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The adequacy of hepatopancreatobiliary training: How does operative exposure and perceived readiness in fellowship translate into subsequent practice?

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entoring is an essential element of a life in surgery. I teach, therefore I am. Programs that promote practice-sharing between experienced surgeons transitioning out of practice and new graduates entering surgery would facilitate effective mentoring.

Gaspare Tagliacozzi (1545–1599), a great teacher of surgery, is credited with the “modern” introduction of the cross pedicle flap graft to reconstruct the nose. There is creditable evidence that his technique originated in India 1500 or more years earlier. The link may have been through Greco-Roman medicine in southern Italy, but the secret was maintained as proprietary knowledge within families of hereditary surgeons. We remember the teacher rather than earlier practitioners who chose not to share their skill. If any surgeon today is likely to be remembered in 500 years it will be the American Thomas Starzl (1926–2017) who taught surgeons from every country including Canada the physiology of the liver and how to transplant the organ.

The Canadian Journal of Surgery (CJS) mourns the recent deaths of 3 surgical masters by celebrating their lives as teachers. Jean Couture (1924–2016) was chairman of the department of surgery at Université Laval, where he mentored generations of surgeons.1 Dr. Couture led and taught nationally through organizations such as the Canadian Association of General Surgeons and the Royal College of Physicians and Surgeons of Canada, which he served in many capacities, including as president of both organizations. In the 1990s, when the future of CJS was uncertain, he intervened to bring in the support, financial and academic, of specialty societies. Don Wilson (1917–2017), chairman of the Department of Surgery at the University of Toronto, was also a president of the Royal College. Dr. Wilson was a pioneer of bioethics in Canada, campaigning for its integration into every aspect of specialty training. Tom McLarty (1925–2017) was neither chairman of a department nor president of a national organization, but he inspired love and gratitude among generations of surgeons in southwestern Ontario. His gentle “let me show you how to do that” approach fostered technical excellence and an open mind to innovation among his devoted followers.

When the time came to sum up the lives of these wonderful surgeons, their contributions as mentors predominated. Though it is popular to consider an image of the surgeon as the lonely pioneer overcoming barriers to new treatments for patients with illness previously considered hopeless, the reality is one of a leader who inspires the team to success. Schools and surgical organizations are keen to formalize programs for mentoring. Virtually all of these programs are destined to fail, because it is difficult to maintain enforced enthusiasm. Indeed, none of the classic mentors were ever trained in the art or participated in a mentoring program. Their success as mentors appears to be due to a combination of character, circumstance and reputational reward. Many of the classic mentors were so successful that their influence continued long after their retirement and even their death. An example is the surgical society named for the founding editor of CJS, Robert Janes (1894–1966), that continued to meet almost 50 years after his death.2

A desire that seems to be common among mentors is to leave the field in a stronger, better position for those who follow. We are entering a period where this wish will be difficult to fulfill. New surgeons in Canada have been forced to accept temporary or locum positions. In addition to the uncertainty, they are frequently left difficult, hazardous operations by their leave-taking established colleagues — a trial by fire. It has been suggested in CJS that a better route to consider would be practice-sharing in which the departing experienced surgeon collaborates with the new graduate over a 5-year transition period.3 The University of Ottawa has implemented such a program.4 As the Royal College seeks to combine residency training with lifelong learning, it is beginning to put shape on the phases of a surgical career. University and Royal College programs of practice-sharing as a means to facilitate successful transition between these phases will promote mentoring more effectively than nonspecific mentoring programs.

Vivian McAlister, MB
Coeditor, Canadian Journal of Surgery

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**Doceo ergo sum : le mentorat des chirurgiens**

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

Dans une vie consacrée à la chirurgie, le mentorat occupe une place essentielle : l’enseigne, donc je suis. Tout programme qui encourage le partage des pratiques entre des chirurgiens chevronnés sur le point de prendre leur retraite et de nouveaux diplômés qui font leurs premières armes en chirurgie faciliterait un mentorat efficace.

Gaspare Tagliacozzi (1545–1599), un éminent professeur de chirurgie, serait à l’origine de l’utilisation moderne du greffon par embout pédiculé croisé pour reconstruire le nez. Or, selon des preuves dignes de foi, sa technique a d’abord vu le jour en Inde quelque 1500 ans auparavant. La pérennité de la technique a peut-être été assurée par la médecine gréco-romaine telle qu’elle s’exerçait dans le sud de l’Italie, mais le secret en a été maintenu d’une génération à l’autre dans des familles de chirurgiens qui en étaient les détenteurs exclusives. Nous gardons donc le souvenir de celui qui a enseigné la physiologie du foie et la transplantation de l’organe à des chirurgiens de tous les pays, y compris le Canada.

Le *Journal canadien de chirurgie* (*JCC*) se désole du décès récent de 3 maîtres de la chirurgie en soulignant leur carrière de professeurs. Jean Couture (1924–2016) a été directeur du département de chirurgie de l’Université Laval, où il a exercé le rôle de mentor auprès de plusieurs générations de chirurgiens 1. Le D’ Couture a exercé son rôle de chef de file et de professeur sur la scène nationale dans des organismes comme l’Association canadienne des chirurgiens généraux et le Collège royal des médecins et chirurgiens du Canada, où il a agi à divers titres, notamment comme président de ces 2 organismes. Au cours des années 1990, lorsque l’avenir du *JCC* était incertain, il est intervenu pour obtenir le soutien financier et intellectuel des associations de spécialistes. Don Wilson (1917–2017), directeur du département de chirurgie à l’Université de Toronto, a également été président du Collège Royal. Le D’ Wilson a été un pionnier de la bioéthique au Canada; il a milité pour qu’elle s’intègre à tous les aspects de la formation en spécialité. Tom McLarty (1925–2017) n’a pour sa part été président ni d’un département ni d’une organisation nationale, mais il a su inspirer l’amour et la reconnaissance chez des généraux de chirurgiens du Sud-Ouest de l’Ontario. Son approche « laissez-moi vous montrer comment on fait ça », tout en douceur, a contribué à l’excellence technique et à l’ouverture d’esprit vis-à-vis de l’innovation parmi ses fidèles adeptes.

Lorsqu’est venu le temps de faire le bilan de la vie de ces chirurgiens hors du commun, ce sont leurs contributions à titre de mentors qui ont attiré l’attention. Même si on imagine souvent le chirurgien comme un valeureux pionnier solitaire qui se bat pour surmonter les obstacles et donne aux patients atteints de maladies autrefois considérées incurables, l’accès à de nouveaux traitements, la réalité est plutôt celle d’un chef de file qui inspire son équipe afin de la conduire au succès. Les écoles et les associations chirurgicales aiment bien formaliser les programmes de mentorat. Ces programmes sont pour ainsi dire tous voués à l’échec parce qu’il est difficile de maintenir l’enthousiasme quand il est forcé. En effet, aucun des mentors classiques n’a appris son art en suivant un programme de mentorat.

