine, azathioprine and prednisone in groups 1 and 2, and tacrolimus, mycophenolate mofetil (MMF) and prednisone in group 3. The treatment was individualized to allow prednisone tapering and cessation if it was possible in a case by case approach (Table 1).

Causes of death for patients in group 2 were cancer (n = 21); myocardial infarction, chronic rejection or graft vasculopathy (n = 18); graft failure (n = 15); acute rejection (n = 5); renal failure (n = 6); bleeding (n = 6); pancreatitis (n = 6); sepsis (n = 5); stroke (n = 3); cardiac failure (n = 4); respiratory infection (n = 2); arrhythmias (n = 1); other
Table 1. Demographic and clinical characteristics of the study sample

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Group 1, ≥ 20 yr survival (n = 46)</th>
<th>Group 2, &lt; 20 yr survival, (n = 110)</th>
<th>Group 3, 2010–2015, (n = 54)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recipient age, yr</td>
<td>38 ± 11</td>
<td>48 ± 8</td>
<td>52 ± 12</td>
<td>0.001</td>
</tr>
<tr>
<td>Recipients, female sex</td>
<td>13 (28)</td>
<td>9 (8)</td>
<td>11 (20)</td>
<td>0.004</td>
</tr>
<tr>
<td>Donor age, yr</td>
<td>29 ± 11</td>
<td>27 ± 10</td>
<td>42 ± 15</td>
<td>0.001</td>
</tr>
<tr>
<td>Donors, female sex</td>
<td>20 (43)</td>
<td>28 (25)</td>
<td>13 (24)</td>
<td>0.05</td>
</tr>
<tr>
<td>Ischemic time, min</td>
<td>141 ± 43</td>
<td>136 ± 47</td>
<td>137 ± 54</td>
<td>0.86</td>
</tr>
<tr>
<td>Waiting time, d</td>
<td>119 ± 179</td>
<td>101 ± 110</td>
<td>99 ± 140</td>
<td>0.73</td>
</tr>
<tr>
<td>Diagnosis pretransplant</td>
<td>0.001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Idiopathic</td>
<td>14 (30)</td>
<td>21 (19)</td>
<td>22 (41)</td>
<td></td>
</tr>
<tr>
<td>Ischemic</td>
<td>19 (42)</td>
<td>71 (65)</td>
<td>10 (18)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>13 (28)</td>
<td>18 (16)</td>
<td>22 (41)</td>
<td></td>
</tr>
<tr>
<td>Status pretransplant</td>
<td>0.001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work/home</td>
<td>37 (80)</td>
<td>99 (90)</td>
<td>28 (52)</td>
<td></td>
</tr>
<tr>
<td>Hospital, IV drugs, VAD or TAH</td>
<td>9 (20)</td>
<td>11 (10)</td>
<td>26 (48)</td>
<td></td>
</tr>
<tr>
<td>LVAD and TAH before transplantation</td>
<td>7 (15)</td>
<td>12 (11)</td>
<td>12 (22)</td>
<td></td>
</tr>
<tr>
<td>No. of HLA-DR mismatches</td>
<td></td>
<td>0.86</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>13</td>
<td>28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>25</td>
<td>54</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

HLA-DR = Human Leukocyte Antigen - antigen D Related; IV = intravenous; SD = standard deviation; TAH = total artificial heart; VAD = ventricular assist device.

Fig. 1. Kaplan–Meier curve for survival after cardiac transplantation for patients operated between 1984 and 1995. Patient survival at 1, 5, 10, 15 and 20 years averaged 84% ± 3%, 76% ± 3%, 69% ± 4%, 49% ± 4% and 35% ± 4%, respectively. The number of patients at risk is shown at the bottom of the graph.
infections ($n = 1$); hepatic failure ($n = 1$); and sudden death ($n = 1$). In 15 patients, the cause of death was unknown.

As shown in Table 1, group 1 included younger patients (mean age $38 \pm 11$ v. $48 \pm 8$ yr, $p = 0.001$), a greater proportion of women (28% v. 8%, $p = 0.001$) and a lower prevalence of ischemic heart disease (42% v. 65%, $p = 0.001$) than group 2. Of interest, the number of Human Leukocyte Antigen - antigen D Related (HLA-DR) mismatches was similar in the 2 groups. Four patients in group 1 underwent a second heart transplant for chronic rejection or transplant vasculopathy 14 ± 4 years after their initial graft.

Freedom rates from cancer and chronic rejection, the 2 main causes of adverse long-term outcome, are shown in Figure 2 and Figure 3, respectively. Although patients in group 1 showed a significantly lower incidence of cancer than patients in group 2 ($p = 0.005$), the rate of allograft vasculopathy was similar in both groups ($p = 0.96$).

**The current era (2010–2015)**

Table 1 also shows the preoperative characteristics of patients transplanted between 2010 and 2015 (group 3), who represent our current population of candidates. Patients in group 3 were older (mean age $52 \pm 12$ v. $38 \pm 11$ yr, $p = 0.001$), sicker (rate of hospital admission at transplantation 48% v. 20%, $p = 0.001$) and transplanted with organs from older donors (mean age $42 \pm 15$ v. $29 \pm 11$ yr, $p = 0.001$) than patients in group 1. It is important to recognize that 12 patients (22%) in group 3 were on mechanical support with LVAD or TAH before undergoing transplantation. Eight patients waited in hospital in status 4, and 4 patients waited at home in status 3 (urgent, but the patient can wait at home) before transplantation. Actuarial survival 5 years after transplantation averaged 71% ± 2% in group 3 and 76% ± 3% in groups 1 and 2. The freedom rate from acute rejection 1 year after transplantation averaged 37% ± 7% in group 1, 41% ± 5% in group 2 and 85% ± 5% in group 3 ($p = 0.001$).

A Cox regression multivariate analysis including all 11 variables reported in Table 1 showed that younger age of recipients (relative risk 1.04, $p < 0.001$) was the only characteristic associated with late survival.

**Discussion**

Results from the present study show that one-third of the patients who underwent cardiac transplantation during the first decade of our experience achieved a long-term survival of 20 years or more. Patients with shorter survival...
after transplantation were older at the time of surgery and were more likely to have ischemic heart disease before transplantation.

Furthermore, in the current era, patients and organs transplanted were both significantly older than in our initial group of long-term survivors. Heart transplantation has made substantial progress in the last 50 years, with dramatic improvements in different fields, such as immunosuppression8,9 and prevention of infectious complications.10,11 As reported by the International Society for Heart and Lung Transplantation (ISHLT) in 2013, the median survival after cardiac transplantation in adults has increased from 8.4 years between 1982 and 1991 to 10.7 years between 1992 and 2011 and has remained at 11 years in 2012.1 Several experienced centres have reported remarkable long-term outcomes after heart transplantation, with survival rates up to 56% at 15 years.12-14 In this regard, our long-term results compare favourably with the published literature and with other Canadian centres16,17 with a 35% survival rate at 20 years. Moreover, acute rejection episodes were significantly reduced in group 3 patients, who were administered long-term tacroliimus and MMF immunosuppression.

Patients who experienced better long-term survival were younger (< 40 yr), were more likely to be women, were less frequently affected by ischemic heart disease and, in most cases, were in stable clinical condition at the time of transplantation. Although, the incidence of cardiac allograft vasculopathy was similar in both groups, cancer was a significant cause of death in patients who experienced a shorter survival after transplantation (Fig. 2 and Fig. 3). The Stanford group15 reported similar results, with long-term survivors being significantly younger at the time of transplantation (35.0 ± 10.5 yr) and with a lower prevalence of coronary artery disease than shorter-term survivors. Others have also reported excellent long-term survival after cardiac transplantation in cohorts of patients who were younger at the time of transplantation and who had a greater prevalence of nonischemic cardiomyopathy.13,14 The causes of death among patients with longer survival after transplantation, in our experience, were similar to those reported in the literature, with chronic rejection or coronary allograft vasculopathy and cancer being the 2 major causes of death.1

The 2002 report of the ISHLT showed that age distribution of heart transplant recipients has changed between the periods 1985–1996 and 1997–2001, with an increase in the proportion of patients between 50 and 64 years old.2 Moreover, as stated in the 2013 report of the ISHLT, the current median age of a

![Graph](image_url)
cardiac transplant recipient was 54 years. In addition to being older, a substantial proportion of patients currently awaiting transplant are in unstable clinical conditions, with a preoperative hospitalization rate of 44% and a need for intravenous drugs in 42%, and they are supported by different types of mechanical circulatory devices (intra-aortic balloon 6%, LVAD 29%, right ventricular assist device 4%, extracorporeal membrane oxygenation 1%). This new reality and the increasing use of ventricular assist devices is a reflection of the extreme shortage of donor organs, which greatly limits the number of patients who can receive a heart transplant. For this reason, we compared the characteristics of our long-term survivors (group 1) with our cohort of patients transplanted during the most recent 5-year period (group 3). This latter group reflects more accurately the present population of patients on the waiting list. These patients are older and more often hospitalized and on inotropes, short-term mechanical support or with device-related complications. In addition to having a higher risk profile, they undergo transplantation with organs from older donors (so-called marginal), which is associated with an increased risk of death and allograft failure. Furthermore, the shortage of donor organs is also associated with longer waiting time and the possibility of further clinical deterioration while on the waiting list.

**Conclusion**

Very long-term survival (≥ 20 yr) has been achieved in almost one-third of patients who received transplants during the first decade of our experience. This outcome will be difficult to match in the current era, considering our present population of older and sicker patients receiving organs from older donors. In the near future, a greater use of increasingly refined ventricular assist devices used as destination therapy may provide the ideal solution for many patients with advanced heart failure. Nevertheless, cardiac transplantation will certainly remain, for a long time, the best available treatment option of advanced heart failure for select patients.

**Affiliations:** From the Department of Cardiac Surgery, Montreal Heart Institute and Université de Montréal, Montreal, Que. (Vistarini, Nguyen, Perrault, Bouchard, Demers, Pellerin, Lamarche, El-Hamamsy, Carrier); and the Department of Medicine, Montreal Heart Institute and Université de Montréal, Montreal, Que. (White, Racine, Ducharme, Giraldeau, Pelletier).

**Competing interests:** None declared.

**Contributors:** All authors designed the study, acquired and analyzed the data, wrote and reviewed the article, and approved the final version for publication.
Topical tranexamic acid reduces transfusion rates in simultaneous bilateral total knee arthroplasty: a retrospective case series

Christopher Kim, MD, MSc
Sam S. Park, MD
Herman S. Dhotar, MD, MPH
Anthony V. Perruccio, PhD
Michael G. Zywiel, MD, MSc
J. Roderick Davey, MD

Background: Topical tranexamic acid (TA) has been reported to be effective in reducing postoperative bleeding and transfusions after total knee arthroplasty (TKA). The main objective of this study was to retrospectively assess the effectiveness and safety of topical TA administration in patients undergoing simultaneous bilateral TKA.

Methods: We conducted a retrospective chart review of consecutive cohorts of patients undergoing simultaneous bilateral TKA. We compared the patients who received TA with patients from a similar time frame who did not receive TA. For those who received TA, a topical concentration of 2 g per 30 mL of normal saline was used in each knee. Preoperative and postoperative hemoglobin, transfusions, length of stay (LOS) and postoperative complications were recorded for each patient until discharge. Outcome measures were analyzed using independent t test, χ² test and logistic regression.

Results: We included 49 patients in our analysis: 25 who received TA and 24 who did not. There were no statistical differences in demographics between the groups. The rate of transfusion in the TA group was 4% compared with 67% in the non-TA group (p < 0.001). The net hemoglobin loss in the TA group was 4.1 g/dL versus 6.2 g/dL in the non-TA group (p < 0.001). The use of TA was found to be associated with a greater than 99% reduced risk of receiving a transfusion (odds ratio 0.003, 95% confidence interval < 0.001–0.072, p < 0.001). There were no thromboembolic events in patients who received TA, and there was 1 pulmonary embolus in the non-TA group. Postoperative LOS was significantly reduced in the TA group (mean difference 1.1 d, p = 0.005).

Conclusion: Topical administration of TA in patients undergoing simultaneous bilateral TKA significantly reduced transfusions, blood loss and postoperative LOS, with no increased risk of thromboembolic events.

Contexte : Selon certains rapports, l’acide tranexamique (AT) topique réduirait efficacement les saignements postopératoires et le recours aux transfusions après une intervention pour prothèse totale du genou. Le principal objectif de cette étude était d’évaluer de manière rétrospective l’efficacité et l’innocuité de l’AT topique chez des patients soumis à une intervention pour prothèse totale des 2 genoux.

Méthodes : Nous avons procédé à une analyse rétrospective des dossiers de cohortes consécutives de patients soumis à une intervention pour prothèse totale des 2 genoux. Nous avons comparé les patients ayant reçu l’AT aux patients d’une période similaire qui n’ont pas reçu l’AT. Pour ceux qui ont reçu l’AT, la concentration topique de 2 g par 30 mL de solution physiologique a été utilisée dans les 2 genoux. On a enregistré chez chaque patient les taux d’hémoglobine pré- et postopératoires, le nombre de transfusions, la durée du séjour hospitalier et les complications postopératoires jusqu’à leur congé. Les paramètres ont été analysés à l’aide du test t, du test du χ² et de la régression logistique.

Résultats : Nous avons inclus 49 patients dans notre analyse : 25 ayant reçu l’AT et 24 ne l’ayant pas reçu. Il n’y avait aucune différence statistique entre les groupes pour ce qui est des caractéristiques démographiques. Le taux de transfusions dans le groupe ayant reçu l’AT a été de 4 %, contre 67 % dans le groupe n’ayant pas reçu l’AT (p < 0.001). La baisse nette de l’hémoglobine dans le groupe ayant reçu l’AT a été de 4,1 g/dL, contre 6,2 g/dL dans le groupe n’ayant pas reçu l’AT (p < 0.001). L’utilisation de l’AT a été associée à une réduction de plus de 99 % du risque de transfusion (rapport des cotes 0,003, intervalle de confiance de 95 % < 0,001–0,072, p < 0,001). On n’a noté aucun incident thromboembolique chez les patients ayant reçu l’AT, et une embolie pulmonaire dans le groupe n’ayant pas reçu l’AT. La durée du
In the United States, approximately 7% of 611,000 total knee arthroplasties (TKAs) were simultaneous bilateral procedures. The potential advantages of simultaneous bilateral TKA include single anesthetic, reduced length of stay (LOS) in hospital, decreased rehabilitation time and decreased associated hospital costs. It is still debated whether the benefits outweigh a potential increase in morbidity and mortality. There are several studies that suggest there is no difference in complication rates between simultaneous bilateral TKA compared with unilateral TKA. However, in a meta-analysis by Restrepo and colleagues, simultaneous bilateral TKA was reported to be associated with a 2-fold greater risk of serious cardiac complications, pulmonary complications and death than unilateral TKA. In the largest data set comparing unilateral TKA with simultaneous bilateral TKA, Odum and colleagues reported increased risk of both minor and major in-hospital complications and death in patients undergoing simultaneous bilateral TKA. Similarly, the systematic review by Fu and colleagues found that simultaneous bilateral TKA increased rates of cardiovascular incidents and venous thromboembolic events and increased the need for perioperative blood product transfusion.

Substantial blood loss and the need for subsequent blood transfusions are of potential concern in patients undergoing simultaneous bilateral TKA and may be one of the causes of increased complications. The average number of units of blood transfused in patients undergoing simultaneous bilateral TKA has been found to be greater than the number transfused in those undergoing unilateral TKA. The increased duration of surgery, use of a thigh tourniquet associated with increased risk of localized fibrinolysis, and hypothermia are plausible explanations for greater blood loss with simultaneous bilateral TKA than unilateral TKA. Thus, blood management in simultaneous bilateral TKA is often more challenging than in unilateral TKA. Recently, topical tranexamic acid (TA) has been reported to be an effective and inexpensive method to reduce postoperative bleeding after unilateral joint replacement.

The main objective for our study was to assess the effectiveness and safety of topical TA administration in patients undergoing simultaneous bilateral TKA based on objective clinical outcome measures.

**METHODS**

We conducted a retrospective chart review to identify consecutive patients undergoing simultaneous bilateral TKA for primary osteoarthritis between Feb. 28, 2012, (when routine topical TA was introduced) and Apr. 8, 2014, at a single academic institution. A control group of patients undergoing simultaneous bilateral TKA without the use of TA between Sept. 4, 2008, and Jan. 31, 2012, was identified and used for the comparative analysis. We set the study end date for April 2014 to allow for at least 1 year of follow-up after surgery for all patients included in the study. We excluded patients with diagnoses other than osteoarthritis (e.g., trauma and rheumatoid arthritis). The research ethics board of the University Health Network, Toronto, Ont., Canada, approved our study.

All simultaneous bilateral TKAs were performed in a similar fashion by the senior author (J.R.D.). Thigh tourniquets were inflated before skin incision and deflated after skin closure. In all cases, TKA was completed on the first side before the contralateral side was begun. A medial parapatellar approach and cemented TKA components were used in all patients. The patella was resurfaced in select patients. Surgical drains were not used. Within the TA group, a solution of 2 g of TA dissolved in 30 mL of 0.9% normal saline was instilled in each wound after implantation of the final components, left for 3 minutes and then removed with suction. The wound was not washed again thereafter and was then closed. Venous thromboembolism prophylaxis was given to all patients, consisting of 40 mg of enoxaparin administered subcutaneously for 10 days postoperatively starting on postoperative day 1.

We assessed clinical outcomes using objective measures. We identified participant characteristics of the case and control groups. Demographic data included age, sex and body mass index (BMI). Preoperative comorbidities that would affect either bleeding or thromboembolism as well as active use of anticoagulants was identified. Laboratory values, including hemoglobin, international normalized ratio (INR), activated partial thromboplastin time (aPTT) and platelet count, were obtained preoperatively and every day postoperatively and extracted from patient charts until the day of discharge. Additionally, the number of units of blood transfused, occurrence of medical complications, such as deep venous thrombosis (DVT) and pulmonary embolism (PE); and total length of hospital stay (LOS) were identified. Guidelines for transfusion in our institution involved a conservative strategy in which blood was transfused on a postoperative hemoglobin level of less than 8 g/dL, or less than 10 g/dL if the patient experienced symptoms of anemia or organ...
dysfunction that may have been caused or exacerbated by anemia and not another cause. The primary outcome measures were postoperative transfusion rates and the difference between preoperative hemoglobin and the corresponding lowest postoperative value. Secondary outcome measures included venous thromboembolic events and LOS.

**Statistical analysis**

Statistics were calculated between the TA group and the non-TA group. We used a paired t test to compare means between the groups. Transfusion rates between groups were compared using a χ² test for categorical data. The effect of TA on the risk of transfusion, age, sex, BMI, preoperative hemoglobin and preoperative platelet count was calculated using logistic regression analysis. We calculated odds ratios (ORs), 95% confidence intervals (CIs) and 2-tailed p values, with the type 1 error rate (α) set at 0.05. We conducted all analyses using SAS software version 9.1 for UNIX (SAS Institute).

**RESULTS**

A total of 49 patients undergoing simultaneous bilateral TKA were identified. Twenty-four patients underwent simultaneous bilateral TKA without TA and 25 patients underwent the same procedure with routine use of TA. A total of 49 patients undergoing simultaneous bilateral TKA were identified. Twenty-four patients underwent simultaneous bilateral TKA without TA and 25 patients underwent the same procedure with routine use of TA.

**Table 1. Demographic and preoperative clinical characteristics of the study sample**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Group; mean ± SD or %</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, yr</td>
<td>63.6 ± 9.6</td>
<td>0.60</td>
</tr>
<tr>
<td>Female sex</td>
<td>45.8</td>
<td>0.98</td>
</tr>
<tr>
<td>BMI</td>
<td>30.5 ± 5.7</td>
<td>0.20</td>
</tr>
<tr>
<td>INR</td>
<td>0.97 ± 0.06</td>
<td>0.84</td>
</tr>
<tr>
<td>aPTT, s</td>
<td>29.1 ± 1.8</td>
<td>0.87</td>
</tr>
<tr>
<td>Platelet count, x10^10</td>
<td>245.7 ± 35.9</td>
<td>0.14</td>
</tr>
<tr>
<td>Hemoglobin, g/dL</td>
<td>14.4 ± 1.25</td>
<td>0.041</td>
</tr>
</tbody>
</table>

aPTT = activated partial thromboplastin time; BMI = body mass index; INR = international normalized ratio; SD = standard deviation; TA = tranexamic acid.

**Table 2. Postoperative outcomes**

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Group; mean ± SD or no. (%)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of patients transfused</td>
<td>16 (66.7)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>No. of units transfused</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>Postoperative hemoglobin, g/dL</td>
<td>8.16 ± 1.43</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Hemoglobin loss, g/dL</td>
<td>6.24 ± 1.25</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>LOS, d</td>
<td>4.4 ± 1.6</td>
<td>0.006</td>
</tr>
</tbody>
</table>

LOS = length of stay; SD = standard deviation; TA = tranexamic acid.

All cases were consecutive and performed for primary knee osteoarthritis.

There were no significant differences in preoperative age, sex, BMI, INR, aPTT, or platelet count between the groups, except the preoperative hemoglobin was higher in the non-TA group than the TA group (14.4 g/dL v. 13.7 g/dL, p = 0.041; Table 1). No patients reported anticoagulant use, history of bleeding, or thrombotic risk factors.