Leur succès à titre de mentors semble être dû tout à la fois à leur caractère, aux circonstances et à leur renommée. De nombreux mentors dits classiques ont connu un succès tel que leur influence a perduré bien longtemps après leur départ à la retraite, voire leur décès. Et la Société de chirurgie portant le nom du rédacteur fondateur du *JCC*, Robert Janes (1894–1966), qui a continué de se réunir près de 50 ans après son décès, en est un bon exemple 2.

Les mentors semblent partager un même désir, c’est qu’a moment de leur départ, leur domaine soit plus fort et en meilleure position, et ce, dans l’intérêt de ceux qui leur succèdent. Nous entrons dans une période où ce souhait sera difficile à réaliser. Au Canada, les nouveaux chirurgiens ont été forçés d’accepter des postes temporaires ou de remplacement. En plus de l’incertitude que cela comporte, leurs collègues chevronnés qui partent leur laissent souvent des

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**References**


interventions difficiles, voire dangereuses. Le JCC a suggéré une meilleure voie, celle qui consiste à partager les pratiques avant de quitter : le chirurgien chevronné collabore ainsi avec le nouveau diplômé pendant une période de transition de 5 ans\(^1\). L’Université d’Ottawa a mis en place ce type de programme\(^4\). Alors que le Collège royal cherche à combiner la formation des médecins résidents et l’apprentissage continu, il commence à définir les différentes phases d’une carrière en chirurgie. Les programmes universitaires et ceux du Collège royal au chapitre du partage des pratiques comme façon de faciliter une transition réussie entre les différentes phases de la formation, seront plus propices à un mentorat efficace que les programmes non spécifiques.

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Corédacteur, Journal canadien de chirurgie  
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Références


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À la mémoire du Dr Jean Couture, un grand chirurgien au Canada et en Chine (1924–2016)

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Natif de la ville de Québec, le Dr Jean Couture s’est éteint paisiblement entouré des membres de sa famille le 16 décembre 2016 à l’âge de 92 ans. Il était un chirurgien talentueux qui a connu une carrière prestigieuse tant au niveau hospitalier (Hôpital du Saint-Sacrement de Québec) qu’au niveau universitaire (Département de chirurgie de la Faculté de médecine de l’Université Laval), au Collège royal des médecins et chirurgiens du Canada et en République populaire de Chine. En raison de ses réalisations, il s’est mérité plusieurs distinctions honorifiques importantes, dont celles octroyées par son alma mater, l’Université Laval (Médaille Gloire de l’Escole, 1995), la ville de Québec (Médaille de la ville de Québec, 2002), la Province de Québec (Chevalier, Ordre national du Québec, 2001), le Canada (Ordre du Canada, 1994) et finalement la Chine (Prix de l’Amitié, 1994).

Un des premiers souvenirs que nous avons du Dr Couture provient d’une photographie suspendue sur l’un des murs de son alma mater (Collège des Jésuites de Québec), le montrant comme un jeune athlète victorieux. Déjà à cette époque, il courait plus vite et sautait plus haut que ses concurrents dans les compétitions athlétiques. C’est d’ailleurs au Collège des Jésuites qu’il a acquis le goût du dépassement de soi et du sens du devoir. Diplômé de la Faculté de médecine de l’Université Laval au début des années 1950, il a poursuivi sa formation en chirurgie générale à New York dans le programme de l’hôpital Bellevue. En 1955, il revenait à Québec avec sa jeune épouse américaine, Virginia, qui le soutiendra pendant toute sa vie professionnelle et jusqu’à la fin de ses jours.

Dès le début de sa carrière, le Dr Couture s’est acquis la réputation d’un chirurgien capable de relever les défis associés aux interventions complexes, ne craignant pas l’innovation. Après avoir complété une experimentation animale rigoureuse, par exemple, il avait proposé l’utilisation de chimiothérapie en perfusion régionale comme traitement de certaines formes de néoplasies.

Devenu chef du service de chirurgie de l’Hôpital du Saint-Sacrement de Québec au cours des années 1960, il démontre rapidement ses talents de leader dynamique et prend goût à la gestion académique manifestant le désir d’améliorer la formation des spécialistes à Québec. En 1973, cet intérêt se confirme alors qu’il accepte le poste de vice-doyen aux études postdoctorales à la Faculté de médecine. Durant ce mandat, il devient un ardent promoteur du concept d’unités d’enseignement clinique comme milieu de formation tant pour les résidents en médecine que pour ceux en chirurgie. Quelques années plus tard, ses efforts sont couronnés de succès puisque depuis 1979, l’ensemble de la formation chirurgicale à Québec se donne maintenant dans des unités d’enseignement clinique.

C’est cette même préoccupation pour la formation spécialisée qui l’amène à devenir membre du Conseil du Collège royal des médecins et chirurgiens du Canada en 1976, institution
donc il en deviendra le président entre 1984 et 1986. Durant son mandat, il a lutté farouchement pour une plus grande implication du Collège dans les politiques nationales de santé et pour la création de liens plus étroits entre le Collège et les différentes associations nationales de spécialités. Il a, de plus, fait la promotion d’une présence francophone accrue au sein du Collège.

En 1980, le projet d’établir une unité d’oncologie regroupant toutes les activités ambulatoires pour malades atteints de cancer du sein devenait sujet de discussion à l’Hôpital du Saint-Sacrement. Dans ce contexte, le Dr Couture prépare un dossier bien étoffé et le projet est accepté par les autorités hospitalières. L’unité a vu le jour en 1981 et depuis ce temps, elle a atteint une réputation enviable sur la scène internationale participant activement à plusieurs projets de recherche clinique en collaboration avec les Instituts nationaux du cancer tant au Canada qu’aux États-Unis. Sans le savoir, le Dr Couture avait mis sur pied un modèle qui sera repris 10 ans plus tard dans le cadre de son projet Chine–Québec.

En 1981, le Dr Couture est nommé chef du département de chirurgie à la Faculté de médecine et c’est dans ce rôle qu’il démontre la pleine mesure de ses talents et de son expérience. Ses initiatives et son leadership assurent un meilleur rayonnement du département tant sur la scène provinciale que nationale. Pour stimuler la recherche clinique, il institue la « journée annuelle de recherche » pour les résidents et organise les « journées chirurgicales de l’Université Laval », journées auxquelles participent, comme conférenciers, plusieurs chirurgiens américains et canadiens. Ces activités d’éducation médicale continue bénéficient à tous, autant résidents que chirurgiens en pratique. Il confère finalement au département sa structure administrative définitive.