The rate of transfusion in the TA group was 4.0% compared with 66.7% in the non-TA group (p < 0.001). The use of topical TA in simultaneous bilateral TKA resulted in greater postoperative hemoglobin levels (9.61 ± 1.48 g/dL v. 8.16 ± 1.43 g/dL, p < 0.001), reduced net hemoglobin loss (4.1 ± 0.93 g/dL v. 6.24 ± 1.25 g/dL, p < 0.001) and significantly reduced LOS (3.3 ± 0.8 d v. 4.4 ± 1.6 d, p = 0.005; Table 2).

Logistic regression analysis revealed that the administration of TA in patients undergoing simultaneous bilateral TKA was associated with a greater than 99% reduced risk of having a transfusion postoperatively (OR 0.003, 95% CI 0.001–0.072, p < 0.001).

There were no thromboembolic events in the TA group and 1 PE in the non-TA group. None of the patients had clinical evidence for DVT, infection or wound complications.

**DISCUSSION**

In the present study, topical administration of TA in patients undergoing simultaneous bilateral TKA compared with controls significantly reduced transfusion requirements, blood loss and postoperative LOS, with no increased risk of thromboembolic events.

A recent study by Hegde and colleagues investigated the use of topical TA in patients undergoing simultaneous bilateral TKA. The authors conducted a prospective study comparing postoperative blood loss and blood requirement after simultaneous bilateral computer-assisted TKA in 3 groups with administration of 10 mL of 0.9% normal saline intravenously alone, 10 mL of intravenous (IV) TA alone, and 1 g of intra-articular TA alone in each knee. According to their results, there was a 61% reduction in postoperative blood loss and an 88% reduction in postoperative blood requirement in the intra-articular TA group compared with the control group. The authors reported no DVT, PE, infection or wound complications in the intra-articular TA group.

Our study found similar results with the use of a solution of 2 g of TA dissolved in 30 mL of 0.9% normal saline in each wound after implantation of the final components. Our findings are consistent with the meta-analysis literature showing that higher doses of topical TA had a greater effect on the reduction of blood loss and transfusion rate. Our rate of transfusion in the TA group was 4.0% compared with 66.7% in the non-TA group, and
administration of TA in patients undergoing simultaneous bilateral TKA resulted in a more than 99% reduced odds of requiring a transfusion postoperatively.

A significant finding in our study was that the routine use of topical TA significantly decreased postoperative LOS, with a mean difference of 1.1 days. Husted and colleagues previously reported that a blood transfusion is the main predictor of increased LOS after TKA, even extending mean LOS 3-fold.  

Topical tranexamic acid is contraindicated in patients with history of DVT or PE, intrinsic risk for thrombosis or thromboembolism, acute renal failure, subarachnoid hemorrhage, history of seizures, hypersensitivity and allergy to TA. Owing to the possible risk of increased thrombosis using TA, numerous studies have excluded patients with a history of thromboembolism. However, this potential risk has not been shown in randomized controlled trials (RCTs) using TA. In a prospective, double-blinded RCT, Wong and colleagues compared 1.5 g and 3.0 g doses of topical TA to an equal volume of normal saline in 99 patients undergoing unilateral, cemented primary TKA. In their study, 35 patients received normal saline, 31 patients received 1.5 g of topical TA, and 33 patients received 3.0 g of topical TA. Topical TA was applied to the wound after all components were cemented into place and left for 5 minutes. Both doses of topical TA resulted in a significant decrease in blood loss and transfusion requirements, with minimal systemic absorption and no increase in venous thromboembolic events. In another prospective, double-blinded, RCT, Alishryda and colleagues compared topical TA to normal saline in 157 patients undergoing unilateral, cemented primary TKA. In their study, 78 patients received normal saline and 79 patients received 1 g of topical TA. The topical TA group had a higher postoperative hemoglobin level and a significant reduction in the transfusion rate, with an absolute risk reduction of 15.4% in the TA group. There were no differences in the incidence of DVT between the normal saline and TA groups.

Topical TA can be a viable alternative in patients with contraindications to IV TA, such as increased risk of thromboembolism or acute renal failure. One of the advantages of topical TA is the minimal systemic absorption. Wong and colleagues reported that plasma levels of topical TA were approximately 70% lower than an equivalent dose of IV TA. The mean plasma levels after application of low (1.5 g) and high (3.0 g) doses of topical TA were 4.5 mg/L and 8.5 mg/L, respectively, whereas the plasma level 1 hour after administration of 10 mg/kg of IV TA was 18 mg/L. Two recent meta-analyses showed that topical TA was safe, with no increase in DVT or PE. The patients included in our study, there were no thromboembolic events in the topical TA group and 1 PE in the non-TA group.

**Limitations**

Owing to the nature of the study design, there were some associated limitations. The retrospective design of the study made it difficult to control perioperative variables, such as demographic characteristics and comorbidities. Additionally, the study involved a relatively small sample size given the rare incidence of bilateral TKA cases. A power analysis was not performed.

Additionally, as this was based on patient population at a single institution, the results may not be generalizable to an entire population. However, considering the results of the study were based on consecutive patients at a single institution and TKA performed by a single surgeon, there was less variability in the care provided to patients, providing more consistent results.

**Conclusion**

Topical administration of TA in patients undergoing simultaneous bilateral TKA compared with controls showed significantly reduced transfusion requirements, blood loss and postoperative LOS, with no increased risk of thromboembolic events. Topical TA should be considered for routine use in patients undergoing simultaneous bilateral TKA to decrease blood loss. Approving and extending the indications for the use of TA in simultaneous bilateral TKA would be a useful measure to reduce blood loss and transfusion rates.

**Affiliation:** From the Division of Orthopaedic Surgery, Toronto Western Hospital, Toronto, Ont.

**Competing interests:** J.R. Davey declares consultancy fees, speaker fees and travel assistance from Zimmer Biomet. No other competing interests declared.

**Contributors:** C. Kim, H. Dhotar, A. Perruccio and J.R. Davey designed the study. C. Kim, S. Park, H. Dhotar, M. Zywiel and J.R. Davey acquired the data, which C. Kim, S. Park and A. Perruccio analyzed. C. Kim wrote the article, which all authors reviewed and approved for publication.

**References**


Intraoperative ultrasonography of the biliary tract using saline as a contrast agent: a fast and accurate technique to identify complex biliary anatomy

Abhijit Chandra, MS, MCh
Vivek Gupta, MS
Rahul Rahul, MS, MCh
Manoj Kumar, MD
Ajeet Maurya, MS

Accepted Feb. 21, 2017; Early-released Aug. 1, 2017

Correspondence to:
A. Chandra
King George’s Medical University
Department of Surgical Gastroenterology
Ground Floor, Centenary Hospital
Shahmina Rd
KGMU Lucknow Uttar Pradesh 226004, India
abhijitchandra@hotmail.com

DOI: 10.1503/cjs.011116

Background: Intraoperative assessment of biliary tract anatomy is relevant for a number of benign and malignant hepatobiliary diseases. During biliary reconstruction, drainage of all relevant bile ducts is imperative to prevent atrophy of undrained segment, cholangitis and secondary biliary cirrhosis. Intraoperative cholangiography, though widely used for intraoperative imaging of the biliary tract, involves heavy equipment use, radiation risk and has a limited role in the evaluation of isolated segmental bile ducts.

Methods: We evaluated the use of a novel technique of intraoperative ultrasonography of the biliary tract using normal saline as a contrast agent. It involves injecting saline in any part of the biliary system while performing real-time intraoperative 2-dimensional ultrasonography.

Results: This procedure was carried out in intraoperative situations to delineate complex biliary anatomy involving segmental bile ducts. Excellent image quality was obtained in the form of opacification and demarcation of the liver segment to which the duct belongs. The flow of saline microbubbles was clearly visible on real-time ultrasound images, leading to accurate identification of the duct.

Conclusion: Intraoperative ultrasonography with saline as a contrast agent can accurately identify small isolated segmental bile ducts and help in surgery of the biliary tract. It is a simple and inexpensive technique that can be performed with minimal resources.

Contehte : L’examen anatomique peropératoire des voies biliaires est justifié pour un certain nombre de maladies hépatobiliaires bénignes et malignes. Durant la reconstruction biliaire, la vidange de toutes les voies biliaires concernées est nécessaire pour prévenir l’atrophie des segments non drainés, la cholangite et la cirrhose biliaire secondaire. Même si elle est couramment utilisée pour l’imagerie des voies biliaires, la cholangiographie peropératoire fait appel à des équipements complexes, comporte un risque d’irradiation et joue un rôle limité dans l’évaluation de segments isolés des canaux biliaires.

Méthodes : Nous avons évalué l’utilisation d’une nouvelle technique d’échographie peropératoire des voies biliaires à l’aide de solution physiologique comme agent de contraste. La technique repose sur l’injection de solution physiologique dans n’importe quelle portion de l’appareil bilaire sous échographie bidimensionnelle peropératoire en temps réel.

Résultats : La technique a été appliquée dans un contexte peropératoire afin de cerner l’anatomie biliaire complexe de certains segments des canaux biliaires. Des images d’excellente qualité ont été obtenues sous forme d’opacification et de délimitation du segment hépatique auquel le canal appartient. La circulation des microbulles de sérum physiologique était clairement visible sur les images échographiques en temps réel et a permis de visualiser les structures avec précision.

Conclusion : L’échographie peropératoire avec sérum physiologique comme agent de contraste permet de visualiser avec précision de petits segments isolés des canaux biliaires et facilite la chirurgie des voies biliaires. C’est une technique simple et peu coûteuse qui peut être effectuée avec un minimum de ressources.
Encountering aberrant biliary anatomy during dissection of the hepatic hilum is common and well described in the literature. These variations are relevant for a number of operative procedures, such as repair of bile duct injuries, liver transplantation, choledochal cysts and other hepatopancreato-biliary lesions, both benign and malignant. In today's era of laparoscopic cholecystectomy, the incidence of bile duct injury still remains around 0.6%. Many of these injuries are complex, involving hepatic hilum and vasculature. Variations in the anatomy of the ducts and fibrosis due to previous surgeries add to the difficulty of repairing such injuries. Proper identification and drainage of all the relevant ducts is imperative to prevent atrophy of undrained segment, cholangitis and secondary biliary cirrhosis.4

Various techniques of evaluating the biliary anatomy are well established. Magnetic resonance cholangiopancreatography (MRCP), endoscopic retrograde cholangiopancreatography (ERCP), fistulography and percutaneous transhepatic cholangiography (PTC) are routine radiological tools for preoperative assessment. Intraoperatively, cholangiography is the most commonly used modality to assess the biliary anatomy.5 We believe that intraoperative cholangiography (IOC) has some important limitations:

- Owing to the 2-dimensional (2D) nature of images and overlapping of different segments in the final image, it may not be possible to allocate a segment exactly to an isolated small duct being evaluated.
- Cannulation of a small segmental duct (often without any stump) is difficult. This may lead to leakage of dye and poor image quality.
- Operating rooms may not all be equipped with an IOC set-up.
- This modality comes with a definite risk of radiation to the patient and medical team.
- The modality prolongs the overall duration of surgery, as heavy equipment needs to be moved and placed, and at times multiple images are required.

Contrast-enhanced ultrasonography by injecting a special contrast agent in the biliary tree has been described in the literature. Such a technique also has limitations, including the need for expensive contrast agents, special ultrasonography probes and 3-dimensional (3D) reconstruction software.

In this article, we describe a very simple and novel technique of intraoperative ultrasonography of the biliary tree using normal saline as a contrast agent. Our aim was to discuss the technical feasibility, image characteristics and ease of use of this technique in the accurate identification of complex biliary ductal anatomy.

**Methods**

We evaluated the feasibility of intraoperative ultrasonography of the biliary tract using saline as a contrast agent. For the purpose of this study, we named this procedure “saline sono-cholangiography” (SSC). The procedure involves injecting normal saline in the biliary tree while performing intraoperative, real-time 2D ultrasonography.

**Procedure**

The SSC procedure involves cannulation of the biliary tract to be able to inject saline. Any part of the biliary system can be cannulated, including the cystic duct, common bile duct, right or left ducts, or segmental ducts, depending on the intraoperative scenario. In our study, the bile duct under evaluation was usually cannulated with a Foley catheter. Once the balloon of the Foley catheter was inside the duct, it was inflated with 0.2–1.0 mL of saline, based on the diameter of the duct, to stop or reduce backflow. If the duct was too small even for an 8-Fr Foley catheter, a 5- or 6-Fr infant feeding tube was used instead. The feeding tube was trimmed, if required, to keep all side holes inside the duct, and it was kept in position by gently holding it with tissue forceps. In a dilated duct, a larger Foley catheter was used.

The intraoperative ultrasonography probe was brought into field at this time. We used the ALOKA SSD-4000 (Hitachi-Aloka Medical Ltd.,) ultrasonography machine with an intraoperative micro-convex probe (ALOKA UST-995–7.5) at a frequency of 5 MHz. Ultrasonography was performed by the operating surgeon (V.G. or A.C.) in the presence of a board-certified radiologist (M.K.) to ensure the expert opinion of a trained radiologist in the evaluation of this new technique. The probe was then held at the possible segment(s) to which the duct belonged. We filled a 10 mL syringe with 9 mL of normal saline at room temperature and 1 mL of air. This was injected into the catheter using a connector in a slow pulsatile fashion, and ultrasound images were assessed and captured (Fig. 1). Injection of saline in a pulsatile fashion enabled it to be churned with air, creating saline bubbles that in turn caused echogenicity visible on the ultrasound.

We assessed the following parameters:

- the ease of identifying flow of saline in the biliary tree using real-time ultrasonography as well as the image quality obtained;
- the ease of identifying the effect of saline contrast in the form of echogenicity of the small biliary radicals or liver parenchyma, leading to identification of the segment and its picture quality in real time; and
- the time of retention of saline as a contrast in the biliary tree before the picture quality deteriorates.

The procedure was performed in a total of 11 operative scenarios, and the above-mentioned parameters were evaluated. The cases included postcholecystectomy biliary stricture (n = 4), postcholecystectomy external biliary fistula (n = 3), choledochal cyst (n = 3) and cholangiocarcinoma (n = 1).
For the purpose of elaborating the feasibility and clinical utility of SSC, we discuss in detail its use in 2 operative situations. The first is a case of postlaparoscopic cholecystectomy bile duct injury with external biliary fistula taken up for surgical repair. Preoperative MRCP suggested a type E-V biliary injury as per Strasberg classification. Intraoperatively, an aberrant duct was found in fibrosed tissue about 2 cm away from the biliary confluence (Fig. 1), and its segmental anatomy was delineated using SSC. The second is a case of type 1 choledochal cyst with 5 different bile duct orifices visible at the confluence after cyst excision.

Postoperative recovery and outcomes of all patients were documented. As this study evaluates the feasibility of an imaging technique, statistical methods were not used. We obtained consent to use this technique during surgery from all patients. All cases involved the same operating surgeons (A.C. or V.G.) and the same radiologist (M.K.).

RESULTS

Scenario 1

The patient in this scenario had a postlaparoscopic cholecystectomy bilioma. It was drained percutaneously, and the patient was referred to our institute with an external biliary fistula. Imaging with MRCP suggested complete transaction of the common bile duct with a separate aberrant right posterior duct. She was taken for surgery after 6 weeks. Intraoperatively we identified confluence of 2 ducts at the end of the fistulous track, with complete transaction of the common bile duct. To confirm the biliary anatomy, a catheter was inserted in the right-sided duct at the confluence, and SSC was performed. While pushing saline in the catheter, we obtained a very clear image of saline bubbles causing echogenicity of the right anterior segment of the liver (Fig. 2A). The left duct at the hilum was also cannulated to obtain an SSC (Fig. 2D), which sharply demarcated the left lobe of the liver.

The SSC images confirmed the findings of earlier MRCP and led us to search for the missing right posterior duct. On further dissection of the fibrotic tissue, bile was seen coming out of a small opening (Fig. 2B). This opening was then cannulated with an infant feeding tube, and SSC was performed, which confirmed it to be the right posterior duct (Fig. 2C). We confirmed a type E-V biliary injury as per Strassburg classification. We performed a Roux-en-Y double hepaticojejunostomy with transanastomotic stenting of the right posterior sectoral duct. A stentogram obtained on postoperative day 10 showed no leak; the stent was then clamped and the patient was discharged. The stent was removed after 4 weeks, and the patient was doing well on follow-up, with normal liver function tests.

Scenario 2

The patient in this scenario presented with recurrent pain in the abdomen and a large cystic common bile duct visible on an abdominal ultrasound. Imaging with MRCP suggested complete transaction of the common bile duct with a separate aberrant right posterior duct. She was taken for surgery after 6 weeks. Intraoperatively we identified confluence of 2 ducts at the end of the fistulous track, with complete transaction of the common bile duct. To confirm the biliary anatomy, a catheter was inserted in the right-sided duct at the confluence, and SSC was performed. While pushing saline in the catheter, we obtained a very clear image of saline bubbles causing echogenicity of the right anterior segment of the liver (Fig. 2A). The left duct at the hilum was also cannulated to obtain an SSC (Fig. 2D), which sharply demarcated the left lobe of the liver.

The SSC images confirmed the findings of earlier MRCP and led us to search for the missing right posterior duct. On further dissection of the fibrotic tissue, bile was seen coming out of a small opening (Fig. 2B). This opening was then cannulated with an infant feeding tube, and SSC was performed, which confirmed it to be the right posterior duct (Fig. 2C). We confirmed a type E-V biliary injury as per Strassburg classification. We performed a Roux-en-Y double hepaticojejunostomy with transanastomotic stenting of the right posterior sectoral duct. A stentogram obtained on postoperative day 10 showed no leak; the stent was then clamped and the patient was discharged. The stent was removed after 4 weeks, and the patient was doing well on follow-up, with normal liver function tests.

Image characteristics

The amount of parenchymal echogenicity visible on ultrasound after saline injection varied from starkly intense to more subtle white streaks. However, in all 11 patients, the segmental differentiation could easily be identified. Ultrasonography in real time clearly showed the saline entering the biliary duct and diffusing rapidly into the parenchyma (Fig. 5). The resulting echogenicity lasted for 1–2 minutes before slowly fading away. In some instances, echogenicity faded quickly (within a minute, \( n = 3 \)), whereas in others it persisted for more than 10 minutes (\( n = 2 \)). Additionally, while saline was being pushed, the bile duct dilated and became distinctly visible on the real-time ultrasound. The catheter lying inside the duct also rendered itself visible on ultrasound, thus revealing the anatomy of duct (Fig. 5B). The ability
of this technique to clearly demarcate the segment to which a duct belongs will be useful in a large number of biliary surgeries, especially when an aberrant duct needs evaluation.

**DISCUSSION**

A normal extrahepatic biliary confluence of the right and left hepatic ducts is present in 72% of the population, and the rest have one or the other variation. Precise knowledge of the biliary anatomy is important in various benign and malignant diseases. Biliary injuries during laparoscopic cholecystectomy often lead to atrophy and hypertrophy complex with rotation of the liver hilum, which along with fibrosis of previous surgeries makes the identification of the ducts difficult at the time of reoperation. It is necessary to drain all the segments of the liver for a good postoperative outcome. The same is true in patients undergoing liver transplantation and all major hepatobiliary surgeries requiring biliary reconstruction.

Preoperative evaluation of the bile ducts generally includes MRCP, ERCP, PTC or fistulography. The gold standard of these modalities is MRCP; however, the sensitivity and specificity of MRCP is low in cases of biliary strictures (67%). These techniques have a limited role when an intraoperative confirmation of biliary ductal anatomy is required.

Intraoperative cholangiography using iodinated contrast and intraoperative radiography are standard investigations to define the biliary tree during surgery. \(^5\)-\(^10\) The contrast leak in the surgical field may result in poor image quality, especially when small ducts are being evaluated. Also, owing to the 2D nature of the image, accurate

![Fig. 2. (A) Intraoperative photograph of complex biliary stricture. The hilum is formed by the junction of the right anterior and left main duct. The aberrant right posterior duct is visible 2 cm away from the hilum. (B) "Saline sono-cholangiography" (SSC) of the right anterior bile duct. The right anterior segment (segment 5+8) is rendered echogenic by saline bubbles. The diaphragm and the right (RHV), middle (MHV) and left (LHV) hepatic veins are marked. (C) The right posterior duct clearly demarcates the right posterior segment on SSC. (D) Bright, echogenic left lobe of the liver clearly demarcated on SSC. IVC = inferior vena cava.](image-url)
identification of 2 overlapping liver segments is very difficult. Many operating theatres (like ours) may not be adequately set up for performing an IOC.

The use of ultrasonography along with various biliary contrast agents either through a percutaneous biliary catheter or T-tube catheter has been described in preoperative and postoperative settings.7–9 The main use of these techniques is to define the level and extent of biliary obstruction (total or partial). Plain ultrasonography without using any biliary contrast does not accurately identify intrahepatic (especially undilated) ducts. Urade and colleagues6 have described using intrabiliary injection of perfluorobutane microbubbles through a cystic duct catheter combined with ultrasonography to define the biliary anatomy intraoperatively. With 3D reconstruction software, the correct identification of biliary anatomy was possible in 90% of cases in their study. However, the images obtained...
Can J Surg, Vol. 60, No. 5, October 2017

using this technique were similar to an MRCP image and did not show the kind of parenchymal echogenicity visible with SSC. Their technique also depended on the use of an expensive contrast agent, a 4-dimensional probe and 3D reconstruction software, which are not universally available. In a similar technique, Xu and colleagues used phospholipid stabilized microbubbles of sulfur hexafluoride as an ultrasonography contrast agent though the cystic duct during living donor hepatectomy. The limitations of their technique were similar to the ones described for the technique of Urade and colleagues.