Après 35 ans de carrière bien remplie, et alors que la plupart d’entre nous prendraient une retraite bien méritée, le Dr Couture débute une deuxième carrière dans le cadre d’un projet humanitaire appelé « Projet Chine–Québec ». Il a, en effet, été l’artisan d’un programme de collaboration qu’on peut qualifier d’avant-gardiste et de visionnaire entre les Facultés de médecine de l’Université Laval et de l’Université Jilin en Chine, programme encore à ce jour considéré comme un modèle de coopération internationale.

Le projet Chine–Québec, subventionné en 1988 par l’Agence canadienne de développement international (ACDI), aura en fin de compte eu des répercussions majeures sur l’évolution des soins oncologiques en Chine. La mise sur pied d’un centre d’oncologie appelé « Bethune Laval Oncology Unit (BLOU) » au « Premier Hôpital Universitaire de Changchun » au début des années 1990 aura été la pierre angulaire de ce programme. Tel que conceptualisé par le Dr Couture, les succès de BLOU dépendaient de l’utilisation d’un registre de tumeurs pour les cancers du sein, du poumon et du colon, la promotion d’un travail d’équipe et l’importance de fournir un entrainement spécialisé aux intervenants dans le domaine de l’oncologie.

Grâce au travail de 2 anciens étudiants du Dr Couture, les Drs Dong et Fan, la clinique du cancer du sein de Changchun est rapidement devenue l’une des meilleures et des plus efficaces dans toute la Chine.

Le travail de pionnier du Dr Couture dans le domaine de l’oncologie en Chine est d’ailleurs souvent comparé à celui du Dr Norman Bethune, un chirurgien canadien qui a restauré les soins médicaux pour les forces militaires de Mao Zedong au début de la guerre sino-japonaise en 1938–1939. Il est particulièrement intéressant de noter que le nom de Jean Couture est souvent mentionné dans la même foulée que celui de Norman Bethune et qu’il est généralement considéré comme le « Norman Bethune des temps modernes ». Le Dr Bethune a d’ailleurs été l’un des fondateurs de la Faculté de médecine de Changchun appelée « The Norman Bethune University of Medical Sciences », là où a œuvré le Dr Couture. Il est aussi intéressant de noter que lors de sa première visite à Changchun en 1987, le Dr Couture a rencontré l’un des derniers survivants des « Médecins aux Pieds Nus » (Barefoot Doctors), organisation créée par le Dr Bethune en 1938.

Au cours de ses années en Chine, le Dr Couture aura aussi été l’instigateur, souvent avec l’aide de Dashaun, un comédien canadien vivant en Chine et de grande renommée au pays, de plusieurs campagnes anti-tabac. Alors que les programmes anti-tabac canadiens se déroulaient généralement en 7 étapes, ceux préconisés en Chine par le Dr Couture se faisaient en 8 étapes parce que le chiffre 8 est un chiffre magique dans ce pays. Ces campagnes anti-tabac étaient basées sur des programmes d’éducation publique proposés par la section québécoise de la Société canadienne du cancer. Il s’agissait d’un effort colossal puisqu’à l’époque, l’industrie du tabac générait près de 10 % des revenus totaux du gouvernement chinois. Les efforts du Dr Couture ont d’ailleurs contribué à l’adoption par le gouvernement chinois en mars 2011 d’un plan de 5 ans visant à réduire le tabagisme au pays.

Le travail du Dr Couture s’est toujours fait dans le respect des traditions et de la culture chinoise et il s’est d’ailleurs vu décerner en 1994 le « Prix de l’Amitié » par le gouvernement chinois pour ses efforts de lutte contre le cancer. Il s’agit de la plus haute distinction attribuée par la Chine à des experts étrangers.

La dernière visite du Dr Couture en Chine remonte à juin 2009, et à cette occasion il a été honoré une fois de plus par les autorités de l’Université Jilin et celles du Premier Hôpital Universitaire. Au soir de sa vie, le Dr Couture confiait à l’un des auteurs de cet article (L.D.) que sa mission en Chine, appuyée par son épouse, avait été la période la plus féconde et la plus satisfaisante de sa carrière professionnelle.

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Contributeurs : Tous les auteurs ont contribué à la conception, la rédaction et la révision de cet article et ont approuvé la version finale.
Surrogate end points save lives

Christopher Vinden, MD

See also the research paper by Adie et al. on page 86.

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Summary

Patient-centric markers are important, and when they can be conveniently measured they should dominate research questions. However, when the research question pertains to serious or potentially fatal illnesses and it will take years or even decades to answer with patient-centric outcomes, then a pragmatic approach based on common sense and surrogate markers should be adopted. This commentary discusses the important role that surrogate markers can play in medical research.

In this issue of CJS, the research paper by Adie and colleagues,1 which was early-released in February, presents the results of a detailed analysis of the frequency of patient-important outcomes in clinical trials. They found that only 60% of outcomes were patient-important and concluded that authors, journals and trial funders should insist that patient-important outcomes rather than surrogate markers or laboratory values be the focus of study.

While I respect the authors’ focus on patient-centred outcomes, I do not share their disdain for surrogate markers. Surrogate end points play an important role in research and are typically chosen in order to expedite the answer to the clinical question. For serious or potentially fatal illnesses, this is not just a matter of getting it right, but can be a question of life or death. Treatment delayed is treatment denied, and the potential harms of such delay need to be considered carefully. From a patient’s perspective, dying on the waiting list for evidence is not a more noble death than dying of a well-intentioned intervention based on imperfect but available evidence. Commissions of inquiry into previous major failures of the Canadian health system share this concern and perspective.

In the 1980s at least 10 000 Canadians were harmed when experts at the Canadian Red Cross did not take appropriate action to protect the blood supply because there was “no high-quality evidence to support change.” They were unwilling to accept surrogate markers (elevated transaminases) as an indicator of infected blood, as had been done in many other countries; instead they were waiting for the results of a multicentre randomized clinical trial. Justice Horace Krever, who authored the report of the commission of inquiry, was highly critical of this approach: “the need for such a study had passed before it was begun.”