In our region, we routinely see a large number of referred patients with postcholecystectomy bile duct injuries. We remain more concerned about an undrained major segmental duct (e.g., right anterior or posterior duct), which is likely to be missed in cases of a high biliary stricture. The SSC procedure is helpful for identifying the draining ducts or an undrained segment in cases of difficult anatomy or fibrosis from previous surgery.

CONCLUSION

Intraoperative ultrasonography of the biliary tract using normal saline as a contrast agent provides excellent images for correctly identifying the segmental anatomy of bile ducts, especially in patients with complex biliary injuries and variant anatomy. This technique is fast, accurate and easy to perform with equipment present in a usual hepatobiliary operating theatre.

Affiliations: From the Department of Surgical Gastroenterology, King George Medical University, Lucknow, India (Chandra, Rahul, Maurya); the Department of Organ Transplant, King George Medical University, Lucknow, India (Gupta); and the Department of Radiology, King George Medical University, Lucknow, India (Kumar).

Competing interests: None declared.

Contributors: A. Chandra and V. Gupta designed the study. R. Rahul and A. Maurya acquired the data, which M. Kumar analyzed. V. Gupta, R. Rahul and A. Maurya wrote the article, which all authors reviewed and approved for publication.

References


We believe in open access to research

To ensure continued worldwide free access to all CJS content, articles submitted for publication as of Jan. 1, 2014, are subject to a submission fee of $100 (Canadian funds). Submission fees will be waived for corresponding authors affiliated with CJS sponsors. Accepted Research, Review and Continuing Medical Education articles are subject to a publication fee of $700, and Commentaries and Discussions are subject to a publication fee of $500, payable on acceptance in Canadian funds.

Benefits of open access

• For researchers and institutions: increased visibility, usage and impact for their work
• For government: a better return on investment for funding research
• For society: efficient, effective patient care resulting in better outcomes

CJS articles are available free of charge on the journal website (canjsurg.ca) and in PubMed Central.
First Canadian experience with donation after cardiac death simultaneous pancreas and kidney transplants

Patrick T. Anderson, MD
Shahid Aquil, MD
Kelly McLean, MD
Vivian C. McAlister, MB
Alp Sener, MD
Patrick P. Luke, MD

Accepted Mar. 1, 2017; Early-released Aug. 1, 2017

Correspondence to:
P. Luke
Department of Surgery
Division of Urology
Western University Hospital
339 Windermere Rd
London ON N6A 5A5
patrick.luke@lhsc.on.ca

DOI: 10.1503/cjs.011315

Background: Compared with neurologic determination of death (NDD) donor organs, donation after cardiac death (DCD) donor organs have traditionally been considered of inferior quality owing to warm ischemia experienced during procurement. We present, to our knowledge, the first analysis of simultaneous pancreas and kidney (SPK) transplants using DCD donor organs in Canada.

Methods: We carried out a retrospective cohort study of SPK transplants from 13 DCD and 68 NDD donors performed between October 2008 and July 2016. In all patients immunosuppression was induced with thymoglobulin and continued with tacrolimus, mycophenolate mofetil and prednisone maintenance therapy.

Results: Donor and recipient characteristics of DCD and NDD groups were similar with respect to age, sex, body mass index, kidney and pancreas cold ischemia times, and donor terminal creatinine. Mean DCD graft warm ischemia time was 0.5 (range 0.4–0.7) hours. Median follow-up was 2.2 (range 0.1–6.7) years and 2.7 (range 0.3–6.3) years for the DCD and NDD groups, respectively. The DCD and NDD groups were similar with regards to recipient percent panel reactive antibody and presence of human leukocyte antigen antibodies. The groups also received similar total doses of thymoglobulin. In total 38% of patients in the DCD group experienced renal delayed graft function (DGF) compared with 10% in the NDD group (p = 0.027). There were 7 cases of pancreas graft thrombosis requiring relaparotomy in the NDD group compared with none in the DCD group. No patients from either group required insulin at any time after transplant. Although the estimated glomerular filtration rate (eGFR) was lower in the DCD than the NDD group on postoperative days 7 and 14 (p = 0.025), no difference was noted on day 30 or through 4 years after transplant. No differences were seen between the groups with respect to amylase, lipase, or glycosated hemoglobin (HbA1c) up to 4 years after transplant, or in kidney, pancreas, or patient survival at any time after transplant.

Conclusion: Our results show that, apart from a higher renal DGF rate, SPK transplants with DCD donor organs have comparable outcomes to standard transplants with NDD donor organs.

Conte: Comparedativement aux organes prélevés après détermination de la mort cérébrale (ou détermination du décès neurologique [DDN]), les organes prélevés après détermination du décès cardiocirculatoire (DDC) sont en général considérés de moindre qualité en raison du phénomène d’ischémie chaude inhérent à ce type de prélèvement. Nous présentons, à notre connaissance, la première analyse sur la double greffe rein–pancréas effectuée avec des organes prélevés après DDC au Canada.

Méthodes : Nous avons procédé à une étude de cohorte rétrospective sur les doubles greffes rein–pancréas effectuées entre octobre 2008 et juillet 2016, soit 13 après DDC et 68 après DDN. Chez tous les patients, l’immunosuppression a été induite par la thymoglobuline et a été maintenue au moyen d’un traitement d’entretien par le tacrolimus, le mycophénolate mofétil et la prednisone. Nous n’avons observé aucun cas de thrombose du greffon pancréatique nécessitant une relaparotomie dans le groupe DDN. Pour les patients du groupe DCD, 38% ont eu une fonction rénale retardée (DGF) au cours des 4 premiers mois après la transplantation, contre 10% dans le groupe DDN (p = 0.027). Nous avons également comparé les taux d’anticorps d’origine panébrystique (anticorps anti-HLA) dans les deux groupes. Les deux groupes ont reçu des doses similaires de thymoglobuline. Bien que le filtrage glomérulaire estimé (eGFR) ait été plus faible dans le groupe DCD que dans le groupe DDN au cours des premiers mois après la transplantation (p = 0.025), ce l’était également au cours des 30 premiers jours et jusqu’à 4 ans après la transplantation. Aucune différence n’a été observée entre les deux groupes en ce qui concerne les amylase, lipase et la glycosérate de l’hémoglobine (HbA1c) jusqu’à 4 ans après la transplantation, ou en ce qui concerne la survie des reins, des pancréas ou des patients à tout moment après la transplantation.

Résultats : Nos résultats montrent que, à l’exception d’une plus haute fréquence de la fonction rénale retardée (DGF), les greffes simultanées rein–pancréas avec des organes prélevés après DCD ont des résultats comparables à ceux des greffes standard avec des organes prélevés après DDN.
Patients with diabetes mellitus and end-stage renal disease (ESRD) have high rates of morbidity and mortality. The simultaneous pancreas and kidney transplant (SPK) has been shown to improve quality of life and substantially impact survival of patients with ESRD and diabetes. However, the global demand for SPK transplant continues to outpace the availability of suitable donor grafts, which has led to long transplant wait lists. To overcome this barrier, expansion of donor criteria is being studied to address the imbalance in organ supply and demand in North America.

One such provision in the expansion of donor criteria has been the use of donation after cardiac death (DCD) donor grafts in patients requiring an SPK transplant. Compared with the standard neurologic determination of death (NDD) donor grafts, pancreas grafts from DCD donors have traditionally been believed to be of inferior quality owing to the damage to these grafts during the period of warm ischemia between cessation of donor cardiopulmonary circulation and administration of cold perfusion during organ procurement. The theoretical risks about graft quality have limited the use of DCD grafts in SPK transplantation. Between 2006 and 2012, only 320 pancreas grafts from DCD donors were transplanted in the United States compared with 20,448 pancreas grafts from NDD donors.

As a measure of quality assurance, we present a study of, to our knowledge, the first Canadian experience with DCD SPK transplants. Specifically, we compared the rates of postoperative complications, laboratory parameters of graft function, and long-term patient and graft survival between SPK transplants from DCD and NDD donors.

METHODS

Patient selection

All patients who underwent SPK transplantation using DCD donor grafts between October 2008 and July 2016 at our single, large tertiary care institution were included in the study. Patient data were collected for analysis from the time of transplant until July 2016.

Organ procurement

After confirming the donors’ histories were free of diabetes or pancreatitis, the decision to accept the grafts was mainly based on donor age, history of diabetes, body mass index (BMI) and quality of the organs during procurement surgery and after flushing. The pancreas was not used if there was evidence of substantial trauma, severe fibrosis, or pancreatitis. Initial warm ischemia time was limited to 30 minutes, but with very minor impact on graft function and pancreas graft thrombosis, we extended this threshold to 60 minutes. Initially only younger patients were considered candidates for DCD grafts, but based on our experience of acceptable graft function with DCD grafts, all patients on our waiting list are considered for DCD transplant.

In all cases the pancreas and kidneys were flushed with Belzer University of Wisconsin solution. Kidneys were stored in either cold static solution using University of Wisconsin solution, or in a pulsatile cold preservation machine (LifePort, Organ Recovery Systems) using KPS solution (Organ Recovery Systems).

Transplant procedure

Standard kidney transplants were performed in the left iliac fossa. Pancreas transplants were completed in the right iliac fossa using systemic and enteric drainage.
Immune suppression

Immunosuppression was induced with 250 mg of methylprednisolone, which was given on call to the operating room. Thymoglobulin (1.5 mg/kg) was started before skin incision and administered over 6–8 hours. Mycophenolic acid (720 mg orally twice daily) was started on postoperative day 0. Tacrolimus was initiated on day 3 (trough level 5–8). Methylprednisolone was then started at 1 mg/kg with daily tapering by 10 mg/d until a minimum of 5 mg/d was reached. Steroids were withdrawn only if a protocol kidney biopsy at 3 months was free of rejection.

Delayed graft function (DGF) was defined as the need for dialysis within the first 7 days after SPK transplant.14

Statistical analysis

Statistical analysis was carried out using Graphpad Prism 6 (GraphPad Software, Inc.). We used the Mann–Whitney test to compare means between groups and the χ² test to compare categorical variables. Survival curves for patient and graft survival were generated using the Kaplan–Meier method and compared using the log-rank test. All statistical tests were 2-sided, and statistical significance was accepted at the 95% confidence interval with p < 0.05. Data are presented as means with standard deviations.

RESULTS

Thirteen DCD and 68 NDD SPK transplants were performed at our institution between October 2008 and July 2016 (Fig. 1). Median follow-up was 2.2 (interquartile range 0.1–6.7) years and 2.7 (range 0.3–6.3) years for DCD and NDD groups, respectively (Table 1).
number of hemodialysis sessions required by patients in either group who experienced DGF was not found to be statistically different. There were also 7 cases of pancreas graft thrombosis requiring repeat laparotomy and graft removal in the NDD group. No cases of pancreas graft thrombosis were observed in the DCD group; however, this difference was not found to be significant ($p = 0.50$).

**Immunosuppression**

Table 3 lists the immunosuppression doses received by both the DCD and NDD groups. The mean total thymoglobulin doses and the number of patients who could be tapered off methylprednisone were not found to be statistically different between the groups.

**Serum biochemistry**

We compared the serum biochemistry of patients in the DCD and NDD groups up to 4 years after SPK transplant (Fig. 2). The mean estimated glomerular filtration rate (eGFR) was significantly higher on postoperative days 7 and 14 in the NDD group than in the DCD group. However, from postoperative day 30 to 4 years after transplant, there was no significant difference in mean eGFR.
between the groups. There were no significant differences in mean serum amylase, lipase or glycosated hemoglobin (HbA1c) up to 4 years after transplant between the groups.

**Patient and graft survivals**

Patient and graft survival were followed up to 6 years after SPK transplant (Fig. 3). No significant differences in patient survival were found between the NDD and DCD groups. There was no significant difference in kidney graft survival between the NDD and DCD groups; however, 1 patient in the NDD group underwent severe acute rejection at 2 years after transplant, resulting in the loss of renal graft function. There were 7 events of acute pancreas graft thrombosis requiring relaparotomy and pancreatectomy in the NDD group. There were no pancreas thrombosis events in the DCD group, and no patient from the DCD group required insulin at any point after transplant. Overall, there was no significant difference in pancreas graft survival between the NDD and DCD groups.

**DISCUSSION**

Our study represents, to our knowledge, the first account from a Canadian institution with regards to the use of grafts from DCD donors in SPK transplants. In select patients with type 1 diabetes and end-stage renal disease, SPK transplant has become an excellent treatment option. Traditionally, grafts are derived from NDD donors owing to concerns of increased graft damage during the low perfusion state experienced with DCD grafts. However, the increasing discrepancy between the demand for grafts and their relative scarcity has led to the increased use of DCD donor grafts in SPK transplants worldwide, and in October 2008 we performed the first DCD SPK transplant in Canada. With the novel use of DCD donor grafts, it was of vital importance to assess whether outcomes of DCD SPK transplants were comparable to those of transplants making use of NDD grafts as a measure of quality.

Following SPK transplant, there was a significantly higher rate of DGF in the DCD group than the NDD group (Table 1). This higher rate of DGF was associated...
with a lower eGFR in the DCD than the NDD group up to 14 days after transplant (Fig. 2A). However, by 30 days, the mean eGFR of the DCD group was comparable to that of the NDD group. Both renal function and survival were similar between the DCD and NDD groups up to 4 years after transplant (Fig. 3B). These results support earlier work by D’Alessandro and colleagues, who found similar patterns when comparing DCD to NDD SPK transplants.

Although no differences were seen with regards to long-term pancreas survival, 7 patients in the NDD group had graft thrombosis and failure. These events primarily occurred within the first 48 hours after transplant. An explanation for the difference in graft thrombosis may be associated with institution changes to the postoperative management of patients receiving SPK transplants. Beginning in July 2009, all patients receiving SPK transplants were placed on a low-dose intravenous heparin infusion in the immediate postoperative period in order to prevent pancreas graft thrombosis. It is important to note that none of the 7 patients with a pancreas graft thrombosis received a heparin infusion as part of this protocol, and following this change, no events of pancreas graft thrombosis occurred, regardless of donor status.

Limitations

The main limitation of our study is the relatively small number of DCD SPK transplants available for our analysis. In addition, donors were relatively young in both groups, and warm ischemic time (WIT) was relatively low in the DCD group. When our institution initially began performing DCD SPK transplants, 30 minutes of WIT was considered the upper threshold owing to concerns of adverse outcomes on graft survival and function. However, our experience allowed us to increase our threshold to 60 minutes of WIT owing to relatively low rates of DGF and pancreas graft thrombosis. The upper limits of WIT for pancreas transplants is not known, but our findings of excellent immediate and long-term pancreatic graft function and absence of thrombosis and pancreatitis (amylase/lipase rise) supports assessment of a longer WIT in the future.

Fernandez and colleagues were the first to report on the long-term outcomes of DCD grafts in SPK transplants. Their study included 37 DCD SPK transplants and supported their use, finding them to be equivalent to NDD grafts in the long term. Our study from a single Canadian tertiary care centre has been able to show similar long-term outcomes and strengthens the current evidence for use of DCD grafts in SPK transplants.

Conclusion

To our knowledge, our study is the first in Canada to support the use of DCD grafts in SPK transplants. We have shown that outcomes of SPK grafts from DCD and NDD donors are comparable in long-term follow-up. As the demand for organs continues to outpace their availability, we have initial evidence that supports the expansion of donor criteria to include DCD grafts in SPK transplantation.


Competing interests: None declared.


References

Results and limitations of outpatient and overnight stay laminectomies for lumbar spinal stenosis

David Yen, MD
Abdu Albargi, MD

Accepted Mar. 3, 2017; Early-released Aug. 1, 2017

Correspondence to:
D. Yen
Douglas 5, Kingston General Hospital
76 Stuart St
Kingston ON K7L 2V7
yend@kgh.kari.net

DOI: 10.1503/cjs.002017

Background: At our centre, laminectomies have been traditionally performed as inpatient surgery. A gradual change in practice occurred between 2010 and 2013 to try to do these procedures as outpatient or overnight stay surgery.

Methods: We conducted a retrospective cohort study of consecutive patients having laminectomies over 2 18-month periods: before the change in practice and after full implementation of the outpatient/overnight stay protocol. We collected information on patient characteristics (age, sex, American Society of Anesthesiologists [ASA] classification, home address, number of laminectomy levels, estimated blood loss) and patient outcome (complications, hospital length of stay, 30-day readmissions).

Results: We found no significant difference in age, sex, ASA classification, number of laminectomy levels, or estimated blood loss between the 2 cohorts. There was a change in the number of outpatient (from 0 to 25) and overnight stay laminectomies (from 0 to 13). There was an increase in total (inpatient, overnight stay and outpatient) laminectomies from 41 to 82, and an increase in patients from out of our region from 15% to 32%. There was 1 readmission within 30 days that occurred in the first cohort.

Conclusion: We found that outpatient and overnight stay laminectomies can be done safely, with no patients requiring postoperative admission to hospital or readmissions within 30 days. They can be done in patients from out of town who need to travel home postoperatively. It is possible to safely reduce the level of resources used for spine surgery by carrying out laminectomies as outpatient or overnight stay surgery in select patients.

Contexte: Par le passé, les laminectomies effectuées dans notre centre nécessitent l’hospitalisation des patients. Un changement graduel de la pratique a toutefois eu lieu entre 2010 et 2013, et les laminectomies constituent maintenant, dans la mesure du possible, une chirurgie d’un jour, ou une chirurgie dont la durée de séjour se limite à une seule nuit.

Méthodes: Nous avons mené une étude de cohorte rétrospective sur des patients ayant subi consécutivement une laminectomie au cours d’une des 2 périodes de 18 mois suivantes : avant le changement de pratique ou après celui-ci, c’est-à-dire après la mise en œuvre du protocole de chirurgie d’un jour ou de chirurgie exigeant un séjour d’une nuit. Nous avons recueilli des données sur les caractéristiques des patients (âge, sexe, classification selon l’American Society of Anesthesiologists [ASA], adresse du domicile, nombre de vertèbres touchées par la laminectomie, perte sanguine estimée) et sur les résultats des patients (complications, durée du séjour à l’hôpital, réadmission dans les 30 jours).

Résultats : Aucune différence significative n’a été observée entre les 2 cohortes du point de vue de l’âge, du sexe, de la classification de l’ASA, du nombre de vertèbres touchées par la laminectomie et de la perte sanguine estimée. Il y a toutefois eu une augmentation du nombre de patients se présentant pour une chirurgie d’un jour (de 0 à 25) ou pour une chirurgie exigeant un séjour d’une nuit (de 0 à 13). Le nombre total de laminectomies (patients hospitalisés, chirurgie d’un jour et chirurgie exigeant un séjour d’une nuit) a également augmenté (de 41 à 82), tout comme la proportion de patients venant de l’extérieur de notre région (de 15 % à 32 %). Il n’y a eu qu’une seule réadmission dans les 30 jours suivant une laminectomie, survenue dans la première cohorte.

Conclusion : Nous avons constaté que les laminectomies effectuées comme chirurgie d’un jour ou comme chirurgie exigeant un séjour d’une nuit peuvent être réalisées de façon sûre, sans que les patients aient besoin d’être hospitalisés en période postopératoire ou d’être réadmis dans les 30 jours suivant l’intervention. Les patients demeurent à l’extérieur de la ville et devant rentrer à la maison en période postopératoire peuvent subir une laminectomie. Il est donc possible de réduire de façon sûre les ressources utilisées pour réaliser des laminectomies en effectuant ces interventions comme chirurgie d’un jour ou comme chirurgie exigeant un séjour d’une nuit chez certains patients.
Discetomy and laminectomy are common surgical procedures for degenerative lumbar spine conditions. Discetomy is used to treat disc herniation/extrusion/sequestration, and laminectomy is used for spinal stenosis. Traditionally, patients undergoing these operations have been admitted to hospital after surgery. Laminectomy is now being performed at many centres as an outpatient procedure. Compared with postoperative in-hospital stays, outpatient discetomy is safe, although it is uncommon for laminectomies to be done this way. Palmer and colleagues reported successful outpatient laminectomies in 7 out of 8 patients. Best and Sasso reported that outpatient laminectomies and discectomies can be done safely and successfully in patients 65 years of age or older, with only a 3.8% conversion rate to inpatient surgery; however, it is not stated how many of their 233 outpatients had laminectomies.

In our academic centre we have followed the lead of others and performed discectomies as outpatient procedures. We wondered if we could apply our discectomy protocol to laminectomies because of the technical similarities between the 2 procedures. However, we recognize that the patient population is different, with those having laminectomies tending to be older and have more comorbidities. Therefore, a gradual change in practice was instituted between 2010 and 2013 to try to perform laminectomies as outpatient and overnight stay surgery in select patients. The purpose of this study was to determine the effect of our change in practice on hospital inpatient days and patient outcomes.

Methods

Study population

We retrospectively reviewed a single surgeon’s practice (D.Y.) comparing consecutive patients in 2 18-month periods: one before the change in practice (April 2009 to October 2010) and the other after full implementation of the outpatient/overnight stay protocol (July 2013 to January 2015). The logistics of the protocol were worked out, and gradual implementation took place in the 32 months between the study periods. We reviewed the hospital medical record for patient factors, including age, sex, American Society of Anesthesiologists (ASA) classification of physical health to grade preoperative health of the patients, home address, number of laminectomy levels, and estimated blood loss (EBL), and patient outcomes, including complications, hospital length of stay (LOS) and readmission within 30 days. We routinely gave patients in both cohorts a 6-week postsurgical follow-up appointment during which we obtained a history, asking them whether they had to seek medical attention or admission to hospital elsewhere for postoperative complications, and performed a physical examination to determine if they had recovered from their surgery. We categorized patients’ homes as being located in our city, outside the city but in our region, or out of our region. Our province divides health care into regions (local health integration networks); each roughly correspond to a major urban centre, its county, and those bordering its county. The Queen’s University Health Sciences Research Ethics Board approved out study.