He was explicit in his criticism: “Where there is reasonable evidence of an impending threat to public health, it is inappropriate to require proof of causation beyond a reasonable doubt before taking steps to avert the threat.” As an editorial in the American Journal of Public Health in May 1984 put it:

The incomplete state of our knowledge must not serve as an excuse for failure to take prudent action. Public health has never clung to the principle that complete knowledge about a potential health hazard is a prerequisite for action. Quite the contrary, the historical record shows that public health’s finest hours often occurred when vigorous preventive action preceded the crossing of every scientific “t” and the dotting of every epidemiological “i.”2

In 2003, an outbreak of severe acute respiratory syndrome (SARS) affected 375 Canadians and killed 44. The subsequent SARS commission, chaired by Justice Archie Campbell, into the failures of the Canadian health system came to an almost identical conclusion.
Perhaps the most important lesson of SARS is the importance of the precautionary principle. SARS demonstrated over and over the importance of the principle that we cannot wait for scientific certainty before we take reasonable steps to reduce risk. This principle should be adopted as a guiding principle throughout Ontario’s health, public health and worker safety systems. If we do not learn this and other lessons of SARS, and if we do not make present governments fix the problems that remain, we will leave a bitter legacy for those who died, those who fell ill and those who suffered so much.1

A more contemporaneous example that those words fell on deaf ears is the current situation with colorectal cancer screening in Canada and the striking difference between American and Canadian approaches and outcomes. The recently resuscitated Canadian Task Force on Preventive Health once again published recommendations based on an interpretation of evidence-based medicine that treats the hierarchy of evidence as if it were an infallible dispensation from higher beings. They recently recommended that persons of average risk for colorectal cancer should not undergo screening colonoscopy owing to a lack of high-quality evidence.4 Presumably they are waiting for the results of a meta-analysis of the 4 clinical trials that are now underway and will be published in the late 2030s when the trials are completed.

Colorectal cancer is a highly preventable disease that kills more than 9000 Canadians every year. The US Preventive Services Task Force (USPSTF), clearly not constrained by any patient-centric evidentiary deficits, made the pragmatic decision to recommended average risk screening for colorectal cancer colonoscopy 14 years ago,5 and after recently reviewing the same body of evidence that its Canadian counterpart reviewed, came to the opposite conclusion and reiterated support for average risk screening colonoscopy.6 Participation rates have been high, and in some states more than 70% of the eligible population has been screened, with colonoscopy dominating. The difference in outcomes is dramatic. In Canada the number of deaths from colorectal cancer has increased by 50% in the last 20 years,7,8 whereas the United States, with a similar population profile, population growth and risk factors, has seen an 8% drop.9,10

To clarify this comparison in a patient-centric manner, if Canada had achieved the same reduction in colorectal cancer mortality that the United States has achieved since 1996, we would have 3200 fewer deaths per year. If we had achieved the same incidence reduction that the United States has achieved, we would have 8800 fewer cases per year. These are not trivial numbers; picture a Boeing 777 crashing every month! These numbers exceed the total annual case and mortality counts of most cancers. Only breast, lung, prostate and pancreatic cancers exceed the calculated excess deaths from colorectal cancer. The estimated cumulative difference over the last 20 years is on the order of 35 000 excess deaths and 80 000 excess cases of colorectal cancer in Canada.

Accepting the non–patient centric surrogate of advanced adenoma detection rate as a valid and appropriate end point could have resulted in the adoption of screening colonoscopy years ago and would likely have saved many of those lives. A generation of Canadians has been denied the opportunity to prevent one of the leading causes of cancer death because of rigid choices about rules of evidence and appropriate end points.

Outside the field of medicine, surrogate markers seem to work very well. I suspect that most of us appreciate the fact that civil engineers use surrogate markers of material strength and durability rather than wait for a patient-centred metric, such as fatality rate due to bridge collapse, when they build our infrastructure. And I suspect that even the most hard-core patient-centred outcome aficionados readily accept rising atmospheric carbon dioxide as a surrogate for climate change rather than waiting for sea levels to intrude into homes in a very patient-important manner.

The cognitive dissonance of accepting surrogate markers in nonmedical situations but rejecting them in medical research is not rational or scientific.

Patient-centred markers are important, and when they can be conveniently measured they should dominate research questions. But when the research question pertains to serious or potentially fatal illnesses and it will take years or even decades to answer with patient-centric outcomes, then a pragmatic approach based on common sense and surrogate markers should be adopted.

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References

Somewhere in France (9 April 17): a centenary review of medical arrangements at Vimy Ridge

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Successful Canadian actions at Vimy Ridge and Hill 70 book-ended the Battle of Arras, a major component of the 1917 Nivelle Offensive of the First World War. Their impact was greater in Canada than Europe, with the Battle of Vimy Ridge, in particular, being considered a nationally defining moment. Although some historians consider the claims of today to be exaggerated, the achievements of the Canadian Corps were recognized for the remarkable feats that they were at the time. Had the Nivelle Offensive been successful in its goal to break the German line, these Canadian actions would be remembered as the turning point in the war. The equally remarkable success of the Canadian Army Medical Corps in these battles is the subject of this essay.

France’s Tenth Army had failed to dislodge the Germans from Vimy Ridge on several occasions in 1915, suffering 150,000 casualties, many of whom remained in no man’s land. The British XVII Corps relieved the French in February 1916. The Canadian Corps arrived in the sector in October 1916. The 3 divisions of the Canadian Corps had been joined by the 4th Canadian Division in August 1916 at the Battle of the Somme. The Canadians had since become adept at raiding German lines, mostly at night, to harass the enemy and capture intelligence. In March 1917, the 4th Division launched the most ambitious raid yet. Combining stealth and gas, they sought to prove their worth to their veteran colleagues by attacking German trenches on Vimy Ridge. The result was disastrous. The casualty rate was 43%, or 687 men. Survivors remembered it as “a proper slaughter.” Combined with the withering losses suffered at the Somme, it put the Canadian Corps at risk of collapse. In March 1917, the Canadian Corps received orders to take and hold Vimy Ridge.

The hallmarks of the Corps’ strategy were meticulous planning, information dissemination, infrastructure development (e.g., communication trenches and attack tunnels), rehearsal and flexibility, all new to the war. Sir Julian Byng, Corps commander, and Arthur Currie, commander of the 2nd Division, are credited with the innovations. No longer would men be left without objectives because their captain had been hit; they could outflank machine guns so long as they did not lose contact with their unit; attacks were coordinated to follow creeping artillery barrages in order to deny the enemy time to reset their machine guns. Uniquely these strategies were rehearsed by units in models of their sector. Medical arrangements for the battle used similar strategies to correct errors of the past. Crucially combat troops were ordered not to stop for injured comrades and were assured of aid by special teams during the battle.