Surgical procedure

The surgical procedure was the same for patients in both cohorts. A CMAX-T (Steris, Mentor) operating room table was used. It is a general-purpose OR table found in all of the rooms in both the ambulatory care centre and the in-patient hospital involved in this study. The patients were positioned prone, supported on 2 cylindrical gel bolsters. The laminectomies were bilateral posterior decompressions from a unilateral approach using an open technique. No microscope or tubular retractor systems were used. No preoperative analgesia was given. We infiltrated 20 mL of 0.25% bupivacaine hydrochloride without epinephrine into the paravertebral muscles and subcutaneous tissue at the start of the procedure and another 20 mL at the end of the procedure.

Discharge protocol

The outpatient/overnight stay protocol for spine surgery consisted of the anesthesiologist limiting the long-acting narcotics and intravenous fluids given during surgery. Patients were given a handout with instructions for after surgery care upon discharge from hospital, and a nurse telephoned patients on the first day after surgery to check on their condition and answer any questions.

All patients having laminectomies were either discharged home from the recovery room and classified as having outpatient surgery, kept overnight (< 24 h stay) in an extended postanesthetic care unit (EPACU) in our ambulatory care centre, or admitted to a ward in our in-patient hospital and classified as having inpatient surgery. The EPACU has a capacity for 10 patients and is shared by multiple surgical services. It is staffed by an anaesthesiologist and 2 nurses, with the rest of the ambulatory care centre closed from 8 pm to 8 am. Imaging and laboratory services are available during the day, but not overnight. Any patients having intraoperative or postoperative complications in our ambulatory care centre are immediately transferred to our in-patient hospital located less than 1 mile away.
The surgeon assigned patients to 1 of these 3 treatment paths when they were put on the waiting list for surgery based on their general health and home support system. An ASA of 3 or less and availability of someone to do the homemaking duties was required for the outpatient or overnight stay EPACU streams. Patients were assigned to the overnight stay EPACU instead of outpatient surgery if the surgeon felt their age and comorbidities required overnight monitoring.

Statistical analysis

Statistical analysis was carried out using a series of t tests for equality of means to compare the 2 groups for age, ASA, EBL and number of laminectomy levels. We used Pearson χ² tests to assess readmissions, sex and percentage of patients from out of our region. We conducted an analysis of variance (ANOVA) with post hoc Tukey tests to compare the ASA and age for the outpatient, overnight stay EPACU and inpatient groups within the second cohort. We considered results to be significant at p < 0.05.

RESULTS

In comparing the 2 18-month periods, one before the change in practice and the other after full implementation of the outpatient protocol, we found no significant differences in age, sex, ASA class, number of laminectomy levels, or EBL (Table 1). We did find a change in the number of outpatient laminectomies (from 0 to 25) and overnight stay EPACU laminectomies (from 0 to 13; Fig. 1). Therefore, by implementation of outpatient surgery and overnight stays in the EPACU, we reduced the average LOS from 2.0 ± 1.7 days in the first cohort to 0.7 ± 0.8 days in the second (p < 0.001), and we reduced resource utilization by 25 inpatient days (Fig. 1).

From the medical record and direct questioning of the patients during the 6-week postoperative follow-up visit, in the first cohort we identified the following complications. One patient had a postoperative acute myocardial infarction. One patient visited the emergency department (ED) twice postoperatively owing to narcotic withdrawal symptoms. Two patients had dural tears repaired intraoperatively, 3 patients had transient urinary retention while still in hospital, and 1 patient had a urinary tract infection. One patient had epigastic and back pain, slowing mobilization by physiotherapy for discharge, and 1 patient had hypotension treated by holding their preoperative antihypertension medications during their hospitalization.

No patients switched from planned outpatient laminectomy to overnight stay in the EPACU or to inpatient admission. No patients switched from planned overnight stay in the EPACU to inpatient admission. The 2 patients with dural tears repaired intraoperatively were allowed to mobilize immediately postoperatively and were scheduled as inpatients preoperatively. Similarly, the 3 patients with transient urinary retention, the patient with a postoperative urinary tract infection, the patient with epigastic and back pain slowing mobilization by physiotherapy for discharge, and the patient with hypotension treated by holding their preoperative antihypertension medications during their hospital stay were all scheduled as inpatients.

One patient required hospital readmission within 30 days in the first cohort, and none required readmission in the second cohort. Two of 41 patients (5%) in the first cohort and 4 of 82 patients (5%) in the second cohort were not seen at their scheduled 6-week follow-up appointment.

There was an increase in total (inpatient, overnight stay EPACU, and outpatient) laminectomies from 41 to 82 in the second cohort (Fig. 1). There was also an increase in the percentage of patients coming from out of our region from 15% to 32% (p = 0.042; Fig. 2).

<p>| Table 1. Demographic and clinical characteristics of the study sample |
|----------------|----------------|--------------|----------|</p>
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Group: mean ± SD (range)*</th>
<th>Group: mean ± SD (range)*</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, yr</td>
<td>68.6 ± 12.3 (37–88)</td>
<td>66.8 ± 7.6 (49–84)</td>
<td>0.32</td>
</tr>
<tr>
<td>Sex, male:female, %</td>
<td>51.2:48.8</td>
<td>59.6:40.2</td>
<td>0.37</td>
</tr>
<tr>
<td>ASA classification</td>
<td>2.61 ± 0.49 (2–3)</td>
<td>2.66 ± 0.53 (2–4)</td>
<td>0.56</td>
</tr>
<tr>
<td>Estimated blood loss, mL</td>
<td>240 ± 231 (50–1400)</td>
<td>187 ± 167 (20–1250)</td>
<td>0.14</td>
</tr>
<tr>
<td>No. of laminectomy levels</td>
<td>2.27 ± 0.87 (1–6)</td>
<td>2.35 ± 0.76 (1–6)</td>
<td>0.58</td>
</tr>
</tbody>
</table>

ASA = American Society of Anesthesiologists; SD = standard deviation.

*Unless indicated otherwise.
Within the second cohort, there was a significant difference in ASA classification between the outpatients and inpatients \( (p = 0.001) \) and between the outpatients and overnight stay EPACU patients \( (p = 0.046; \text{Table 2 and Table 3}) \). Similarly, there was a significant difference in age between the outpatients and inpatients \( (p = 0.014) \) and between the outpatients and overnight stay EPACU patients \( (p = 0.001; \text{Table 4 and Table 5}) \). However, there was no difference between the EPACU and inpatient groups for ASA \( (p = 0.90) \) or age \( (p = 0.17) \).

**DISCUSSION**

There was no significant difference in age, sex, ASA classification, number of laminectomy levels, or EBL between the laminectomy patients in the 2 periods studied. We included in our study all patients of a single surgeon who had been in practice for 17 years by the time of the first cohort without any changes in practice pattern. Therefore, we believe that the change in process rather than a difference in our patient population or surgeon’s proficiency resulted in the increase in the number of outpatient laminectomies from 0 of 41 (0%) to 25 of 82 (30%) and an increase in the number of overnight stay EPACU laminectomies from 0 of 41 (0%) to 13 of 82 (16%). Reviewing the surgeon’s practice, we noted that there was more overall surgical volume during the 18 months of the second cohort. Therefore, we believe that the mechanism allowing the increase in total (inpatient, overnight stay EPACU, and outpatient) laminectomies from 41 to 82 was more OR time due to the change in process.

Some studies on outpatient discectomy restricted their patients to those who resided close to hospital owing to concerns about their ability to travel any distance immediately after having surgery.5,6 However, Bednar12 reported that travel distance was never an issue in failure of outpatient discectomy in his series. We found that it is possible to carry out outpatient and overnight stay laminectomies even with 51% of our patients living out of town and 32% out of our region.

We did not actively recruit patients and are not aware of any changes in accessibility to spine surgery outside of our region between the 2 study periods. However, there was an increase in total (inpatient, overnight stay EPACU, and outpatient) laminectomies from 41 to 82 and in patients from outside of our region from 15% to 32%. Therefore, we believe that the change in practice did not deter referrals.

We found that outpatient and overnight stay EPACU laminectomies are safe, with no patients requiring admission to hospital. They were also safe in terms of readmissions within 30 days, with none identified from the hospital record or at 6-week postoperative follow-up visits.

<table>
<thead>
<tr>
<th>Home address</th>
<th>No. of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>In city</td>
<td>10</td>
</tr>
<tr>
<td>Outside city but in region</td>
<td>25</td>
</tr>
<tr>
<td>Outside region</td>
<td>6</td>
</tr>
</tbody>
</table>

**Table 2. American Society of Anesthesiologists classification for July 2013–January 2015 cohort groups**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Outpatient ((n = 25))</th>
<th>EPACU overnight stay ((n = 13))</th>
<th>Inpatient ((n = 44))</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASA classification</td>
<td>2.33 ± 0.482 (2–3)</td>
<td>2.75 ± 0.452 (2–3)</td>
<td>2.82 ± 0.495 (2–4)</td>
</tr>
</tbody>
</table>

ASA = American Society of Anesthesiologists; EPACU = extended postanesthetic care unit; SD = standard deviation.
We were able to reduce the level of resources used for spine surgery by performing 30% of our laminectomies as outpatient procedures. We were further able to avoid admitting patients to hospital with use of an EPACU for an additional 16% of laminectomies. Therefore, in comparing the April 2009–October 2010 and the July 2013–January 2015 periods, we reduced the average hospital stay from 2.0 to 0.7 days and hospital resources by 25 inpatient days while increasing the total number of patients having laminectomies by 41 (Fig. 1). These changes freed up inpatient beds for other patients while still providing spine surgery at our centre. However, we believe that significant medical comorbidities and lack of home support in some of our laminectomy patients limited our ability to offer outpatient surgery to more of them for safety reasons and risk of readmission to hospital.

As would be expected with our selection process for postoperative pathways, there was a statistically significant difference in ASA classification and age between the outpatients and inpatients and between the outpatients and overnight stay EPACU patients. However, there was no difference in the ASA classification and age between the EPACU and inpatient groups. Despite the statistics, in the EPACU group there was only 1 complication of a patient presenting to the ED twice after discharge owing to narcotic withdrawal, whereas in the inpatient group there were 8 patients with complications delaying their discharge home: 2 with dural tears, 3 with urinary retention, 1 with a urinary tract infection, 1 with epigastric and back pain, and 1 with hypotension. We believe this means that assigning patients to the postoperative pathway requires not only considering ASA classification and age, but also use of clinical judgment about the patient’s independence and the nature and severity of their comorbidities.

**Limitations**

A weakness in our study was that we were conservative in directing patients to the inpatient stream, as evidenced by no outpatient laminectomy patients requiring postoperative admission to hospital unlike the 3.8% conversion rate reported by Best and Sasso,11 no overnight stay EPACU laminectomy patients requiring postoperative admission to hospital, and no hospital readmissions within 30 days. Therefore, the number of outpatients and hence inpatient days saved potentially could have been higher, but with greater risk of patient complications. Another weakness is that we did not assess patient satisfaction with their pain control after discharge home or their satisfaction with their overall experience of having their laminectomy as an outpatient. However, although the patients tended to be older, we believe that owing to the similarities in surgical technique, our laminectomy patients would have had the same satisfactory experience reported by Hersht and colleagues12 for outpatient discectomy. Finally, we did not determine the cost savings of outpatient versus inpatient laminectomy. Ontario has a universal coverage single-payer health care system; therefore, no bills for hospitalization are generated, and our focus is on efficient resource utilization to control our wait times for surgery. However, because our laminectomy patients receive standard postoperative care on a surgical ward while in hospital, we believe that the dollar cost savings from not admitting the patients should be similar to those reported for outpatient discectomy4,6,8 and outpatient procedures in general.10

**Conclusion**

Best and Sasso11 reported that outpatient discectomies and laminectomies can be done safely and successfully, but with some patients needing to be converted to inpatients. Our study clarifies that outpatient and overnight stay laminectomies can also be performed safely without the need for conversion to inpatients if the

---

**Table 3. Analysis of variance with post hoc Tukey test analysis of the ASA classification of patients in July 2013–January 2015 cohort groups**

<table>
<thead>
<tr>
<th>Group</th>
<th>Comparison group</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outpatient</td>
<td>EPACU</td>
<td>0.046</td>
</tr>
<tr>
<td></td>
<td>Inpatient</td>
<td>0.001</td>
</tr>
<tr>
<td>EPACU</td>
<td>Outpatient</td>
<td>0.046</td>
</tr>
<tr>
<td></td>
<td>Inpatient</td>
<td>0.90</td>
</tr>
<tr>
<td>Inpatient</td>
<td>Outpatient</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>EPACU</td>
<td>0.90</td>
</tr>
</tbody>
</table>

ANOVA = analysis of variance; ASA = American Society of Anesthesiologists; EPACU = extended postanesthetic care unit.

*Overall 1-way ANOVA (F = 7.98, p = 0.001).

**Table 4. Age of the July 2013 to January 2015 cohort groups**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Group; mean ± SD (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Outpatient (n = 25)</td>
</tr>
<tr>
<td>Age, yr</td>
<td>62.6 ± 7.3 (49–81)</td>
</tr>
</tbody>
</table>

EPACU = extended postanesthetic care unit; SD = standard deviation.

**Table 5. Analysis of variance with post hoc Tukey test analysis of age in the July 2013–January 2015 cohort groups**

<table>
<thead>
<tr>
<th>Group</th>
<th>Comparison group</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outpatient</td>
<td>EPACU</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>Inpatient</td>
<td>0.014</td>
</tr>
<tr>
<td>EPACU</td>
<td>Outpatient</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>Inpatient</td>
<td>0.17</td>
</tr>
<tr>
<td>Inpatient</td>
<td>Outpatient</td>
<td>0.014</td>
</tr>
<tr>
<td></td>
<td>EPACU</td>
<td>0.17</td>
</tr>
</tbody>
</table>

ANOVA = analysis of variance; EPACU = extended postanesthetic care unit.

*Overall 1-way ANOVA (F = 8.03, p = 0.001).
candidates are selected carefully. We found significant inpatient bed savings by using a protocol for outpatient/overnight stay laminectomies and would encourage others to try this method of providing spine surgery.

Affiliation: From the Department of Surgery, Queen’s University, Kingston, Ont.

Competing interests: None declared.

Contributors: Both authors designed the study, acquired and analyzed the data, wrote the article, and reviewed and approved the final version for publication.

References


CJS’s top viewed articles*

1. Research questions, hypotheses and objectives
   Farrugia et al.

2. Clinical practice guideline: management of acute pancreatitis
   Greenberg et al.

   Karanicolas et al.

4. Hardware removal after tibial fracture has healed
   Sidky and Buckley

5. Complications associated with laparoscopic sleeve gastrectomy for morbid obesity: a surgeon’s guide
   Sarkhosh et al.

6. Treatment of an infected total hip replacement with the PROSTALAC system
   Scharfenberger et al.

7. Surgical approach in primary total hip arthroplasty: anatomy, technique and clinical outcomes
   Petis et al.

8. Tracheostomy: from insertion to decannulation
   Engels et al.

9. Defining medical error
   Grober and Bohnen

10. Pharmacological management of postoperative ileus
    Zeinali et al.

*Based on page views on PubMed Central of research, reviews, commentaries and discussions in surgery. Updated Sept. 19, 2017.
The usefulness and costs of routine contrast studies after laparoscopic sleeve gastrectomy for detecting staple line leaks

Background: Although laparoscopic sleeve gastrectomy (LSG) has been shown to be a safe and effective treatment for severe obesity (body mass index ≥ 35), staple line leaks remain a major complication and account for a substantial portion of the procedure’s morbidity and mortality. Many centres performing LSG routinely obtain contrast studies on postoperative day 1 for early detection of staple line leaks. We examined the usefulness of Gastrografin swallow as an early detection test for staple line leaks on postoperative day 1 after LSG as well as the associated costs.

Methods: We conducted a retrospective review of a prospectively collected database that included 200 patients who underwent LSG for severe obesity between 2011 and 2014. Primary outcome measures were the incidence of staple line leaks and the results of Gastrografin swallow tests. We obtained imaging costs from appropriate hospital departments.

Results: Gastrografin swallow was obtained on postoperative day 1 for all 200 patients who underwent LSG. Three patients (1.5%) were found to have staple line leaks. Gastrograffin swallows yielded 1 true positive result and 2 false negatives. The false negatives were subsequently diagnosed on computed tomography (CT) scan. The sensitivity of Gastrografin swallow in this study was 33%. For 200 patients, the total direct cost of the Gastrografin swallows was $35 000.

Conclusion: The use of routine upper gastrointestinal contrast studies for early detection of staple line leaks has low sensitivity and is costly. We recommend selective use of CT instead.

Contexte : Même si la gastrectomie longitudinale par laparoscopie (GLL) s’est révélée sûre et efficace pour le traitement de l’obésité sévère (indice de masse corporelle ≥ 35), les fuites survenant à la ligne d’agrafes demeurent une complication majeure et sont responsables d’une bonne partie des complications et des décès associés à cette chirurgie. Plusieurs des centres effectuant des GLL procèdent au dépistage systématique des fuites à la ligne d’agrafes en réalisant des tests avec des agents de contraste le jour suivant la chirurgie. Nous avons évalué l’utilité du test à la gastrografine comme méthode de dépistage prématuré des fuites à la ligne d’agrafes au jour 1, ainsi que les coûts qui y sont associés.

Méthodes : Nous avons mené une étude rétrospective à partir d’une base de données créée de façon prospective qui portait sur 200 patients ayant subi une GLL entre 2011 et 2014 en raison d’une obésité sévère. Les principaux indicateurs de résultats étaient l’incidence de fuites à la ligne d’agrafes et les résultats obtenus aux tests à la gastrografine. Les renseignements sur le coût des tests d’imagerie nous ont été fournis par les départements appropriés des hôpitaux.

Résultats : Selon les résultats des tests à la gastrografine au jour 1 obtenus pour les 200 patients ayant subi une GLL, 3 patients (1,5 %) présentaient des fuites à la ligne d’agrafes. Il s’agissait en réalité d’un vrai positif et 2 faux négatifs. Le diagnostic des faux négatifs a ensuite été effectué par tomographie par ordinateur. La sensibilité du test à la gastrografine était donc de 33 % au cours de cette étude. Le coût total de ce test, pour les 200 patients, était de 35 000 $.

Conclusion : Le recours à des examens systématiques du tractus gastro-intestinal supérieur au moyen d’agents de contraste pour le dépistage prématuré des fuites à la ligne d’agrafes a une faible sensibilité et est associé à des coûts élevés. Nous recommandons plutôt l’utilisation sélective de la tomographie par ordinateur.
Obesity has been an increasing global health problem. In 2008, 1.4 billion people were overweight and 0.5 billion were obese worldwide. The prevalence of adult obesity (body mass index [BMI] ≥ 30) in Canada has increased dramatically over the last 3 decades from 6.1% in 1985 to 20.2% in 2014. In 2014, the proportion of obese adult residents in the Canadian province of Newfoundland and Labrador was 30.4%, which was much higher than the national average of 20.2%.

Bariatric surgery has emerged as the most effective treatment for patients in whom conservative management has failed. Globally, Roux-en-Y gastric bypass (RYGB) surgery and laparoscopic sleeve gastrectomy (LSG) are the most common bariatric procedures performed for the treatment of obesity. Laparoscopic sleeve gastrectomy works by decreasing the volume of the stomach, thereby restricting food intake, as well as by means of neurohormonal effects (e.g., lowered ghrelin levels) resulting from the partial excision of the stomach. Based on a 2013 meta-analysis conducted by Parikh and colleagues, LSG has been shown to result in 57.6% excess weight loss (EWL) at 1 year and 70.1% EWL at 3 years. The procedure has grown in popularity, trending from 0% in 2003 to 5.3% in 2008 and 37% in 2013. Canadian Institute for Health Information data indicate that 2362 of the 6525 (36.2%) bariatric surgeries carried out in Canadian hospitals in 2013–2014, were LSGs.

Laparoscopic sleeve gastrectomy is considered a relatively safe procedure; however, it carries a risk of several serious and potentially fatal complications, including staple line leak, staple line bleed and stricture. The procedure is associated with a leak rate of 2.2%, an overall mortality of 0.3% and a leak-related mortality of 0.1%. In a 2012 systematic review of 29 studies involving 4888 patients, the authors reported leaks occurred in 0%–7% of LSG cases, with a higher leak rate observed in patients with a BMI above 50 than in those with a BMI below 50 (2.9% vs. 2.2%). Csendes and colleagues reported that 3 types of leaks may develop after bariatric operations: 1) early leak, which appears 1–3 days after surgery and is usually secondary to technical surgical problems; 2) intermediate leaks, which appear 4–7 days after surgery; and 3) late leaks, which appear 8 or more days after surgery.