Summary

In April 1917, medical units of the 4 divisions of the Canadian Corps combined for the first time in support of a single action, the assault upon Vimy Ridge. Detailed planning, infrastructure development, information dissemination and rehearsal were features of preparations by the combat arms and medical elements of the Canadian Forces. Extraordinary coordination resulted in the rapid rescue and evacuation by Canadian medical services of 8000 casualties over 4 days. Characteristics of today’s military medical services are evident in the work of the Canadian Army Medical Corps 100 years ago.
Twelve of Canada’s 16 field ambulance units were deployed in the Battle of Vimy Ridge. Field ambulances were the favoured destination for medical students from Canadian universities who volunteered for service, interrupting their studies. Famous examples include Frederick Banting, Norman Bethune and Harold Griffith (pioneer anesthesiologist). Even though each unit was attached to 1 of the 4 Canadian divisions, they pooled resources to form a central trunk supporting each unit as a branch. Most of the field ambulances were tasked with “clearing the field” and maintaining an advance dressing station. Upon receiving instructions, each unit surveyed its sector and prepared structures including the advance dressing station, field ambulance relay posts, accommodation for stretcher bearers and regimental aid posts. Roads leading to Vimy had 3 lines of traffic to accommodate the buildup to the battle, and still medical units had difficulties receiving materials and supplies. For divisions 1–3, stretcher cases were taken to a Corps dressing station at Les Quatre Vents while the walking wounded went to Villers-au-Bois. The 4th Division was separated from the rest of the Corps by topography and took stretcher and walking casualties to la Haie and Hersin-Coupigny, respectively. Efficient and effective evacuation was the priority of the medical services close to the front. The No. 1 Canadian Casualty Clearing Station, the first point where surgery could be performed, was placed at Aubigny, and a motor ambulance convoy was stationed at Bruay. Tramlines were constructed to move casualties along lines of evacuation that would otherwise have become impassable owing to mud (Fig. 1). Improvised stretcher cars were moved by men or mules. The tramlines converged at Ambulance Point, from where the Army controlled evacuation of casualties out of the area of operations.

At 5:30 am on Easter Monday, Apr. 9, 1917, pipers with the Princess Patricia’s Canadian Light Infantry Regiment of the 3rd Canadian Division struck up their bagpipes as their men, with the rest of the Canadian Corps, entered no man’s land, chasing the artillery barrage up the Vimy hillside. It is doubtful if the Germans or even the Canadians heard the pipes, such was noise of bombardment. The pipers were there because their main role was as stretcher bearers and they followed the first line of men out into the field of battle. Fighting was fierce. Lance Sergeant Ellis

![Fig. 1. Canadian medics, aided by German prisoners, move 4 casualties on an improvised stretcher car along tram lines during the Battle of Vimy Ridge, April 1917. (Library and Archives Canada: MIKAN 3194779).](image-url)
Sifton from the tiny town of Tyrconnell, Ont., made it into a German machine gun dugout. He first kicked over the machine gun and then attacked its crew with his bayonet before being killed. He was posthumously awarded the Victoria Cross — 1 of 4 awarded to Canadians for their efforts that day.

By dark, it was clear that the assault had been successful even though fighting continued for 4 days. Remarkably the field was cleared of casualties by midnight. The rapidity with which the injured were rescued taxed the lines of evacuation considerably. Rain and then snow worsened the situation. MacPhail1 blames the back-up on delays removing treated casualties out of the area of operations — an Army rather than a Medical Corps responsibility. This may be reasonable, as all transport was requisitioned temporarily to resupply the combat units. Telephone communication remained open to the front lines throughout the battle. Frantic calls eventually resulted in 2 additional roads being opened followed by rapid clearance of casualties. By 2 am on Apr. 10, 5976 patients were safe in casualty clearing stations, warmly housed at Les Quatre Vents, or evacuated.4 In the 4 days of fighting Canadian medical services looked after 4265 stretcher cases and 3791 walking wounded, including 706 enemy casualties. Fit German prisoners assisted the medical crews, with only casual guarding apparent.

Field ambulances today are responsible for North Atlantic Treaty Organization (NATO) Role 1 care, treatment at the point of injury and evacuation.5 The organization, priorities and actions of the Royal Canadian Medical Service today can trace their origins to Vimy, where for the first time brigade and divisional medical resources were pooled in a great scheme of coordination. Rapid rescue from the point of injury, with effective primary care, remains the priority of the service. Senior medical officers today will sympathize with their Vimy ancestors when lines of supply or evacuation are threatened by the priority they receive from centralized transport. Cooperation between echelons of care, today defined by NATO but based on those used in the First World War, remains the basis for achieving the goal of ameliorating the injuries of war.4

The feat achieved by the Canadian medical services parallel that by combat arms at the Battle of Vimy Ridge. From today’s perspective, both are unfathomable. Victory at Vimy was celebrated in Canada and recognized by the authorities. Arthur Curry was knighted in the field by the King and given command of the Canadian Corps, itself a recognition of Canadian self-sufficiency. Curry would revise higher command’s mission to take the town of Lens into a successful repeat of Vimy Ridge at Hill 70, where he drew German forces into a terrible slaughter. Byng was given command of Britain’s Third Army and was elevated to the peerage as Baron (later Viscount) Byng of Vimy. He served as Canada’s twelfth Governor General. An impromptu memorial at Vimy was replaced in 1936 by Canada’s iconic monument to the bravery, sacrifice and savagery of war.

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Competing interests: None declared.

References
Are outcomes reported in surgical randomized trials patient-important? A systematic review and meta-analysis

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Rajat Mittal, BSc(Med), MBBS, MMed(Clin Epi) MS

Background: The dangers of using surrogate outcomes are well documented. They may have little or no association with their patient-important correlates, leading to the approval and use of interventions that lack efficacy. We sought to assess whether primary outcomes in surgical randomized controlled trials (RCTs) are more likely to be patient-important outcomes than surrogate or laboratory-based outcomes.

Methods: We reviewed RCTs assessing an operative intervention published in 2008 and 2009 and indexed in MEDLINE, EMBASE or the Cochrane Central Register of Controlled Trials. After a pilot of the selection criteria, 1 reviewer selected trials and another reviewer checked the selection. We extracted information on outcome characteristics (patient-important, surrogate, or laboratory-based outcome) and whether they were primary or secondary outcomes. We calculated odds ratios (OR) and pooled in random-effects meta-analysis to obtain an overall estimate of the association between patient importance and primary outcome specification.

Results: In 350 included RCTs, a total of 8258 outcomes were reported (median 18 per trial). The mean proportion (per trial) of patient-important outcomes was 60%, and 66% of trials specified a patient-important primary outcome. The most commonly reported patient-important primary outcomes were morbid events (41%), intervention outcomes (11%), function (11%) and pain (9%). Surrogate and laboratory-based primary outcomes were reported in 33% and 8% of trials, respectively. Patient-important outcomes were not associated with primary outcome status (OR 0.82, 95% confidence interval 0.63–1.1, \(I^2 = 21\%\)).

Conclusion: A substantial proportion of surgical RCTs specify primary outcomes that are not patient-important. Authors, journals and trial funders should insist that patient-important outcomes are the focus of study.
Ideally, outcome measurements in clinical trials are important to patients, and therefore immediately relevant to clinical practice. Outcome measurements must be valid and reliable, which poses some difficulty when measuring patient-centred outcomes, such as function or health-related quality of life (HRQoL). Other patient-important outcomes, such as death and morbidity may require trials with large sample sizes and long-term follow-up. Thus researchers may choose surrogate outcomes that are easier to measure, but only reflect an issue important to the patient, and are not necessarily important themselves.

Surrogate outcomes are defined as “a laboratory measurement or a physical sign used as a substitute for a clinically meaningful end point that measures directly how a patient feels, functions or survives.” In diabetes trials, only 18% of primary outcomes were patient-important, and other specialties had similarly low rates after empirical reviews. The dangers of using surrogate outcomes are well documented. They may have little or no association with their patient-important correlates, leading to the approval and use of interventions that lack efficacy. Of greater concern are approved interventions that are in fact harmful, and the use of surrogate outcomes has been blamed for unnecessary deaths.

Little is known about the patterns of outcome reporting in surgical trials. We performed a systematic review and meta-analysis of published randomized controlled trials (RCTs) of surgical interventions. Our primary aim was to determine the proportion of primary outcomes in surgical trials that were patient-important.

**METHODS**

**Design and study selection**

The methods for this systematic review and meta-analysis were prespecified in a protocol as part of a doctoral thesis. This study is reported here according to the PRISMA statement guidelines. We obtained ethics approval for the present study from the South Western Sydney Local Health District, Human Research Ethics Committee.

We included RCTs published in English and in full text, conducted on humans (not cadavers), that compared a surgical intervention to any other intervention. We defined a surgical intervention as any procedure that requires surgical training and is usually performed by a surgeon of any subspecialty recognized by the Royal Australasian College of Surgeons. This included upper and lower gastrointestinal, transplant, cardiothoracic, neuro-, ear nose and throat, pediatric, plastic and reconstructive, urological, vascular and orthopaedic surgery. Obstetric/gynecologic, ophthalmic and dental surgeries were excluded. Injections of any material, applications of splints, and interventions purely for diagnostic purposes were also excluded.


Study identification began with the most recent reference and proceeded backward in time. We aimed to include the 350 most recently published surgical RCTs. Using 1000 references, study identification was piloted by 2 authors (S.A., I.A.H.) in order to resolve issues with interpretation of the eligibility criteria. We screened the titles and abstracts of references and retrieved the full text of potentially eligible articles. Studies were included only after assessment of their full text. The pilot search resulted in almost perfect agreement between the 2 assessors (n = 1000, $\kappa = 0.85$, 95% confidence interval [CI] 0.77–0.93), and thereafter study identification was performed by 1 author (S.A.), in an identical process.

**Data extraction**

We created an electronic proforma for data extraction, after piloting by 3 authors (S.A., R.M., J.N.) using a sample

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**Box 1: Operational definitions of patient-important outcomes**

**Patient-important outcomes**

Outcomes that are likely to be informative to patients and clinicians and measure factors directly related to patient health. Includes the following:

- Mortality/survival (e.g., 30-d mortality, 5-yr survival)
- Pain (e.g., visual analogue score pain; incidence of a painful symptom, such as dysuria or headache; questionnaire resulting in an aggregate score of pain, such as the Western Ontario and McMaster Universities Arthritis Index pain subscale)
- Function (e.g., validated measures of function, such as the International Index of Erectile Function, or the New York Heart Association Functional Classification)
- Quality of life (e.g., validated measures, such as the Short Form 36 survey, or the EuroQol 5 dimension survey)
- Any morbid event or symptom (e.g., incidence of wound infection, fracture nonunion, incontinence), or a measure of their opposites (e.g., wound healing, fracture union, continence)
- Patient satisfaction (e.g., a survey of overall patient satisfaction with their surgical procedure, or satisfaction with cosmesis)
- Any intervention to address the previous 6 outcomes (e.g., use of analgesia for pain, catheterization for urinary retention, interventions to restore vascular patency, revision surgery)

**Surrogate outcomes**

Outcomes that may indicate progression or an increased risk of a patient-important outcome, but are not intrinsically important to patients (e.g., operative duration for any procedure, urine flow rate for patients with prostatism, hemodynamic measurements after coronary bypass, fracture alignment after operative fixation, surgeon-reported “success” of a procedure)

**Laboratory outcomes**

Nonclinical tests that measure physiologic parameters without any direct or tangible effects on patients (e.g., inflammatory markers after surgery, troponin after coronary bypass, cholesterol levels after obesity surgery, amylase/lipase after pancreatic surgery)
of 10 trials. After calibration of the data, 1 author (S.A.) extracted the data. Another researcher (R.M.) checked a random sample of 100 included RCTs, and disagreements were resolved by discussion. One data point from 5 trials (<1% of the checked sample) was changed after double-checking, and no data relating to classification of patient importance were changed.

Data items

We extracted trial-level characteristics, including author background in epidemiology/statistics, study type (superiority/noninferiority), study design (parallel/split body/crossover/factorial), journal impact factor, total sample size, multicentre status and trial registration. Risk of bias domains were also extracted, including adequacy of random sequence generation, allocation concealment, blinding, reporting of attrition and source of funding. Operational definitions of these variables may be found in Appendix 1.

We defined an outcome as a variable used to compare the randomized groups in a trial in order to assess the efficacy or harm of an intervention. We extracted all outcomes in each trial and recorded outcome-level characteristics, including patient importance and whether the outcome was specified as primary or secondary.

Individual trial outcomes were classified as patient-important, surrogate, or laboratory measurements. Box 1 presents the operational definitions used, with examples from various surgical specialties. Patient-important outcomes included measurements of mortality/survival, pain, function, HRQoL, any morbid event, patient satisfaction and any intervention used to address these. Surrogate outcomes did not meet the criteria for being patient-important, but instead were indicators of progression or an increased risk of a patient-important outcome. Laboratory outcomes were

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**Fig. 1.** Selection of studies for inclusion in the review and meta-analysis.
defined as nonclinical tests that measure physiologic parameters without any direct or tangible effects on patients. When composite outcomes were reported, the components of that outcome were graded separately according to the previously mentioned criteria.  