The rationale for obtaining an upper gastrointestinal (UGI) contrast study after LSG may be attributed to the risk of staple line leak or stricture. Unidentified staple line leak may lead to abdominal sepsis, which could lead to the development of a gastric fistula, multisystem organ failure, or death. However, the necessity of routine UGI contrast studies has been questioned and remains a point of controversy. A recent meta-analysis by Quartararo and colleagues evaluated the results of routine and selective postoperative UGI series after RYGB to assess its utility and cost-effectiveness. No differences in leakage detection or in clinical benefit between routine and selective approaches were observed. The authors concluded that tachycardia and respiratory distress were the best criteria to perform UGI contrast studies for early diagnosis of leak after RYGB. It is important to note that the meta-analysis focused only on RYGB, the most popular procedure performed worldwide. As Rawlins and colleagues pointed out, “LSG is inherently different in anatomy and in causes of leak and obstruction.” A limited number of studies have evaluated the usefulness of routine UGI contrast studies on postoperative day 1 (POD 1) after LSG. Studies conducted in the United States, Europe, Egypt and the Middle East have reported low sensitivity of the test. We have not identified any Canadian studies that investigated the utility and cost-effectiveness of routine UGI contrast after LSG.

A number of bariatric centres across Canada have adopted programs for early detection of staple line leaks, whereas others have decided to discontinue the use of routine contrast studies and have chosen to order imaging only when clinically indicated. These imaging studies usually involve a routine Gastrografin swallow study on POD1. This has also been the practice at our centre, where LSG accounts for 98% of the procedures performed. Because of the low frequency of early staple line leak and the substantial costs associated with early detection programs, we have questioned the usefulness of routine contrast studies. As a result, the aim of the present study was to determine the usefulness and costs of routine Gastrografin swallow studies on POD1 after LSG in detecting early complications.

**METHODS**

**Study setting**

The Provincial Bariatric Surgery Program was established in Newfoundland and Labrador in May 2011. The multidisciplinary team consists of 3 surgeons trained in bariatric surgery, a nurse practitioner and a dietician. The 3 surgeons (D.P., D.B., and C.S.), performed all procedures in this study and have advanced laparoscopic skills. Two surgeons (D.P. and C.S.) are fellowship-trained in minimally invasive (MIS) and bariatric surgery.

**Study design**

The study is a retrospective review of prospectively collected data combined with a chart review of patients undergoing bariatric surgery in order to assess the usefulness of the routine Gastrografin swallow test in the detection of early complications (e.g., leak). The present study is part of a larger study, the Newfoundland and Labrador Bariatric Surgery Cohort Study, which has been described elsewhere. For the present study, we examined data from 200 consecutive laparoscopic sleeve gastrectomies performed between May 11, 2011, and May 5, 2014.
study was approved by the provincial Health Research Ethics Authority (No. 11.101). All participants provided written informed consent to take part in the study.

Participants

Patients were referred, selected and worked-up according to previously published protocol.25 Throughout this process, they were seen by a nurse practitioner, dietician, appropriate medical specialists, and 1 of the 3 bariatric surgeons. Patients were excluded if they were pregnant or planning a pregnancy within 2 years of surgical treatment; had a medical condition that would make surgery too risky, such as end-stage organ disease; or had a BMI greater than 60.

Operative procedure

The operative technique has been described previously.23 The gastrocolic omentum is divided close to the stomach with a vessel-sealing device, completely freeing up the greater curve of the stomach from the distal antrum to the angle of His. Multiple firings of the stapler are performed along a 42-Fr bougie starting at about 6 cm proximal to the pylorus. The staple line is leak tested using a gastroscopic forceps. Staple line bleeds are clipped.

Gastrografin swallow procedure

All patients underwent the Gastrografin swallow study on POD 1. Patients received no more than a single 120 mL bottle of Gastrografin. Occasionally it was diluted with 10–15 mL of water to make it more palatable. Fluoroscopy was used to acquire images. Standing position and anteroposterior orientation was used to obtain most images; however, supine position and oblique orientation were used as well to improve image quality. On average 1 image was taken per swallow of Gastrografin. Most patients found Gastrografin very unpleasant and difficult to consume. If the radiologist reported the study as normal (i.e., negative results), patients were started on a clear fluid diet and advanced as per protocol. Patients were seen by a dietician and the nurse practitioner before discharge and were instructed to return on an as-needed basis. Otherwise patients were seen in clinic at 4 weeks by the nurse practitioner and dietician for advice on dietary progression. Patients attended a follow-up consultation with the surgeon between 6 and 8 weeks after surgery. Follow-up visits with the multidisciplinary team were scheduled for 3, 6, 12, 18 and 24 months and annually thereafter.

Definition of a staple line leak

A definition of staple line leak was proposed by the UK Surgical Infection Study Group; they define a leak as “the leak of luminal contents from a surgical join between two hollow viscera.” A second definition proposed by the same group suggests that a leak may also be defined as “an outflow of gastrointestinal content through a suture line around an organ. Thus, luminal content can exit through the wall or drain, or can collect next to the anastomosis.”26 In addition, these leaks have been classified in the literature by Csendes and colleagues12 based on the time period in which they appear:

• early leaks appear between the first and third day after surgery,
• intermediate leaks appear between the fourth and seventh day after surgery, and
• late leaks appear more than 8 days after surgery.

In the present study, we define staple line leak based on the second definition proposed by the UK Surgical Infection Study group.

Data collection

Presurgical data were collected from patients using standardized case report forms. Sociodemographic data and presurgical clinical data were collected by the nurse practitioner. Clinical data (e.g., leak, diagnostic testing) were obtained from chart review by the first author (D.T.). All staple line leaks were recorded, and the clinical course and management of theses cases was reviewed by the bariatric clinical team. Costs of the Gastrografin swallow and of the abdomen and pelvis computed tomography (CT) scanning were obtained from the radiology department at the Health Sciences Department at Eastern Health.

Statistical analysis

Descriptive analyses were performed for continuous variables, and data are presented as means and standard deviations or medians and interquartile ranges. For categorical variables data are presented as numbers and percentages. Leak incidence as well as overall test accuracy, sensitivity, specificity, and positive (PPV) and negative predictive values (NPV) of the Gastrografin swallow test were calculated.

RESULTS

The data on 200 patients who underwent laparoscopic sleeve gastrectomy between May 20, 2011, and May 5, 2014, were collected. Mean age was 44 years, mean BMI was 49, and 82% of patients were women. Preoperative demographic characteristics and comorbidities are shown in Table 1. Staple line leak was diagnosed in 3 of 200 (1.5%) patients. One contrast study correctly confirmed a leak (a true positive), whereas 2 studies did not reveal a leak (false negatives). Details of the contrast studies, including leak information and treatment, are presented in Table 2 and Table 3. The Gastrografin swallow test had a sensitivity of 0.33, specificity of 1.00, PPV of 1.00 and NPV of 0.99 (Table 4).
A description of the clinical details of patients who experienced a leak in the present study follows. Three of 200 patients experienced staple line leaks near the gastroesophageal junction, which presented on PODs 1, 7 and 30, respectively. The results of postoperative Gastrografin swallow performed on POD 1 were negative in 2 of the 3 patients. In those patients, the clinical suspicion of staple line leak was confirmed by CT scan. One of the leaks required reoperation, whereas the other 2 were treated conservatively.

The first patient was a 45-year-old woman who was found to be tachycardic (i.e., up to 137 beats/min), with a white blood cell count of 21 × 10^9/L on POD 1. She was taken for a Gastrografin swallow, and a large leak was detected. She was then taken to the operating room for closure of the defect, irrigation of the abdominal cavity, drainage of the upper abdomen, and placement of a feeding jejunostomy tube. She recovered uneventfully.

The second patient was a 47-year-old woman who had an uneventful LSG and a negative Gastrografin swallow. On POD 7, she presented to the bariatric clinic with shortness of breath, chest pain and a white blood cell count of 23 × 10^9/L. A CT pulmonary angiogram was done to rule out a presumed pulmonary embolism. It showed a small proximal staple line leak, which was confirmed by repeat Gastrografin swallow. The patient was managed conservatively with intravenous antibiotics and total parenteral nutrition. The leak was monitored with several repeat CT scans, endoscopies and contrast studies. The patient left against medical advice after a 2-month hospital admission.

The third patient was a 50-year-old woman who had an uneventful LSG and a negative Gastrografin swallow. She presented 1 month later with dysphagia, dehydration and a white blood cell count of 18 × 10^9/L. A subsequent CT scan confirmed a small proximal staple line leak. She was treated successfully with conservative measures and was discharged home after a 1-month admission.

The cost of 1 Gastrografin swallow with a radiologist’s interpretation at our centre was Can$175. Therefore the total cost of conducting the swallow test on all 200 patients was $35 000. On the other hand, based on patient symptomology, the cost of 1 contrast CT scan of the abdomen and pelvis with a radiologist’s interpretation was estimated at $1107. The total cost of the 2 CT scans performed in 2 patients for leak detection was $2214.

**Discussion**

Staple line leak is a complication dreaded by bariatric surgeons performing LSGs. Routine, early Gastrografin swallow studies have been used by some centres in an attempt to detect this complication before clinical symptoms appear. In this study, we assessed the usefulness of this test for patient management and its costs. Several conclusions and remarks can be made based on the results

---

### Table 1. Demographic and clinical characteristics of the study sample (n = 200)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Mean ± SD or no. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, yr</td>
<td>44 ± 10</td>
</tr>
<tr>
<td>Weight, kg</td>
<td>135.1 ± 23.7</td>
</tr>
<tr>
<td>BMI</td>
<td>48.8 ± 6.8</td>
</tr>
<tr>
<td>Duration of surgery, min</td>
<td>80.8 ± 29.6</td>
</tr>
<tr>
<td>Hospital stay, d</td>
<td>2.3 ± 1.6</td>
</tr>
<tr>
<td>Female sex</td>
<td>163 (81.5)</td>
</tr>
<tr>
<td>Leak</td>
<td>3 (1.5)</td>
</tr>
<tr>
<td>30-day mortality</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>

BMI = body mass index; SD = standard deviation.

### Table 2. Leak information and treatment (n = 3)

<table>
<thead>
<tr>
<th>Patient</th>
<th>Classification as per POD</th>
<th>POD at presentation</th>
<th>Presenting symptoms</th>
<th>Location</th>
<th>Severity*</th>
<th>Treatment</th>
<th>CT abdomen/ pelvis</th>
</tr>
</thead>
<tbody>
<tr>
<td>45-yr F</td>
<td>POD 1–3 d (early)</td>
<td>1</td>
<td>Tachycardia (137 beats/min BP 93/60) Abdominal tenderness WBC 21.2 × 10^9/L</td>
<td>Proximal stomach (below gastroesophageal junction)</td>
<td>Type II</td>
<td>Emergency laparotomy, primary closure of defect, drainage of the upper abdomen, placement of a feeding jejunostomy tube</td>
<td>No</td>
</tr>
<tr>
<td>47-yr F</td>
<td>POD 4–7 d (intermediate)</td>
<td>7</td>
<td>SOB Chest pain WBC 22.9 × 10^9/L</td>
<td>Proximal stomach (below gastroesophageal junction)</td>
<td>Type I</td>
<td>Intravenous antibiotics, total parenteral nutrition</td>
<td>Yes</td>
</tr>
<tr>
<td>50-yr F</td>
<td>POD &gt; 7 d (late)</td>
<td>30</td>
<td>Dysphagia Not tolerating fluids Dehydration Weakness WBC 18.0 × 10^9/L</td>
<td>At gastroesophageal junction</td>
<td>Type I</td>
<td>Intravenous antibiotics, total parenteral nutrition; 4 clips placed across defect endoscopically</td>
<td>Yes</td>
</tr>
</tbody>
</table>

BP = blood pressure; CT = computed tomography; F = female; POD = postoperative day; SOB = shortness of breath; WBC = white blood cell count.

* Type I or subclinical leaks are those that appear as a localized leak, without spillage or dissemination, with few clinical manifestations; they are easy to treat medically. Type II leaks are those with dissemination or diffusion into the abdominal or pleural cavity by way of an irregular pathway, with the appearance of contrast medium (methylene blue, radiological contrast) or food through any of the abdominal drain, with severe clinical consequences.
presented here. First, the staple line leak rate in our study was similar to those previously published at 1.5%. Second, although some centres in Canada use routine Gastrografin studies, we found that the test was not effective in early detection of leaks. The sensitivity, specificity, PPV and NPV were 0.33, 1.00, 1.00 and 0.99, respectively. Finally, the costs of such an early detection program are very high considering its ineffectiveness. In our sample of 200 patients, the total cost of Gastrografin swallows performed was $35 000, whereas the cost of 2 CT scans used to diagnose leaks was $2214.

The Gastrografin swallow proved to be an ineffective test for early leak detection. The sensitivity of the test was 33%, which is especially poor for an outcome with a low prevalence. One should not be misled by the high NPV of 0.99. In this study, it does not indicate the test’s ability to rule out leaks, but simply reflects the relative rarity of the outcome. Although the PPV was also high at 1.00, this result simply reflects the fact that there were no false positive studies. A single positive study result would have decreased the PPV to 0.5.

Of the 3 leaks, only 1 was detected by Gastrografin swallow on POD 1. However, in this particular patient scenario, it could be argued that the swallow test was being used as a diagnostic rather than as an early detection test. Before the test was performed, the patient was tachycardic and reported abdominal pain. Her white blood cell count was elevated at 21 × 10^9/L. The other 2 leaks were missed by the Gastrografin swallow and detected on the CT scan of the abdomen when the patients presented with symptoms after hospital discharge. It must be noted that these 2 patients presented with symptoms at 7 days and 4 weeks after surgery, respectively. It is very likely that these patients experienced delayed leaks, which could be the reason for the negative test on POD 1. Thus, the sensitivity of the Gastrografin swallows may have been limited by the timing of the test. Although most centres do the contrast study on POD 1, an editorial by Afthinos and Gibbs expressed the view that most leaks are delayed and caused by ischemia rather than by technical error, and in 1 study have been observed to occur between 5 and 28 days after surgery.

Comparing our study results to those of other published studies that evaluated the usefulness of routine contrast studies after LSGs, we find similar results in that most authors have not found routine contrast studies on POD 1 useful in detecting staple line leaks. The sensitivities quoted are consistent with the results of the present study and, as in our study, most leaks were detected on CT. In contrast, there is 1 small study from Greece that looked at routine Gastrografin swallows after LSG on POD 3. That study found that all leaks (3 of 85) were detected by the contrast studies and concluded that the routine contrast studies were indeed useful.

A larger number of similar studies have been conducted on patients who have undergone laparoscopic RYGB (LRYGB), and the findings are inconsistent. Most conclude that routine Gastrografin swallow studies on POD 1 are not useful or cost-effective methods of early detection of anastomotic leaks. However, 2 studies published on LRYGB have conducted sensitivity analyses comparing sensitivities of clinical signs versus routine Gastrografin swallows. These 2 studies found clinical signs to be less sensitive and therefore support the use of routine contrast studies.

Some of the common reasons quoted in support of routine Gastrografin swallows on POD 1 are documentation (especially for young surgeons), ability to detect strictures, and the consideration that many CT scanners are not bariatric patient–rated.

When examining the costs of the imaging studies in the present analysis, it becomes evident that the total cost of the Gastrografin swallows, which proved to have low sensitivity, was more than 10 times greater than the cost of the 2 CTs used to diagnose the leaks in symptomatic patients. The early detection program was found to be very costly without providing any benefit to the patients. Studies on sleeve gastrectomies from Israel and

### Table 3. Swallow study 2 × 2 contingency table (n = 200)

<table>
<thead>
<tr>
<th>Gastrografin swallow</th>
<th>Complication, no.</th>
<th>Normal, no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Negative</td>
<td>2</td>
<td>197</td>
</tr>
</tbody>
</table>

### Table 4. Gastrografin swallow test statistical probabilities

<table>
<thead>
<tr>
<th>Variable</th>
<th>Percentage</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevalence</td>
<td>1.5</td>
<td>Overall complication rate</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>33</td>
<td>Probability of a positive swallow test when leak or obstruction was present</td>
</tr>
<tr>
<td>Specificity</td>
<td>100</td>
<td>Probability of a normal swallow test when leak or obstruction was absent</td>
</tr>
<tr>
<td>PPV</td>
<td>100</td>
<td>Probability of a leak or obstruction when the swallow test was positive</td>
</tr>
<tr>
<td>NPV</td>
<td>99</td>
<td>Probability of no complication when the swallow test was negative</td>
</tr>
<tr>
<td>True positive</td>
<td>33</td>
<td>Probability that swallow test is positive when there is a complication</td>
</tr>
<tr>
<td>True negative</td>
<td>100</td>
<td>Probability of negative swallow test when there is no complication</td>
</tr>
<tr>
<td>False positive</td>
<td>0</td>
<td>Overall missed diagnosis rate (false positive + false negative)</td>
</tr>
<tr>
<td>False negative</td>
<td>66</td>
<td></td>
</tr>
</tbody>
</table>

NPV = negative predictive value; PPV = positive predictive value.
the United States also looked at the costs of the early detection program and arrived at a similar conclusion.18,21 In Canada, in a publicly funded health care system with limited resources and reduced budgets with a focus on cost-effectiveness, any test with low accuracy should be questioned in terms of money spent.

Strengths and limitations

The strengths of this study include the use of prospectively collected data. In addition, all procedures were performed by surgeons at the same academic-affiliated health care institution using 2 surgeons per case approach. The limitations of this study are as follows. First, we did not have access to data on patients who had a CT for symptoms, but in whom a leak was not subsequently diagnosed. This could potentially change the estimates for the cost analysis. Second, we did not examine strictures, for which some authors report the utility of routine contrast analysis. Instead, we and others37 recommend being mindful of patient clinical signs and symptoms suggestive of a leak and having a low threshold to investigate them either with a Gastrografin swallow, a CT scan, or early reoperation.

Affiliations: From the Eastern Health Sciences Centre, St. John’s, NL (Tetterov, Leung, Boone, Pace); the Faculty of Medicine, Memorial University of Newfoundland, St. John’s, NL (Tetterov, Leung, Twells, Gregory, Smith, Boone, Pace); and the School of Pharmacy, Memorial University of Newfoundland, St. John’s, NL (Twells).

Competing interests: None declared.

Contributors: D. Tetterov, C. Smith and D. Pace designed the study. All authors acquired and analyzed the data. D. Tetterov, P. Leung, L. Twells, D. Gregory and D. Pace wrote the article, which all authors reviewed and approved for publication.

References


Improving spine surgical access, appropriateness and efficiency in metropolitan, urban and rural settings

Mohammad Zarrabian, MD
Andrew Bidos, DC
Caroline Fanti, PT
Barry Young, DC
Brian Drew, MD
David Puskas, MD
Raja Rampersaud, MD

Background: The Inter-professional Spine Assessment and Education Clinics (ISAEC) were developed to improve primary care assessment, education and management of patients with persistent or recurrent low back pain–related symptoms. This study aims to determine the effect of ISAEC on access for surgical assessment, referral appropriateness and efficiency for patients meeting a priori referral criteria in rural, urban and metropolitan settings.

Methods: We conducted a retrospective review of prospective data from networked ISAEC clinics in Thunder Bay, Hamilton and Toronto, Ontario. For patients meeting surgical referral criteria, wait times for surgical assessment, surgical referral–related magnetic resonance imaging (MRI) scans and appropriateness of referral were recorded.

Results: Overall 422 patients, representing 10% of all ISAEC patients in the study period, were referred for surgical assessment. The average wait times for surgical assessment were 5.4, 4.3 and 2.2 weeks at the metropolitan, urban and rural centres, respectively. Referral MRI usage for the group decreased by 31%. Of the patients referred for formal surgical assessment, 80% had leg-dominant pain and 96% were deemed appropriate surgical referrals.

Conclusion: Contrary to geographic concentration of health care resources in metropolitan settings, the greatest decrease in wait times was achieved in the rural setting. A networked, shared-cared model of care for patients with low back pain–related symptoms significantly improved access for surgical assessment despite varying geographic practice settings and barriers. The greatest reductions were noted in the rural setting. In addition, significant improvements in referral appropriateness and efficiency were achieved compared with historical reports across all sites.

Contexte : Les cliniques interprofessionnelles d’évaluation de la colonne vertébrale et d’éducation (Inter-professional Spine Assessment and Education Clinics [ISAEC]) ont été mises sur pied pour améliorer les soins primaires d’évaluation, d’éducation et de prise en charge des patients atteints de symptômes persistants ou récurrents de lombalgie. Cette étude a pour but d’évaluer l’effet des ISAEC sur l’accès à une évaluation chirurgicale et sur la pertinence et l’efficacité de la référence des patients en milieux ruraux, urbains et métropolitains répondant à priori aux critères de référence.

Méthodes : Nous avons mené une étude rétrospective de données prospectives issues de cliniques du réseau des ISAEC situées à Thunder Bay, à Hamilton et à Toronto, en Ontario. Nous avons retenu pour l’étude les patients répondant aux critères de référence en chirurgie; pour chacun de ces patients, nous avons consigné le temps d’attente pour obtenir une évaluation chirurgicale, les images obtenues par résonance magnétique (IRM) aux fins de référence et la pertinence de la référence.

Résultats : Au total, 422 patients, soit 10 % des patients des ISAEC au cours de la période étudiée, ont été dirigés en évaluation chirurgicale. Les temps d’attente moyens pour obtenir une évaluation chirurgicale étaient de 5,4 semaines, de 4,3 semaines et de 2,2 semaines dans les centres métropolitains, urbains et ruraux, respectivement. Le recours à l’IRM aux fins de référence a diminué de 31 % par rapport à la situation initiale. Parmi les patients référés en évaluation chirurgicale formelle, 80 % présentaient une douleur principalement localisée dans les jambes. La référence de 96 % des patients a été jugée adéquate.
Conclusion: Même si les ressources en soins de santé sont concentrées en milieu métropolitain, c’est le milieu rural qui a connu la plus grande baisse du temps d’attente. La mise sur pied d’un modèle de soins partagés en réseau pour les patients aux prises avec des symptômes de lombalgie a amélioré l’accès aux évaluations chirurgicales de façon significative, malgré la variété géographique des milieux de pratique et les divers obstacles rencontrés. Les baisses les plus importantes ont été observées en milieu rural. De plus, des améliorations significatives de la pertinence et de l’efficacité des références ont été observées lors de la comparaison avec les rapports antérieurs, pour tous les sites de l’étude.