Each outcome was also recorded as to whether it was specified as primary, secondary, or unclear. A primary outcome was either used in a sample size calculation, defined explicitly as such in the text (using the word “primary” or a synonym), or was stated explicitly in an aims/hypothesis statement. When a primary outcome was specified, we regarded other outcomes as secondary outcomes. When no primary or secondary outcomes were specified in a trial, we marked that trial’s outcomes as unclear.

**Statistical analysis**

We recorded the total number of outcomes per trial, and calculated the proportion of patient-important outcomes (as well as a composite of any patient-important outcome), surrogate outcomes and laboratory outcomes at the trial level. Mean proportions were calculated for the whole sample of trials.

For each trial, we populated a contingency (2 × 2) table with that trial’s outcomes, characterizing whether each outcome was patient-important or not, and whether each outcome was specified as primary or secondary. Trials that did not specify primary and/or secondary outcomes were not eligible for this analysis. If the contingency table contained a single zero cell or 2 diagonal zero cells, we added 0.5 to all 4 cells as per standard methods found in statistical packages. When a whole row or column contained zero cells, an odds ratio (OR) was incalculable and that trial was excluded from this statistical analysis. An OR greater than 1 meant that a patient-important outcome was more likely to be specified as a primary outcome. We then combined ORs in a random-effects meta-analysis and calculated a pooled OR (along with its 95% CI and I² as a measure of heterogeneity) as an overall indicator of whether surgical trials uses patient-important outcomes as primary outcomes.

Exploratory meta-regression was modelled using the restricted maximum likelihood method in order to explore trial-level variables associated with the reporting of patient-important primary outcomes.

**Results**

**Characteristics of included trials**

We included 350 trials assessing a surgical intervention in our analysis (Fig. 1). Table 1 presents the characteristics of included trials. Most (335, 96%) were superiority trials, and parallel arm (331, 94.5%) trials, and 18% had an author with a reported epidemiology and/or statistics background. The primary outcome was specified in 225 (64%) trials.

A total of 8258 outcomes (4141 efficacy and 4117 harm outcomes) were reported in the included RCTs, with a median of 18 outcomes per trial. The mean proportion per

<table>
<thead>
<tr>
<th>Table 1. Characteristics of included trials (n = 350)</th>
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<tbody>
<tr>
<td>Characteristic</td>
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<tr>
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<td>Noninferiority/equivalence</td>
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<td>&lt; 1</td>
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<tr>
<td>1–2.4</td>
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<tr>
<td>2.5–4.9</td>
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<tr>
<td>5–9.9</td>
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<td>≥ 10</td>
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<tr>
<td>Total sample size</td>
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<td>100–199</td>
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<td>≥ 200</td>
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<td>Unclear</td>
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<td>Allocation concealment</td>
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<tr>
<td>Blinding</td>
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<tr>
<td>Any blinding</td>
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<tr>
<td>Patient</td>
</tr>
<tr>
<td>Carer</td>
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<tr>
<td>Outcome assessor</td>
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<td>Primary outcome blinded</td>
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</tr>
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<td>Partial industry</td>
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</tr>
<tr>
<td>No external source</td>
</tr>
<tr>
<td>Unreported</td>
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The mean proportions of surrogate outcomes and laboratory outcomes were 29% and 10%, respectively. A median of 1 (interquartile range [IQR] 3) primary outcome was identified for each of the 225 trials that specified primary and/or secondary outcomes. Of these, 148 (66%) specified a patient-important outcome as a primary outcome. The most common patient-important primary outcome was a morbid event or symptom (92 trials, 41%), followed by intervention outcomes (25 trials, 11%) and function outcomes (24 trials, 11%). Seventy-four (33%) trials specified a surrogate outcome as a primary outcome, and 17 (8%) trials specified a laboratory outcome as a primary outcome (Table 3).

**Are primary outcomes more likely to be patient-important?**

Figure 2 depicts the results of our random-effects meta-analysis that pooled trial-level ORs of the association between patient importance and a primary outcome specification. Of the 225 trials that specified a primary outcome, 59 had entire rows or columns with zero cells in our $2 \times 2$ table and did not contribute to the meta-analysis. Patient-important outcomes were not associated with being a primary outcome (OR 0.82, 95% CI 0.63–1.07, $I^2 = 21$%). Exploratory meta-regression showed that trials that had an author with a declared epidemiology and/or statistics background had twice the odds of other trials of specifying a patient-important primary outcome (OR 2.08, 95% CI 1.10–3.94, $p = 0.025$, Table 4).

### Table 2. Mean proportions of patient-important outcomes per trial, stratified by trial characteristics

<table>
<thead>
<tr>
<th>Outcome</th>
<th>All trials</th>
<th>Superiority trials</th>
<th>Noninferiority trials</th>
<th>Full or partial industry funding</th>
<th>Nonindustry funding</th>
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<tr>
<td>No. of trials</td>
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<td>335</td>
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<td>60</td>
<td>67</td>
<td>58</td>
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<tr>
<td>Pain</td>
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<td>7</td>
<td>6</td>
<td>7</td>
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<tr>
<td>Function</td>
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<td>8</td>
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<td>6</td>
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<td>Morbid events/symptoms</td>
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<td>Laboratory outcomes</td>
<td>10</td>
<td>10</td>
<td>7</td>
<td>8</td>
<td>12</td>
</tr>
</tbody>
</table>

*Unless indicated otherwise.