Low back pain (LBP) has a global 1-month prevalence of 23%, with estimates of a North American lifetime incidence of 80%.[2] In light of a high potential for chronicity,[3–5] negative impact on productivity,[6] inappropriate health care utilization[6–8] and inefficiencies in care delivery, LBP is increasingly the target of studies to reduce its burden on the health care system.[8,9]

In Canada, the traditional referral process from a primary care provider to a spine surgeon has many regional barriers and inefficiencies.[10–11] The majority of surgeons report wait times from primary care referral to consultation for nonurgent spinal conditions in excess of 6 months despite a substantial proportion closing their practices to new referrals or screening them.[10] Approximately 75%–85% of patients referred to a spine surgeon in Canada are not surgical candidates.[12–14] As a result, the majority of Canadian surgeons require advanced imaging (77% require magnetic resonance imaging [MRI] of the spine) prior to referral in an attempt to screen out nonsurgical patients.[11]

To improve access, referral and imaging appropriateness and delivery of care for both surgical and nonsurgical patients, several spine models of care have recently been established in Ontario, Saskatchewan, Quebec and Manitoba.[12–15] These models have used nurse practitioners, chiropractors and physical therapists as adjunctive members of the medical team to assess and educate patients referred by their primary care providers and in some scenarios as a screening tool for surgical referral (i.e., serving as a triage function). Initial reports have shown a reduction in wait times and MRI utilization, and an increase in the surgical conversion rate.[16,17]

The purpose of this study was to examine the effect of the Inter-professional Spine Assessment and Education Clinics (ISAEC), Ontario’s low back shared-care model, on surgical referral MRI utilization rates, surgical assessment wait times, and referral appropriateness and efficiency as compared with historical practices in rural (northern), urban, and metropolitan settings.

Methods

The ISAEC was established in Ontario in November 2012 with funding from the Ontario Ministry of Health and Long-Term Care to enable shared-care management of LBP among primary care providers (doctors and nurse practitioners), allied health providers (physiotherapists and chiropractors) and specialists (surgeons, pain specialists and rheumatologists). The model utilizes a network structure among primary care providers, specially trained physiotherapists and chiropractors (advanced-practice clinicians [APCs]) and specialists to deliver evidence-based LBP assessment, education and care recommendations; timely access; and support to enable patients to self-manage LBP. Purposeful operational variation regarding method and location of service delivery was instituted to meet regional and geographic needs (e.g., community v. centrally located APCs, telemedicine). However, to provide a consistent and reproducible assessment, stratification and patient/provider education process, all providers in the ISAEC network undergo a standardized and relevant education process (continuing medical education [CME] and non-CME training). Further details on ISAEC processes and education are available at www.ISAEC.org. For the present study, 386 participating primary care providers referred patients with LBP for assessment when they had unmanageable, persistent LBP for more than 6 weeks but less than 52 weeks, or recurrent LBP (regardless of duration) that had become unmanageable. Exclusion criteria were diagnosed pain disorder, narcotic dependency (i.e., actively treated by a specialist), pregnancy or postpartum less than a year, and presence of red flags in the patient presentation (e.g., fever/chills, symptoms of cauda equine syndrome, tumour, history of intravenous drug use). Figure 1 shows the pattern of surgical referral in the ISAEC model.

Patients were seen at ISAEC by APCs, who are physical therapists and chiropractors with additional clinical training specific to the multidisciplinary aspects (e.g., surgical referral criteria and clinical assessment) of LBP assessment and management. Comprehensive baseline clinical information was obtained, and the patients were categorized into 1 of 4 clinical mechanical LBP presentations based on the classification system proposed by Hall and colleagues.[18,19] Pattern 1 was back-dominant pain exacerbated by flexion. Pattern 2 was back-dominant pain aggravated by extension but not increased with flexion. Pattern 3 was leg-dominant pain that is constant with or without neurologic manifestations (i.e., radiculopathy, typically caused by a symptomatic disc herniation). Pattern 4 was leg-dominant pain that is intermittent, aggravated by extension and relieved by rest and/or flexion (i.e., neurogenic claudication, typically due to significant
spinal stenosis). Patients were also stratified by presence or absence of risk factors for surgical or nonsurgical red flags (e.g., inflammatory LBP, narcotic dependency and chronicity risk).4,20,21

If patients were deemed by the APCs to be a surgical candidate (i.e., meeting a priori criteria for surgical referral: patients with leg-dominant pain, or neurologic symptoms or signs), they were sent on for surgical assessment at the centre of the ISAEC network spine surgeon. Each ISAEC site had only 1 network spine surgeon. Prior to APC or surgical assessment, primary care providers had the discretion of ordering an MRI (based on ISAEC education recommendations); however, this was not a requirement for surgical referral as it has been in the pre-ISAEC practices of the 3 network ISAEC surgeons. At surgical assessment, if a patient was deemed to be a surgical candidate and was interested in surgical treatment, required imaging (if not already completed) was organized and the standard perioperative surgical process of the surgeon was initiated. The number and type of imaging, the presenting pain pattern, the referral appropriateness for surgery, and the wait time from primary care provider referral to assessment at ISAEC were recorded at the initial assessment and after the surgeons’ assessment. Referral appropriateness was defined as current or past presenting symptoms and signs amenable to surgical intervention. For example, a patient with resolved or partially resolved radiculopathy from a disc herniation treated nonsurgically or a surgically appropriate patient not interested in pursuing surgery following a discussion about the risks and benefits of surgery at the time of surgical assessment was still categorized as an appropriate surgical referral.

**Statistical analysis**

We used descriptive statistics and analysis of variance (ANOVA) to describe and compare differences between the subpopulation of primary care LBP patients seen at the various ISAEC centres who were deemed to be surgical candidates and seen by an ISAEC network spine surgeon. We considered results to be significant at \( p < 0.05 \).

**Results**

The study group consisted of 422 consecutive potential surgical candidates (out of 4059 patients seen by ISAEC) with nonemergent low back and/or leg symptoms assessed by APCs in Toronto, Hamilton and Thunder Bay and were referred for surgical consultation between January 2013 and August 2015. The number of patients referred was 166 at the Toronto centre, 83 in Hamilton and 173 in Thunder Bay. Wait times for assessment at each centre were 5.4, 4.3 and 2.4 weeks, respectively. Differences in wait times among the centres were statistically significant (\( p < 0.001 \)).

Of the 422 patients assessed in the various ISAEC locations, 227 (54%) did not have an MRI upon referral to the surgeon by the APC. Of that group, 140 subsequently had...
MRIs (62%), for a total of 335 MRIs from 422 patients (79%). Table 1 summarizes the MRI utilization data per ISAEC centre.

The clinical patterns seen at each respective centre are summarized in Table 2. At both the metropolitan and urban centres, the type 3 pattern (i.e., radicular leg pain) predominated the other diagnoses. The type 4 pattern (i.e., claudicant leg symptoms) was the most common in the rural setting.

Clinical agreement between the surgeon and the APC was 93% overall. Agreement was present for 151 patients in Toronto (96%), 77 patients in Hamilton (94%) and 163 patients (95%) in Thunder Bay. After assessment by the surgeon the number of patients deemed to be appropriate surgical candidates was 153 (92%) in Toronto, 75 (90%) in Hamilton and 168 (97%) in Thunder Bay.

**DISCUSSION**

The present study shows the ability of a networked shared-care LBP model to improve access and referral appropriateness for surgical spine assessments while eliminating the participating surgeon’s requirement for MRI before acceptance of a referral. Reduction in wait time was the most striking finding in our study. Prior to ISAEC implementation the senior author’s elective wait time was a mean of 6 (range 1–19) months, depending on the referring diagnosis compared with 38 days at the Toronto ISAEC site. Wait times for surgical assessment before implementation of ISAEC at the Hamilton site ranged from 6 to 18 months, with urgent referrals seen in 6 months. At the Thunder Bay site, wait times ranged from 12 to 24 months for elective referrals and varied by case for urgent referrals. Although lengthy, the pre-ISAEC wait times were achieved with periodic closure of practices to new consults and/or refusal to see a percentage of referrals (deemed nonsurgical cases based on clinical referral information and imaging reports) in order to reduce wait times. If all surgical referrals were seen, pre-ISAEC surgical wait times would be longer. The reductions in wait times in our study are similar to those found in Saskatchewan; Wilgenbusch and colleagues found that after implementation of a multidisciplinary care pathway wait times for surgical assessment dropped from an average of 130 days to 69 days. Recent implementation of a similar pathway in Manitoba has allowed wait times to decrease from an average of 24 months to 30 days (Dr. Michael Johnson, University of Manitoba, Winnipeg, Man., personal communication; 2015).

To our knowledge, our study is the first to show that this shared-care model functions across different regions with distinct system and geographic barriers. With a higher concentration of health care resources in metropolitan and urban areas, we expected wait times in these locations would be the lowest. However, wait times had an unexpected inverse association with the population density of the city in which the ISAEC was located, with the population densities of Toronto, Hamilton and Thunder Bay being 4149/km², 465/km² and 47.6/km², respectively. Given the similar number of surgical referrals between the Toronto and Thunder Bay sites, these differences are likely due to 2 effects. The decreased population density in rural settings requires patients to travel longer distances to receive health care; subsequently, a greater effort is made to coordinate all the required tests and consultations. In addition, in the smaller ISAEC clinics in Hamilton and Thunder Bay, there was closer interaction between the surgeons and the APCs. In Thunder Bay, where the APC and surgeon are located in the same clinic, it was not uncommon for the surgeon to see the surgical referrals on the same day that they had been assessed by the APC. As geographical mal-distribution of health care providers, especially physicians, toward higher population centres is a ubiquitous problem, this finding is particularly relevant to the delivery of health care in less populated regions. In the ISAEC model the majority of patients do not require surgical or specialist assessment, thus wherever possible, APCs are located in proximity to primary care providers, not the specialists (i.e., decentralization of services). In a region like Thunder Bay, where there is a limited number of physiotherapists or chiropractors to train as APCs and the geographical distance between primary care providers and possible APCs was prohibitive, a more centralized service delivery process with the support of telemedicine as required was instituted.

In the Canadian health care system a number of factors increase the wait time to surgical assessment in the traditional pathway. Low back pain is one of the most common presenting symptoms of patients seen by primary care

<table>
<thead>
<tr>
<th>Centre</th>
<th>No. of patients without MRI before surgical assessment</th>
<th>No. (%) of MRIs ordered</th>
<th>No. of patients with MRI before surgical assessment</th>
<th>Overall MRI utilization, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toronto</td>
<td>91</td>
<td>40 (44)</td>
<td>75</td>
<td>69</td>
</tr>
<tr>
<td>Hamilton</td>
<td>50</td>
<td>34 (68)</td>
<td>32</td>
<td>81</td>
</tr>
<tr>
<td>Thunder Bay</td>
<td>86</td>
<td>66 (77)</td>
<td>87</td>
<td>88</td>
</tr>
<tr>
<td>Total</td>
<td>227</td>
<td>140 (62)</td>
<td>196</td>
<td>79</td>
</tr>
</tbody>
</table>

MRI = magnetic resonance imaging.
physicians. At present, there is a large number of referrals to spine surgeons with a high proportion of nonsurgical patients; 75%–85% of patients referred to a spine surgeon for assessment are not surgical candidates. With the exception of spine surgical red flags (e.g., cauda equina syndrome), there is substantial variation in surgical decision-making for degenerative spinal disorders among spine surgeons. The more recent reliance on MRI to differentiate between the different sources of LBP has compounded the problem, as MRI has been shown to be unreliable in detecting pathology that should be managed surgically. Consequently, it would be unrealistic to expect primary care providers to achieve a high level of referral appropriateness without an active process like ISAEC. Unfortunately, the impact of a high degree of referrals is the delay in assessment of the 15%–25% of referrals who are surgical candidates and would likely benefit from surgical treatment. This is of concern, as Braybrooke and colleagues showed that longer wait time to surgery had a negative impact on patient-reported outcomes following elective spine surgery. The parameters most affected by a longer wait to surgery included physical function and subjective pain severity measures. Basic science research has also solidified the link between effective treatment of LBP and changes in neural structure and function in patients with chronic LBP. In other words, the development of what can be irreversible pain-related changes in the brain is time-dependent.

Our study focused only on the portion of primary care patients with LBP seen by ISAEC APCs who met surgical referral criteria and were sent for formal surgical assessment by the network ISAEC spine surgeon. However, our shared-care model also had benefits for patients who did not require assessment by a surgeon. Of the 4059 patients assessed in the various ISAEC clinics, approximately 90% were deemed to be nonsurgical by the screening APCs. Patients deemed nonsurgical, many of whom would have had to wait to see a specialist (before ISAEC), were assessed in the various ISAEC clinics, approximately 90% were deemed to be surgically appropriate after assessment by APCs. Once assessed by the accepting surgeons 93% (Toronto), 85% (Hamilton) and 94% (Thunder Bay) were deemed appropriate surgical candidates. There was also close agreement (90%–93%) between the APCs and surgeons in regards to diagnostic categorization of the patients referred for surgical assessment. The rate of agreement between APCs and surgeons is very high despite the surgeons having no standardized criterion when assessing surgical candidacy. This shows flexibility in our shared-care model to accommodate differences in surgical practices. Our study also shows that a shared-care model can positively influence the type and appropriateness of surgical spine referrals.

Table 2. Summary of diagnostic patterns

<table>
<thead>
<tr>
<th>Pain pattern</th>
<th>Total</th>
<th>Toronto</th>
<th>Hamilton</th>
<th>Thunder Bay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pattern 1</td>
<td>30 (7)</td>
<td>7 (4)</td>
<td>3 (4)</td>
<td>5 (3)</td>
</tr>
<tr>
<td>Pattern 2</td>
<td>14 (3)</td>
<td>8 (5)</td>
<td>4 (5)</td>
<td>2 (1)</td>
</tr>
<tr>
<td>Pattern 3</td>
<td>230 (55)</td>
<td>96 (59)</td>
<td>61 (73)</td>
<td>73 (45)</td>
</tr>
<tr>
<td>Pattern 4</td>
<td>151 (36)</td>
<td>53 (32)</td>
<td>15 (18)</td>
<td>83 (51)</td>
</tr>
</tbody>
</table>

The cost savings associated with our multidisciplinary clinic in terms of MRI utilization are potentially substantial. It is common practice for spine surgeons in Canada to require an MRI upon referral. Faced with a large number of nonsurgical referrals, this requirement may be an attempt to exclude patients with nonsurgical pathology. It is also quite common for primary care providers to order MRIs for patients with chronic back pain, possibly owing to worsening, persistent or recurrent symptoms. This has contributed to a significant increase in the use of MRI. Between 1993–94 and 2003–04 there was a 600% increase in the number of MRI scans. This utilization rate is particularly concerning, as MRIs have failed to show any effect on patient treatment in the majority of patients referred for surgical assessment. In the present study 227 patients were assessed at the 3 centres without preexisting MRIs. Of those, 87 (39%) MRIs were not ordered after assessment. In the simplest manner, this represents a...
cost savings of $87,000 based on the cost of an MRI being $1000. Of the 422 patients referred for surgical assessment, 195 patients had pre-existing MRIs ordered by their primary care physicians. Estimating conservatively that 25% of the MRIs the patients obtained before assessment at the ISAEC would not have been ordered if they had first been seen at the ISAEC, another 49 MRIs may have been avoided, for a total potential savings of $136,000. It must be noted that the modest reduction in MRI utilization occurred in a population of referrals among whom more than 90% were deemed appropriate surgical candidates. Actual cost savings would likely be higher if the care model was applied to all initial referrals to ISAEC. Indeed, in current practice, where a large number of referrals are not considered surgical candidates, the senior author has previously shown that effective surgical spine triage could result in annual spine imaging–related cost avoidance of $24 million in Ontario.

**Limitations**

This study has several limitations, 1 of which is its retrospective analysis of prospective data. Costs were estimated only in respect to MRI utilization rather than a systemic analysis of total costs of our shared-care model per spine patient seen in both the surgical and nonsurgical treatment arms. Unfortunately gathering health utilization data is difficult, even when considering the small subset of patients who go on to surgical management. In regards to nonoperative management, there is currently no practical method to estimate health care costs. In regards to patient outcome, our study focused on surgical candidacy rather than the actual number of patients who went on to receive surgery or to be placed on a surgical wait list. Our analysis assessed surgical candidacy upon initial referral. It is likely that nonoperative management failed in some of the patients who were deemed nonsurgical and that these patients were reassessed and offered surgical management at a subsequent date. Although we know our model produces a high level of agreement between the APC and surgeon in regards to surgical candidacy and diagnostic categorization for patients referred to the surgeon, these factors are not known in the 90% of patients who were deemed nonsurgical by the APC. Our shared-care model is specific, but we don’t know its sensitivity as the study assesses only surgical by the APC. Our shared-care model is specific, but we don’t know its sensitivity as the study assesses only surgical candidacy upon initial referral. It is likely that nonoperative management failed in some of the patients who were deemed nonsurgical and that these patients were reassessed and offered surgical management at a subsequent date. Although we know our model produces a high level of agreement between the APC and surgeon in regards to surgical candidacy and diagnostic categorization for patients referred to the surgeon, these factors are not known in the 90% of patients who were deemed nonsurgical by the APC. Our shared-care model is specific, but we don’t know its sensitivity as the study assesses only surgical candidacy upon initial referral.

Despite the limitations, our study mirrors the findings of other groups, both in Canada and abroad, that a shared-care model for patients with spine pathology can expedite assessment and diagnosis, reduce costs, and streamline the delivery of care. The fact that these results occurred in metropolitan, urban and rural settings expands their applicability.

**Conclusion**

The ISAEC spine model of care, which is a shared-care interprofessional model with a stratified approach to LBP assessment, self-management and care recommendations, is adaptable and functions well in metropolitan, urban and rural settings. In all regions, ISAEC has resulted in a dramatic decrease in wait times for surgical assessment, improved referral appropriateness and efficiency of MRI utilization. A high level of APC and surgeon agreement was achieved both in terms of clinical categorization and surgical candidacy across settings and makes this interprofessional model particularly relevant to areas suffering from shortages of specialist surgical care.

**Affiliations:** From the Division of Orthopedic Surgery, University of Manitoba, Winnipeg, Man. (Zarrabian); the Toronto Western Hospital University Health Network, Toronto, Ont. (Bidos); the Thunder Bay Regional Health Sciences Centre, Thunder Bay, Ont. (Fanti, Puskas); Absolute Chiropractic, Hamilton, Ont. (Young); the Division of Orthopedic Surgery, McMaster University, Hamilton, Ont. (Drew); the Arthritis Program, Toronto Western Hospital, University of Toronto, Toronto, Ont. (Rampersaud); and the Division of Orthopaedic Surgery and Neurosurgery, Department of Surgery, University of Toronto, Toronto, Ont. (Rampersaud).

**Competing interests:** None declared.

**Contributors:** R. Rampersaud designed the study. A. Bidos, C. Fanti, B. Young, B. Drew and D. Puskas acquired the data, which M. Zarrabian, A. Bidos and R. Rampersaud analyzed. M. Zarrabian and R. Rampersaud wrote the article, which all authors reviewed and approved for publication.

**References**


Regional consolidation of orthopedic surgery: impacts on hip fracture surgery access and outcomes

Sara A. Kreindler, DPhil
Lanette Siragusa, MN
Eric Bohm, MD, MSc
Wendy Rudnick, MN
Colleen J. Metge, PhD

Accepted May 18, 2017

Correspondence to:
S. Kreindler
Department of Community Health Sciences
University of Manitoba
451-753 McDermot Ave
Winnipeg MB R3E 0T6
skreindler@wrha.mb.ca

DOI: 10.1503/cjs.000517

Background: Timely access to orthopedic trauma surgery is essential for optimal outcomes. Regionalization of some types of surgery has shown positive effects on access, timeliness and outcomes. We investigated how the consolidation of orthopedic surgery in 1 Canadian health region affected patients requiring hip fracture surgery.

Methods: We retrieved administrative data on all regional emergency department visits for lower-extremity injury and all linked inpatient stays from January 2010 through March 2013, identifying 1885 hip-fracture surgeries. Statistical process control and interrupted time series analysis controlling for demographics and comorbidities were used to assess impacts on access (receipt of surgery within 48-h benchmark) and surgical outcomes (complications, in-hospital/30-d mortality, length of stay).

Results: There was a significant increase in the proportion of patients receiving surgery within the benchmark. Complication rates did not change, but there appeared to be some decrease in mortality (significant at 6 mo). Length of stay increased at a hospital that experienced a major increase in patient volume, perhaps reflecting challenges associated with patient flow.

Conclusion: Regionalization appeared to improve the timeliness of surgery and may have reduced mortality. The specific features of the present consolidation (including pre-existing interhospital performance variation and the introduction of daytime slates at the referral hospital) should be considered when interpreting the findings.

Contexte : En traumatologie, l’accès rapide à la chirurgie orthopédique est essentiel pour l’obtention de résultats optimaux. La régionalisation de certains types de chirurgie a eu des effets positifs sur l’accès aux soins, leur rapidité et leurs résultats. Nous avons vérifié l’effet qu’a eu la consolidation des soins chirurgicaux orthopédiques dans une région sanitaire canadienne sur les patients qui ont eu recours à la chirurgie pour une fracture de la hanche.


Résultats : On a noté une augmentation significative de la proportion de patients traités par chirurgie à l’intérieur des délais. Les taux de complications n’ont pas varié, mais il semble y avoir eu une certaine diminution de la mortalité (significative à 6 mois). La durée des séjours a augmenté dans un hôpital qui a connu un accroissement majeur de sa clientèle, témoignant peut-être de difficultés liées à l’afflux de patients.

Conclusion : La régionalisation a semblé améliorer l’accès rapide à la chirurgie et pourrait avoir réduit la mortalité. Il faut tenir compte des caractéristiques spécifiques de la présente consolidation (y compris la variation préexistante du rendement interhospitalier et la création de listes de jour à l’hôpital de référence) avant d’interpréter ces conclusions.
Hip fractures are an important source of morbidity and mortality among older adults in Canada and elsewhere. Studies have shown that timely access to hip fracture surgery decreases mortality and may have positive impacts on length of stay (LOS) in hospital and surgical complications.\(^1,4\) The Canadian Institute for Health Information has set a national benchmark for hip fracture repair to 48 hours from time of admission to hospital.\(^3\)

Consolidation or regionalization of surgical care is common in many Western countries and is widely considered to be best practice.\(^5 \textsuperscript{-7}\) In particular, the regionalization of trauma care has been shown to reduce mortality.\(^8,9\) Moreover, there is consistent evidence that high-volume surgeons/hospitals achieve superior outcomes to low-volume surgeons/hospitals (e.g., reduced mortality, adverse events, and/or LOS).\(^5,10\textsuperscript{-13}\)

On the other hand, regionalization has not shown universally positive outcomes. An American study of various consolidations at 19 hospitals found that complications decreased for 2 procedures (including total hip replacement), increased for 3, and remained unchanged for 2.\(^6\) A Canadian study found that the consolidation of acute care surgery increased wait times owing to the time required to transfer patients who presented at nonreferral hospitals.\(^14\)

There is a lack of evidence on the impacts of consolidating orthopedic trauma surgery. In one Canadian health region, the consolidation of all high-acuity procedures at designated hospitals was associated with reduced LOS and no increase in mortality; however, this consolidation was not specific to orthopedic surgery and, furthermore, was accompanied by other major changes, such as a dramatic alteration to the nurse staffing model.\(^15\) Another study described the consolidation of orthopedic trauma surgery in a different Canadian region; however, that study investigated only impacts on residents, not patients.\(^16\) Accordingly, it was important to investigate how such a consolidation affected access and outcomes with respect to hip fractures.

The Winnipeg Regional Health Authority (WRHA) is a Canadian regional health system whose 6 hospitals serve a population of approximately 700,000. Prior to 2012, orthopedic trauma surgery had already been consolidated at 4 sites (hospitals A, B, C and D). In January 2012, a further consolidation saw orthopedic trauma patients redistributed from hospital B to hospital A; the 2 facilities are about 16 km apart. Hospital C remained the site for all complex trauma surgery and for out-of-province patients; hospital D continued to provide orthopedic trauma surgery as before. Concurrently, hospitals B and D became the primary locations for elective hip and knee replacements. The consolidation was accompanied by the introduction of daytime surgical slates at hospital A in order to enable it to accommodate a greater volume of surgeries. Daytime slates already existed 2 days per week at hospital D, and this did not change during the study period. The initiative was intended to promote a better match between bed capacity and demand, improve patient flow, minimize disruptions to elective slates from emergency needs, and improve patient outcomes by ensuring that surgeons could perform a high volume of the same type of surgery.

The 2012 consolidation built on a multicomponent intervention that the WRHA had introduced in 2008 to redress 7 identified sources of delay to hip fracture surgery; components included several changes to facilitate the transfer of patients from and back to rural hospitals, creation of daytime orthopedic trauma slates at 1 hospital, elimination of mandatory internal medicine consultations before surgery, clarification of standards regarding patients on clopidogrel, and provider education about the importance of timely surgery.\(^4\) The proportion of patients receiving surgery within the 48-hour benchmark rose from 67% before 2008 to 85% after 2008, with concomitant decreases in LOS and mortality.\(^4\) It should be noted that the 2008 intervention was well established before the present study’s “preintervention” period began.

The objective of this study was to investigate the impact of consolidation on patients requiring hip fracture surgery, in terms of access (receipt of surgery within the 48-hr benchmark) and surgical outcomes (complications, inhospital/30-day mortality, and LOS). The preintervention period extended from January 2010 through December 2011; the postintervention period was from January 2012 through March 2013.

**METHODS**

**Data sources**

We retrieved data on all regional emergency department (ED) visits for lower-extremity injuries and all linked inpatient hospital visits from Jan. 1, 2010, through Mar. 31, 2013; inpatient records were also linked to data on date/time of surgery and 30-day mortality. The ED and inpatient data came from regional administrative databases, the operative log data came from electronic files provided by each hospital, and the mortality data came from Vital Statistics.

Among the inpatient admissions we identified were patients with hip fracture diagnoses (ICD-10 S72 codes) and patients having hip surgery. There was considerable overlap between these 2 categories; of all patients with a diagnosis of hip fracture, 94% received hip surgery. We considered hip fracture surgery patients to be those who fit into both categories. We were unable to identify patients who may have had orthopedic trauma surgery without being admitted or who presented with a condition other than lower-extremity injury.

In keeping with our methodology in a prior study,\(^14\) we defined the patient journey as beginning with the first...
presentation to a WRHA ED (time of registration) and including the index ED visit, any ED attendances occurring within 24 hours of this visit, the first subsequent inpatient admission to any WRHA hospital and any subsequent acute care admissions reflecting inpatient transfers (transfer noted in the “transfer-to” field and/or admission occurring within 6 h of the previous discharge). We did not include transfers to rehabilitation units or facilities, as there were some concerns about data quality.

Complications (adverse events) were defined as the receipt of an ICD-10 T code that was not identified as a preadmission comorbidity (T codes are assigned for infection, hemorrhage, mechanical complications and “other complications” of procedures or devices). Our measure of mortality combined in-hospital and 30-day mortality (i.e., 30 d from inpatient admission). We included the commonly studied outcome of LOS for completeness, much as we recognize that LOS is affected by numerous factors unrelated to surgical outcomes.

This study was part of a broader evaluation that also assessed (but did not detect significant change in) rates of admission and readmission to institutions, and included some analyses of nonoperative patients; details are available from the authors.

Statistical analysis

Patient outcomes were analyzed with statistical process control and interrupted time series analysis. Statistical process control involves plotting the data on a control chart to evaluate the timing and magnitude of any changes. Results are tested for significance according to rules that include 1 data point outside the upper and lower control limits, 6 consecutive data points ascending or descending, and 9 consecutive data points above or below the mean.

Interrupted time series analysis enabled us to test the significance of intervention effects (measured at 6 and 12 mo) and any changes in trend, while controlling for patient characteristics (age, sex, out-of-region origin, Charlson comorbidity score). As a sensitivity analysis, we subsequently included type of procedure (internal fixation v. arthroplasty); however, this variable was not statistically significant in any of the models and did not affect the direction or significance of other effects.

Multiple linear regression was used for continuous variables (after log-transforming those with skewed distributions), and logistic regression for binary variables. Before choosing this method, we used the Durbin-Watson test to check for autocorrelation of errors in all continuous data. These tests did not show significant results (the Durbin–Watson statistic was near 2), indicating that it was unnecessary to use a procedure, such as autoregressive integrated moving average, that controls for autocorrelation.

RESULTS

We identified 4595 inpatient admissions; of these, 1855 fit our definition of hip fracture surgery patients. We determined that an additional 31 hip-fracture surgery patients whose hospital stays extended beyond March 2013 were missing from the inpatient data set. Of these, 22 had presented in March 2013, and no more than 3 had presented in any prior month. Accordingly, we excluded all patients who presented in March 2013 from the analysis, leaving a sample size of 1854 patients.

Characteristics of the sample

As intended, hospital B ceased to provide hip fracture surgery, and most of the patients it would otherwise have served were absorbed by hospital A (Table 1). Patient demographic characteristics (sex and age) remained constant pre- and postconsolidation, but there was some increase in the proportion of patients with comorbidities, especially multiple comorbidities (Mantel–Haenszel $\chi^2 = 4.09, p = 0.043$). There was also a significant increase in the proportion of patients who were transferred in from an out-of-region hospital (odds ratio [OR] 1.86, $p < 0.001$); this was not logically related to the consolidation and may reflect the provincial amalgamation of certain health regions in

<table>
<thead>
<tr>
<th>Table 1. Sample characteristics</th>
<th>Group; no. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Characteristic</td>
<td>Preintervention (n = 1145)</td>
</tr>
<tr>
<td>Hospital of admission</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>331 (28.9)</td>
</tr>
<tr>
<td>B</td>
<td>309 (27.0)</td>
</tr>
<tr>
<td>C</td>
<td>182 (15.9)</td>
</tr>
<tr>
<td>D</td>
<td>323 (28.2)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>307 (26.8)</td>
</tr>
<tr>
<td>Female</td>
<td>838 (73.2)</td>
</tr>
<tr>
<td>Age, yr</td>
<td></td>
</tr>
<tr>
<td>0–17</td>
<td>4 (0.3)</td>
</tr>
<tr>
<td>18–64</td>
<td>137 (12.0)</td>
</tr>
<tr>
<td>65–79</td>
<td>261 (22.8)</td>
</tr>
<tr>
<td>≥80</td>
<td>743 (64.9)</td>
</tr>
<tr>
<td>No. of comorbidities</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>682 (59.6)</td>
</tr>
<tr>
<td>1</td>
<td>351 (30.7)</td>
</tr>
<tr>
<td>≥2</td>
<td>112 (9.8)</td>
</tr>
<tr>
<td>Origin</td>
<td></td>
</tr>
<tr>
<td>WRHA</td>
<td>1107 (96.7)</td>
</tr>
<tr>
<td>Non-WRHA site</td>
<td>38 (3.3)</td>
</tr>
<tr>
<td>Transferred for surgery</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1081 (94.4)</td>
</tr>
<tr>
<td>Yes</td>
<td>64 (5.6)</td>
</tr>
</tbody>
</table>

WRHA = Winnipeg Regional Health Authority.
mid-2012 or coincidental orthopedic shortages in some regions. The proportion of within-region transfers for surgery also increased significantly postconsolidation ($\text{OR} = 1.73 \ p = 0.007$); specifically, more patients were transferred from hospital B to hospital A. However, such transfers remained relatively uncommon, as most hip-fracture patients travel to the ED by ambulance and are triaged to the appropriate site by paramedics. The frequency of hip-fracture presentations and surgeries did not show clear time trends or seasonality, although there appeared to be some increase in the operative rate following the consolidation (data not shown).

**Patient access**

Time to surgery was defined as time from first registration at any WRHA ED to receipt of first surgical intervention on the hip. The proportion of patients receiving surgery within the 48-hour benchmark increased significantly (Fig. 1), rising from 80.8% to 88.4%. Regression modeling, controlling for patient sex, age, out-of-region origin and comorbidities, confirmed this result (Appendix 1, Table A-1, available at canjsurg.ca/000517-a1). The change detected was immediate; there was no indication of an ongoing increase or decrease.

The consolidation, of course, entailed that patients who would have otherwise had surgery at hospital B instead had it at hospital A. This may have affected the timeliness of surgery, as hospital A had the best performance on the 48-hour benchmark (91.9%), and hospital B had the worst (68.9%; notably, hospital B was also a site for emergency general surgery, which competed with orthopedic trauma for operating room time). When we controlled for hospital in the analysis, the intervention effect only approached significance at 6 and 12 months (data not shown).

As noted earlier, the consolidation was accompanied by the introduction of daytime surgical slates for orthopedic trauma. Post hoc analyses (data not shown) showed that the proportion of patients receiving surgery during the day shift (7:30 am to 4:30 pm) increased significantly. Including time of day in the prediction of time to surgery did not negate the intervention effect; however, the availability of daytime slates may have improved the timeliness of surgery in general by preventing backlogs. The relative contribution of daytime slates versus consolidation per se could not be assessed, as the 2 were introduced concurrently.

**Surgical outcomes**

Statistical process control analyses (not shown) detected no postconsolidation trend in the rate of surgical complications or in-hospital/30-day mortality. However, regression analysis with controls, while also finding no significant change in complications, suggested a decrease in mortality that was significant at 6 months but that only approached significance at 12 months (Appendix 1, Table A-2, available at canjsurg.ca/000517-a1).

Regression modelling showed that LOS had been falling before the consolidation and began to rise thereafter, with a
significant increase apparent at 6 and 12 months (Appendix 1, Table A-3, available at canjurg.ca/000517-a1). Statistical process control analysis did not detect a region-wide intervention effect, but did find that LOS at hospital A rose markedly at the time of consolidation, remaining well above its preintervention mean and typically above the preintervention mean for hospitals A and B combined (data not shown).

**Discussion**

The consolidation succeeded in providing patients with more timely hip-fracture surgery: there was a significant increase in the proportion of patients receiving surgery within 48 hours. This increase seems to be at least partially attributable to the redirection of patients from one specific hospital to another; it also seems plausible that the introduction of daytime slates was an important factor in allowing hospital A to maintain its short wait times while absorbing a large increase in volume. The increased timeliness of surgery may have translated into reduced mortality; no impact on the rate of complications was observed.

Length of stay showed some increase, specifically at hospital A; this seems more likely to have reflected changes in patient flow (efficiency) rather than changes in patient outcomes (quality/safety). It is plausible that at hospital A, the changes in bed allocation and patient mix put increased strain on rehabilitation beds and/or discharge-planning resources, resulting in longer stays. It should also be noted that following the consolidation many nurses left hospital A, resulting in bed closures; it is unclear how this may have affected bed utilization.

This study's findings contrast with those of an analysis of the consolidation of acute care surgery in the same region. In the latter case, consolidation was associated with longer time to surgery; although the efficiency of within-hospital processes appeared to increase, any time savings were more than offset by the time required to transfer patients from nonreferral to referral hospitals. In the present study, consolidation reduced time to surgery, and few transfers occurred. The divergent findings can be explained in terms of the different surgical populations involved. Patients with hip fracture almost always present to hospital by ambulance, and emergency medical services staff can ensure that all patients with lower-extremity injuries are taken to a referral hospital. Indeed, as part of the consolidation, the WRHA implemented an algorithm to facilitate this. In contrast, about one-third of the acute care surgery patients who resided within the region did not call an ambulance, but instead presented directly to hospital; when this turned out to be a nonreferral hospital, their surgery was delayed owing to the need for a transfer. These contrasting findings suggest that surgical consolidation is more likely to improve access when it can be reliably ensured that patients with relevant symptoms present to a referral hospital.

**Limitations**

This study has certain limitations. We could not identify patients who may have presented with a condition other than lower-extremity injury (e.g., lower-extremity pain, major trauma). The range and specificity of patient characteristics and outcomes studied were limited by the variables present in administrative databases; clearly, each studied outcome is affected by multiple patient factors, of which we could control only a few. Also, the aggregate nature of the data used made it impossible to highlight unique outcomes (positive or negative) that some patients may have experienced. We were unable to measure the segment of the patient journey before presentation at an ED; thus, although it seems highly likely that patients were better off travelling an extra 16 km to take advantage of a 92% rather than a 69% rate of within-benchmark surgery, our analyses did not factor in the length of the ambulance trip. Lack of randomization was also an important limitation, but was offset by the long interrupted time series design; a randomized controlled trial of this complex, multihospital intervention would have been impracticable. The unequal length of the pre- and postintervention periods (24 v. 15 mo) might have introduced a seasonality effect, although this seems unlikely, as no seasonal pattern could be detected.

Perhaps the study’s greatest limitation was its inability to distinguish the impacts of the consolidation per se, the specific hospitals involved, and the addition of daytime slates. Although the change we studied had fewer components than the intervention package introduced in 2008, it was nonetheless composite and, moreover, built upon prior measures that had already improved timeliness and related outcomes. This inhibits generalization of the findings to other potential consolidations of orthopedic surgery. However, it is important to recognize that the regionalization of surgery is never a simple, single-component intervention. Regionalization necessarily involves moving patients from certain hospitals to others (thus, its outcomes will inevitably be affected by any pre-existing performance variation) and increases the volume of the relevant type of surgery at the referral hospital (thus, there needs to be some mechanism to ensure that this hospital’s operating rooms can manage the new referrals). The present study suggests that it is probably beneficial to redistribute patients from a hospital with longer wait times to one with shorter wait times, that daytime slates may help a referral hospital absorb increased volume, and that an increased contingent of hip-fracture patients may pose challenges associated with patient flow. Such considerations are integral to the implementation of surgical consolidation and must be addressed by any region contemplating a similar intervention. In general, it is important to consider the unintended impacts that consolidation might bring to programs involved in pre- and postsurgical components of the patient journey (e.g., emergency
medical services, EDs, rehabilitation/geriatric services) and to all affected locations (particularly when one urban region serves multiple rural areas).

**ConClusion**

To our knowledge, this is the first study to investigate how the consolidation of orthopedic trauma surgery affects patients. We found a positive impact on the timeliness of surgery and a potential improvement in mortality, but were unable to determine the relative contribution of interlinked intervention components and contextual factors to these results. Thus, although our findings were broadly supportive of regionalization, regions undertaking such an enterprise should ensure that mechanisms are in place to fully evaluate its impacts on patient access and outcomes.

**Acknowledgements:** We are most grateful to Miroslava Svitlica for her assistance with data acquisition and linkage.

**Affiliations:** From the Department of Community Health Sciences, Rady Faculty of Health Sciences, University of Manitoba, Winnipeg, Man. (Kreindler, Bohm, Metge); the George and Fay Yee Centre for Healthcare Innovation, University of Manitoba and Winnipeg Regional Health Authority, Winnipeg, Man. (Kreindler, Bohm, Metge); the College of Nursing, Rady Faculty of Health Sciences, University of Manitoba, Winnipeg, Man. (Siragusa); the Department of Surgery, University of Manitoba and Winnipeg Regional Health Authority, Winnipeg, Man. (Bohm); the Concordia Hip and Knee Institute, Winnipeg Regional Health Authority, Winnipeg, Man. (Bohm); and the St. Boniface Hospital, Winnipeg, Man. (Rudnick).

**Competing interests:** None declared.

**Contributors:** S. Kreindler and C. Metge designed the study. S. Kreindler acquired the data, which all authors analyzed. S. Kreindler wrote the article which all authors reviewed and approved for publication.

**References**

Toward late career transitioning: a proposal for academic surgeons

Robin Richards, MD
Robin McLeod, MD
David Latter, MD
Shaf Keshavjee, MD
Ori Rotstein, MD
Michael G. Fehlings, MD, PhD
Najma Ahmed, MD, PhD
Avery Nathens, MD, PhD
James Rutka, MD, PhD

Accepted June 8, 2017; Early-released Aug. 1, 2017

Correspondence to: J. Rutka
Department of Surgery
University of Toronto
149 College St, 5th Floor
Toronto ON M5T 1P5
james.rutka@utoronto.ca
DOI: 10.1503/cjs.007617

SUMMARY

In the absence of a defined retirement age, academic surgeons need to develop plans for transition as they approach the end of their academic surgical careers. The development of a plan for late career transition represents an opportunity for departments of surgery across Canada to initiate a constructive process in cooperation with the key stakeholders in the hospital or institution. The goal of the process is to develop an individual plan for each faculty member that is agreeable to the academic surgeon; informs the surgical leadership; and allows the late career surgeon, the hospital, the division and the department to make plans for the future. In this commentary, the literature on the science of aging is reviewed as it pertains to surgeons, and guidelines for late career transition planning are shared. It is hoped that these guidelines will be of some value to academic programs and surgeons across the country as late career transition models are developed and adopted.

The science of aging is becoming an important area of investigation, especially as professionals, such as surgeons, enter their seventh and eighth decades. In North America, demographic analyses have indicated that male and female longevity is increasing, and the workforce is now made up of a growing number of individuals who are older than 65 years. That said, with physiologic aging comes a distinct and well-studied decline in cognitive and physical function. Some signs of cognitive decline include personality change, confusion, tardiness and forgetfulness. In addition, it has been documented that visuospatial ability, inductive reasoning and verbal memory decline in most individuals older than 65 years. As surgeons, we must recognize and accept this correlation between aging and the decline in our physiologic systems, as there is arguably a potential matter of patient safety at hand.

What is the evidence that the aging surgeon performs less well than younger colleagues? Hartz and colleagues reported that mortality rates of surgeons performing coronary artery bypass grafting increased with increasing years of practice; O’Neill and colleagues showed that carotid endarterectomy mortality increased when performed by older surgeons; Neumayer and colleagues showed that there were higher rates of recurrence of hernias when older surgeons were involved. These and other studies have helped to underscore the performance of the aging surgeon, and provide caution to all in this age category. It has been stated that surgeons’ overall abilities may decline less quickly than those of physician counterparts, but they are still shown to decline.

Despite evidence suggesting an effect of the aging process on cognition, there are numerous laws that prevent discrimination on the basis of age itself. These laws also bar against discrimination on the basis of race, religion, nationality and immutable physical characteristics. For example, in the United States, the Federal Age Discrimination in Employment Act (ADEA) prohibits discrimination on the basis of age for employment of medical practitioners, including surgeons.
In several professions where public safety is potentially an issue, specific retirement ages have been mandated, such as for airline pilots (65 yr), Federal Bureau of Investigation agents (57 yr), park rangers (57 yr), lighthouse operators (55 yr) and air traffic controllers (56 yr). Given the roles that medical practitioners play in the lives of the public, it seems surprising that a specific retirement age is not enforced for these professionals. In fact, the increasing longevity of individuals in the developed world has led to an aging workforce in which surgeons well over age 65 continue to use their skills for patients. It is estimated, for example, that there are more than 20 000 actively practising surgeons in the United States who are older than age 70. In defence against implementing a mandatory retirement age for surgeons is the well-accepted principle that for medical practitioners, including surgeons, the ability to conduct one’s practice, although difficult to do, should ideally be based on functional age, not strictly on chronological age. However, it is recognized that the assessment of functional status in this context is challenging.

It may come as no surprise that there are varying mandatory retirement ages for physicians across the globe. Many of these retirement stipulations apply to physicians and surgeons working in the public sector. For example, retirement in the public sector is set at 65 years in India; at 60 years in Russia and China, at 65 years in Ireland and at 62–66 years in Japan. There is also great variation across the globe regarding the availability of a retirement pension to facilitate transition. For countries such as the United States, Canada, Germany, Italy and Australia, there are no set retirement policies for physicians or surgeons.

As practising surgeons in Canada, we should adhere to certain principles as espoused by our associative bodies. For example, in the Canadian Medical Association’s Code of Ethics it is stated that the practice of the art and science of medicine must be performed competently with integrity, and without impairment. It is also stated that physicians and surgeons are duty-bound to participate in peer review processes and to undergo review by one’s peers when required.

Our practices as surgeons are protected in part by the Canadian Human Rights Act, the Canadian Charter of Rights and Freedoms and provincially by different Human Rights Codes. In these documents, it is stated that the practice of professional work, as performed by surgeons, should be considered independent of age. However, the Public Hospitals Act (PHA) states that the boards of directors are required on an annual basis to appoint and grant privileges to members of the medical staff. The most important aspect of the PHA is to ensure the safety of patients. In this regard, hospitals will not be liable if systems are in place to annually review and credential staff (see the case of Yepremian et al. v. Scarborough General Hospital, 1980).

What are some potential solutions to ensure that surgeons will transition out of surgical practice in a timely manner and with grace and dignity? The guideline from California Public Protection & Physician Health states that the establishment of a “well-being committee” can serve to review a surgeon’s experience and practice and to perform periodic assessments of cognitive function. This well-being committee could then report to the institutions’ credentials committee to ensure that all medical staff are treated fairly. The American College of Surgeons 2016 Statement on Aging states that chart reviews, peer review of clinical decision-making, proctoring and videotaping in the operating room with a 360° evaluation may be sources of information that can be used to assess overall skill among aging surgeons. The College of Physicians and Surgeons of Ontario initiates a peer assessment process at age 70 years, and then every 5 years thereafter, to examine the practices of surgeons.

With these concerns and issues relating to the aging surgeon in mind, the Department of Surgery at the University of Toronto has developed some principles to help guide surgeons in their transition out of practices involving operative procedures toward the end of their academic surgical careers. These principles provide an opportunity for surgeons to initiate a constructive dialogue in conjunction with the hospital surgical leadership, as represented by the surgeon-in-chief, the hospital division head, and the university division and department chairs. The goal of this process is the early development of an individual plan for each faculty member, as agreeable to the academic surgeon, to inform the relevant stakeholders and allow the late-career surgeon, the hospital division and the department to make plans for the future.

The Guidelines for Late Career Transitions in the Department of Surgery at the University of Toronto are presented in Box 1. Importantly, these guidelines are now written into the “Memorandum of Agreement” (MOA) that each faculty surgeon signs upon beginning her or his surgical career. It is our firm belief that the dialogue about late career transitioning and planning must begin early, as such transition planning can take years to crystallize. The topic should be broached at an early stage in each surgeon’s career as part of an annual review by the surgeon-in-chief at the hospital. All full-time surgeons in the Department of Surgery at the University of Toronto undergo an annual assessment of academic and surgical activity and productivity. As can be seen from the guidelines, it was the intent of the Department of Surgery to link the surgeon’s hospital resource allocation to on-call responsibilities, and that both should decrease in a planned and step-wise fashion as late career transition occurs.

The transitioning surgeon still has numerous academic opportunities to pursue, even when hospital and operating room resources are diminishing. For example, transitioning
surgeons can serve as mentors to new faculty recruits and embark on a planned program of shared resources with these new faculty members. As hospital resource packages are constrained and allocated to specified groups of surgeons, this gives an opportunity for job sharing. A recent example of such job sharing between a more senior and a more junior orthopedic surgeon was reported in the National Post. This approach to late career transitioning is beneficial, as it allows the late-career surgeon to maintain her or his appointment and status in the hospital, it introduces newly recruited surgeons to the concept of practice sharing and mentoring by the senior surgeon, and it continues to provide financial support for the late-career surgeon until such time that the mentoring program is completed — usually a period of 1–3 years.

Greater levels of teaching, research and administration among late-career surgeons must also be encouraged. A common theme in our discussions with numerous surgeons who were approaching senior status is that they valued being treated with the respect, dignity and support commensurate with a life-long career in a demanding and challenging profession. Accordingly, a celebration of a surgeon’s contributions and accomplishments throughout her or his career is an appropriate way to acknowledge this next phase of their career.

At this time, surgical specialist underemployment across Canada is an additional valid reason for attempting to implement late career transition guidelines. The Royal College of Physicians and Surgeons of Canada (RCPSC) has examined specialist underemployment in some detail. In the RCPSC report from 2013, approximately one-third of resident graduates pursue further training to become more employable. Approximately 20% of graduates accept locum tenens or part-time positions as a default option to unemployment. Resource-intense specialties have been hit the hardest by such underemployment risks. These included several surgical specialties, such as neurosurgery, general surgery, orthopedic surgery, vascular surgery,16 cardiac surgery17 and urology. As a result, more physicians and surgeons are competing for fewer academic positions. With slow growth in the economy, this means that fewer surgeons are leaving their practices at a customary age of retirement. It is fully appreciated, however, that workforce planning can be a highly complicated endeavour, and even at the best of times it is difficult to take into account all societal needs and available resources.

There are many other factors that must be considered when academic surgeons are considering transitioning, not the least of which is individual long-term financial stability. Accordingly, in the Department of Surgery, we have implemented biannual financial planning seminars for senior residents and junior faculty members. Led by senior faculty members, these seminars cover a number of important topics, such as incorporation, negotiating your first contract, disability insurance, tax planning and hiring personnel for your office. Unless late career transition is discussed at an early stage in an academic surgeon’s career, preparation for financial stability may not begin in a timely manner, exacerbating the situation.

It is hoped that the guidelines that have been defined by the Department of Surgery at the University of Toronto will be of some value to academic programs and surgeons across the country. We recognize that leadership and reporting structures in departments of surgery vary among institutions, and that these guidelines will need to be modified accordingly to suit each institution’s needs. As a living document, ours will undoubtedly change over time; however, these guidelines set a precedent for ongoing conversations and expectations for all stakeholders in university centres.

Acknowledgements: The authors thank members of the Senior Advisory Committee in the Department of Surgery for their many contributions to the generation of the Guidelines for Late Career Transitions.

Affiliation: From the Department of Surgery, University of Toronto, Toronto, Ont.

Competing interests: M. Fehlings declares consultancy agreements with Pfizer, Zimmer Biomet and InVivo Therapeutics. No other competing interests declared.

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

Subscription rates (2017)
Libraries, research establishments and other multiple-reader institutions: Canada, Can$360; United States and other countries, US$420. Individual: Canada Can$235; USA US$270. Canadian subscribers please add applicable taxes. For other pricing information, please contact the Canadian Medical Association Subscription Office, PO box 810350, Birmingham AL 35283-0350; phone 800 633-4931 (Canada, USA) or 205 995-1567; fax 205 995-1588; cma@subscriptionoffice.com.

Other subscription information
All subscriptions are payable in advance, in Canadian currency to Canadian addresses, in US currency to all other addresses. Payment should be made to Joule Inc. in the funds specified, drawn on a Canadian or US bank, respectively. Visa, MasterCard and American Express are also accepted. Orders and requests for information on other journals should be addressed to the Member Service Centre.

Change of address
We require 8 weeks’ notice to ensure uninterrupted service. Please send your current mailing label, your new address and the effective date of change to the Member Service Centre.

Replacing missing issues
Claims for missing issues must be made within 3 months of the date of publication to be honoured and replaced (subject to availability) free of charge. Replacement copies of older issues, when available, must be prepaid at the single-copy rates listed below. Please submit claims, with a copy of your mailing label, to the Member Service Centre.

Single-copy sales
Subject to availability, single copies may be purchased for Can$15 or US$45. Please submit your order and payment to the Member Service Centre.

Article reprints
Commercial and author reprints can be purchased through Sheridan Press. To purchase commercial article reprints and ePrints, or to request a quote, please contact Lori Laughman, Customer Service Representative, Sheridan Reprints Services; lori.laughman@sheridan.com. Authors can order reprints by submitting an author reprint order form available at the Sheridan Press Electronic Order Centre at sheridan.com/cma/eoc or by contacting Lori Laughman using the contact information above.

Microform, abstracting and indexing
CJS appears in the following indexing/abstracting services: ASCA, AbHyg, CBCARef, CINAHL, CPerf, ChemAb, CurCont, DentInd, ESPM, ExerpMed, H&SSA, HelmAb, ICR, IndMed, Inpharma, MEDLINE, NN, NutrAb, PESON, RM&VM, REAC, ReZh, SCI, TDB — BLDSC (3035.80000), CISTI, GNLM, IDS, IE, infotrieve, ingenta, KNAW.CCC.

Electronic availability
All articles are available on the Internet (canjsurg.ca) in PDF format.

Permissions
Copyright for all material is held by Joule Inc. or its licensors. We are a member of Access Copyright, The Canadian Copyright Licensing Agency, and have an agreement in place permitting them to grant organizations and individuals, on our behalf, the right to respond to copyright requests. Please submit requests to Access Copyright using the Online Permission Request Service: http://discovery.accesscopyright.ca/. To find more information on licensing or to obtain a quote, please visit the Permission Services page at www.accesscopyright.ca/permissions/.

Tarifs des abonnements (2017)
Bibliothèques, établissements de recherche et autres établissements à lecteurs multiples : Canada, 360 $Can; États-Unis et ailleurs, 420 $US. Individuels : Canada 235 $Can; États-Unis 270 $US. Pour les abonnés au Canada, veuillez ajouter les taxes applicables. Pour obtenir des renseignements sur les prix, veuillez communiquer avec le Canadian Medical Association Subscription Office, PO box 810350, Birmingham AL 35283-0350; tél 800 633-4931 (Canada, É-U) ou 205 995-1567; fax 205 995-1588; cma@subscriptionoffice.com.

Autres renseignements sur les abonnements
Tous les abonnements sont payables d’avance en dollars canadiens s’ils sont livrés au Canada, et en dollars américains ailleurs dans le monde. Prière d’envoyer votre paiement, tiré sur une banque canadienne ou américaine respectivement, à Joule Inc. Visa, MasterCard et American Express sont aussi acceptées. Les commandes et les demandes de renseignements sur les autres journaux doivent être adressées au Centre des services aux membres.

Changement d’adresse
Un préavis de 8 semaines est nécessaire pour assurer la livraison ininterrompue de votre abonnement. Veuillez envoyer votre étiquette postale actuelle, votre nouvelle adresse et la date d’entrée en vigueur au Centre des services aux membres.

Remplacement de numéros manquants
Pour recevoir gratuitement (sous réserve de sa disponibilité) un numéro manquant, vous devez présenter votre demande dans 3 mois de la date de publication. Toute commande d’anciens numéros doit être réglée d’avance selon les prix de vente au numéro qui sont indiqués ci-après. Veuillez envoyer votre demande ainsi qu’une copie de votre étiquette postale au Centre des services aux membres.

Vente d’exemplaires à l’unité
On peut se procurer des exemplaires à l’unité (sous réserve de leur disponibilité) pour 15 $Can, 45 $US. Veuillez envoyer votre commande et votre paiement au Centre des services aux membres.

Tirés à part
On peut acheter des tirés à part à un auteur ou commerciaux auprès de Sheridan Press. Pour les tirés à part commerciaux et les cyberimpressions (ePrints), ou encore pour demander un prix, veuillez communiquer avec Lori Laughman, représentante du service à la clientèle, Sheridan Reprints Services (lori.laughman@sheridan.com). Les auteurs peuvent commander des tirés à part en remplissant le bon de commande de tirés à part d’auteur disponible au centre de commandes électroniques de Sheridan Press (sheridan.com/cma/eoc) ou en communiquant avec Lori Laughman en utilisant les coordonnées ci-dessus.

Microcopies, résumés et index
Le JCC est résumé et fiché dans l’index des services spécialisés suivants : ASCA, AbHyg, CBCARef, CINAHL, CPerf, ChemAb, CurCont, DentInd, ESPM, ExerpMed, H&SSA, HelmAb, ICR, IndMed, Inpharma, MEDLINE, NN, NutrAb, PESON, RM&VM, REAC, ReZh, SCI, TDB — BLDSC (3035.80000), CISTI, GNLM, IDS, IE, infotrieve, ingenta, KNAW.CCC.

Accès électronique
Tous les articles sont disponibles sur internet en format PDF (canjsurg.ca).

Permissions
Le droit d’auteur de tout le matériel appartient à Joule Inc. ou à ses concédants. Nous sommes membre d’Access Copyright, l’agence canadienne de gestion du droit d’auteur, avec qui nous avons une entente qui permet à l’agence d’accorder à des organisations et à des personnes le droit de répondre à des demandes de reproduction de matériel protégé par droit d’auteur. Veuillez soumettre vos demandes au http://discovery.accesscopyright.ca/. Pour plus de renseignements ou pour obtenir un prix, veuillez consulter la page www.accesscopyright.ca/permissions/.
The Canadian Journal of Surgery is pleased to accept career/classified advertisements. The deadline is 1 month before issue date.

Rates:
Display ads: 1 page $1200; 2/3 page $900; 1/2 page vert/horiz $800; 1/3 page $650; 1/4 page $500. Word ads: $120 for the first 40 words or less, additional words $1.20 each (additional $25 for frame). Special Display under 100 words, 55 × 55 mm, $205.

VISA, MASTERCARD AND AMERICAN EXPRESS ACCEPTED.

Advertisements should be sent to: email advertising@cma.ca; tel 800 663-7336 or 613 731-8810 x8460/8475.

The Ontario Human Rights Code prohibits discriminatory employment advertising.

Le Journal canadien de chirurgie accepte volontiers les annonces sur les carrières et annonces classées. Celles-ci doivent être reçues au JCC au plus tard 1 mois avant la date de parution.

Tarifs:
Grand format: 1 page 1200 $; 2/3 page 900 $; 1/2 page vert/horiz 800 $; 1/3 page 650 $; 1/4 page 500 $. Mot des annonces: 120 $ jusqu’à 40 mots et 1.20 $ par mot supplémentaire (25 $ pour encadrement au trait). Encadré spécial jusqu’à 100 mots, 55 × 55 mm, 205 $.

VISA, MASTERCARD ET AMERICAN EXPRESS ACCEPTÉS.

Le texte des annonces doit être adressé à : courriel advertising@cma.ca; tél 800 663-7336 ou 613 731-8810 x8460/8475.

Le Code des droits de la personne de l’Ontario interdit la discrimination dans la publicité relative à l’emploi.

PLASTIC SURGEON

The Department of Surgery, Section of Plastic Surgery, and Alberta Health Services invite applications for a clinical faculty position as a PLASTIC SURGEON at the Rockyview General Hospital in Calgary, Alberta, joining an existing group of five surgeons (two of whom will be assuming senior surgeon status).

The Department of Surgery requires the applicant to have at least one year of post-residency fellowship training, and be competent in hand surgery, microsurgery, and reconstructive breast surgery. The surgeon will be expected to participate actively in undergraduate and resident education. Preference will be given to candidates with additional interest and expertise in Surgical Quality Improvement.

The successful candidate will be expected to maintain an off-site private office. The Rockyview General Hospital will provide operative and ambulatory clinic privileges. The surgeon will be expected to participate in the plastic surgery call schedule at the Rockyview General Hospital.

The successful candidate must be eligible for licensure by the College of Physicians and Surgeons of Alberta and must hold Fellowship certification in Plastic Surgery from the Royal College of Physicians and Surgeons of Canada.

The position will commence in 2018. All qualified candidates are encouraged to apply, however Canadian citizens and permanent residents will be given priority. Please forward your curriculum vitae, letter of intent, and three letters of reference by November 7, 2017 to:

Dr. Mark Haugrud, Section of Plastic Surgery
Department of Surgery, University of Calgary

c/o Jessica Bartolome
Room 382, Foothills Medical Centre
1403–29 Street NW
Calgary, AB T2N 2T9
Email Jessica.Bartolome@ahs.ca
**PLASTIC SURGEON**

The Department of Surgery, Section of Plastic Surgery, and Alberta Health Services invite applications for a clinical faculty position as a PLASTIC SURGEON at the South Health Campus in Calgary, Alberta, joining an existing group of four surgeons. The SHC has a busy combined Plastic Surgery and Orthopaedic hand program and is also expanding its breast reconstruction program, including both immediate and delayed reconstruction.

The Department of Surgery requires the applicant to have at least one year of post-residency fellowship training, and be competent in hand surgery, microsurgery, and reconstructive breast surgery. The surgeon will be expected to participate actively in undergraduate and resident education. Preference will be given to candidates with additional interest and expertise in clinical research.

The successful candidate will have an on-site office and be provided with operative and ambulatory clinic privileges at the South Health Campus. The surgeon will be expected to participate in the plastic surgery and hand surgery call schedules at the South Health Campus.

The successful candidate must be eligible for licensure by the College of Physicians and Surgeons of Alberta and must hold Fellowship certification in Plastic Surgery from the Royal College of Physicians and Surgeons of Canada.

The position will commence in 2018. All qualified candidates are encouraged to apply, however Canadian citizens and permanent residents will be given priority. Please forward your curriculum vitae, letter of intent, and three letters of reference by November 7, 2017, to:

Dr. Fred Loiselle  
Section of Plastic Surgery  
Department of Surgery, University of Calgary  
c/o Jessica Bartolome  
Room 382, Foothills Medical Centre  
1403–29 Street NW  
Calgary, AB T2N 2T9  
Email Jessica.Bartolome@ahs.ca

**SECTION CHIEF OF ORTHOPAEDIC SURGERY**

The Department of Surgery, Alberta Health Services–Calgary Zone and University of Calgary invite applications for the position of Section Chief, Orthopaedic Surgery. Alberta Health Services and the University of Calgary is an academic hospital complex comprised of Rockyview General Hospital, Foothills Medical Centre, Alberta Children’s Hospital, Peter Lougheed Centre, South Health Campus and numerous Non-Hospital Surgical facilities—working together to create a premier integrated health system.

The successful candidate will be responsible for quality of care and services, education and research within the Section in a manner consistent with the mission and goals of the Department of Surgery, Alberta Health Services and the University of Calgary.

The successful candidate will be a leader in the Bone and Joint initiative. The aim of the initiative is to provide optimal access to bone and joint care including health promotion, disease prevention and, innovation in cross-Sectional integrated service delivery. The Section Chief Orthopaedic Surgery will work closely with other Sections and Departments in Alberta Health Services to achieve these goals.

Qualifications include an MD, a fellowship from the Royal College of Physicians and Surgeons of Canada and/or its equivalent in Orthopaedic Surgery. The applicant must be eligible for licensure in the province of Alberta. The successful applicant will hold a joint appointment with the University of Calgary, Cumming School of Medicine in the Department of Surgery. The ideal candidate will possess excellent communication skills and proven leadership in working with multiple providers and teams. In accordance with Canadian immigration requirements, priority will be given to Canadian citizens and permanent residents of Canada. Alberta Health Services and The University of Calgary are committed to employment equity.

Effective start date is on or before July 1, 2018. Applications for this position will close on October 31, 2017. Interested candidates should forward cover letter, curriculum vitae and three reference letters to:

Dr. Sean Grondin  
Zone Clinical Department Head  
Alberta Health Services  
Department of Surgery  
1403–29th Street NW  
Calgary, AB T2N 2T9
Canadian physicians have lots of ideas
That's not the problem.

At Joule, we believe that when we work together, great things happen — things like helping physicians keep pace with today’s rapid rate of change. When it comes to our aging population, system inefficiencies, or improved patient outcomes, Joule connects physicians to innovators and innovations to help shape the future of health care.

Innovation Challenges
Stimulate ideas through collaboration that result in competitive new products that improve patient outcomes.

Innovation Grants
Identify and fund ventures with the potential to have an impact on national and global health care needs.

Innovation Showcase

Innovation Education
Joule and the World Health Innovation Network assist physician leaders and health teams in accelerating innovation adoption and scalability across health systems.

Joule raises the grade

Innovation
9\textsuperscript{th}
16
Canada’s 2015 ranking behind Sweden, Denmark, Finland, U.S., Switzerland, Netherlands, Austria and Norway.*

Health Care System
10\textsuperscript{th}
11
Performance of Canada’s health care system remains far behind that of other OECD countries, ranking 10\textsuperscript{th} out of 11. **

Business Enterprise Research and Development
D
Canada might get an A for entrepreneurial ambition but we get a D in our commitment to innovation.*

** (Davis K, Stremikis K, Squires D, Schoen C. Mirror, Mirror on the Wall, 2014 Update: How the U.S. Health Care System Compares Internationally; 2016.)