### Table 3. Proportion of trials reporting patient-important outcomes as primary outcomes, stratified by trial characteristics*

<table>
<thead>
<tr>
<th>Outcome</th>
<th>All trials</th>
<th>Superiority trials</th>
<th>Noninferiority trials</th>
<th>Full or partial industry funding</th>
<th>Nonindustry funding</th>
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<tbody>
<tr>
<td>No. of trials</td>
<td>225</td>
<td>212</td>
<td>13</td>
<td>58</td>
<td>58</td>
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<tr>
<td>Any patient-important outcome</td>
<td>148 (66%)</td>
<td>139 (66)</td>
<td>9 (69)</td>
<td>35 (60)</td>
<td>34 (59)</td>
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<tr>
<td>Mortality/survival</td>
<td>10 (4)</td>
<td>10 (5)</td>
<td>0</td>
<td>0</td>
<td>2 (3)</td>
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<tr>
<td>Pain</td>
<td>20 (9)</td>
<td>20 (9)</td>
<td>0</td>
<td>4 (7)</td>
<td>4 (7)</td>
</tr>
<tr>
<td>Function</td>
<td>24 (11)</td>
<td>23 (11)</td>
<td>1 (8)</td>
<td>9 (16)</td>
<td>4 (7)</td>
</tr>
<tr>
<td>Quality of life</td>
<td>8 (4)</td>
<td>7 (3)</td>
<td>1 (8)</td>
<td>3 (5)</td>
<td>2 (3)</td>
</tr>
<tr>
<td>Morbid events or symptoms</td>
<td>92 (41)</td>
<td>86 (41)</td>
<td>7 (54)</td>
<td>20 (34)</td>
<td>22 (39)</td>
</tr>
<tr>
<td>Patient satisfaction</td>
<td>1 (0.4)</td>
<td>1 (0.5)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Intervention outcomes</td>
<td>25 (11)</td>
<td>25 (12)</td>
<td>0</td>
<td>7 (12)</td>
<td>8 (14)</td>
</tr>
<tr>
<td>Surrogate outcomes</td>
<td>74 (33)</td>
<td>71 (33)</td>
<td>3 (23)</td>
<td>25 (43)</td>
<td>20 (34)</td>
</tr>
<tr>
<td>Laboratory outcomes</td>
<td>17 (8)</td>
<td>15 (7)</td>
<td>2 (15)</td>
<td>5 (9)</td>
<td>3 (5)</td>
</tr>
</tbody>
</table>

*aData presented only from trials that explicitly specified a primary outcome. Some trials reported more than 1 primary outcome, hence the classifications were not mutually exclusive.

†Unless indicated otherwise.
**Discussion**

We systematically reviewed 350 recently published RCTs of surgical interventions to determine the extent of reporting of patient-important outcomes. We found that a mean proportion of 60% of outcomes per trial were patient-important, but substantial proportions of outcomes were surrogate (29%) or laboratory-based (10%). Of the surgical trials that specified a primary outcome, only two-thirds specified a patient-important primary outcome. Patient-important outcomes were not more likely to be specified as primary outcomes than surrogate or laboratory outcomes.

Surrogate outcomes have been accepted as proxy measures of patient-important outcomes in clinical trials for many years. They are often easier and quicker to measure, and statistical inferences can be made with smaller numbers of patients owing to larger treatment effect sizes. Thus they are useful in the early evaluation of the bioactivity of an intervention, and many drug interventions have been approved by regulatory bodies on the basis of a positive effect on surrogate outcomes. However, assumptions are often made that surrogate outcomes lie on a causal pathway to a patient-important, clinically relevant outcome. These assumptions of causality often rely on observational evidence, such as laboratory, ecologic and cohort studies, and have resulted in grave misinterpretations of the benefits of some interventions. For example, class I antiarrhythmic medications were approved for use after myocardial infarction based on a proven reduction in ventricular ectopic beats (a surrogate outcome of mortality), but a subsequent large clinical trial reported an increase in mortality with these agents, with thousands of patients likely to have been harmed (or killed) in the intervening period. Hormone replacement therapy was shown to improve cholesterol levels in women, but subsequent evidence suggested an increase in the incidence of myocardial infarction and stroke with this therapy. On the other hand, there are examples of trials for which surrogate and patient-important outcomes have been aligned, such as an increase in bone mineral density and fracture risk in trials of bisphosphonates. Some commentators have argued strongly against the adoption of interventions based on surrogate outcomes.

Surgical innovation has been criticized for not requiring rigorous evaluation before its availability to patients, and it is likely that its early evaluation suffers from similar problems with the use of surrogate outcomes. We found that 60% of all outcomes were patient-important outcomes and that a slight majority (60%) of outcomes per study were patient-important. Further, 66% of trials specified patient-important primary outcomes. Studies in other specialty areas have found smaller proportions of patient-important outcomes in their samples of RCTs. Gandhi and colleagues assessed RCTs of diabetes care and found that only 46% of trials reported any patient-important outcomes and only 18% of trials reported patient-important, primary outcomes. However, in their assessment of recent RCTs published in 6 high-impact general medical journals, Ciani and colleagues found that 27% of trials specified a surrogate primary outcome. It is
possible that surgical interventions (compared with drug interventions) are more conducive to assessment by practical, clinically relevant outcomes, since surgeons often use patient performance and morbid events as markers of success. It is also likely that surgeons focus on clinically relevant outcomes (e.g., morbid/adverse events or functional outcomes) rather than laboratory measures to monitor their patients after surgery. Nevertheless, a significant proportion of outcomes (both primary and otherwise) in surgical trials remain non-patient-important, and this warrants some concern.

**Strengths and limitations**

Our study has a number of strengths. First, we used a protocol-driven systematic review design, which allows study replication and generalizability of the results to recently published surgical RCTs. Second, the definitions of patient-important outcomes were unambiguous, and there was minimal disagreement between the 2 researchers when the data were checked. This study also has weaknesses. First, it did not account for the occurrence of selective outcome reporting. It is likely that a certain proportion of outcomes remain unreported (possibly based on statistical significance). Further, some studies may have retrospectively selected primary outcomes based on their results or statistical significance, which would affect the analyses presented here on the association between primary outcomes and patient importance. Second, to be included in the pooled analysis, a trial’s outcomes had to populate a 2 × 2 table so that an OR could be calculated. Trials that had entire rows or columns with zero events (e.g., a trial reported entirely with surrogate outcomes), or trials that did not specify whether outcomes were primary or secondary, were excluded. This may have reduced the power of our analysis to detect a significant association, although the calculated CI was relatively narrow (0.63–1.07). Third, we used a trial sample published between August 2008 and May 2009. While this sample is now several years old, there was an inevitable time delay for collection and analysis of such a large amount of data, which was similar to previous studies.

**Conclusion**

We found that a substantial proportion of surgical trials did not specify a patient-important primary outcome and that patient-important outcomes were not more likely to be specified as primary outcomes than surrogate or laboratory outcomes. Consequently, many surgical trials may not be clinically useful. Surrogate outcomes should be used only when they have a strong, evidence-based link with a patient-important outcome. Trial reporting guidelines (e.g., CONSORT statement) should include reporting on the clinical relevance of any surrogate outcomes measured, and trial funders and publishers should consider the importance of outcomes to patients in their decision-making.

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**Affiliations:** All authors are from the Whitlam Orthopaedic Research Centre, Ingham Institute for Applied Medical Research, Liverpool, New South Wales, Australia.

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**Competing interests:** None declared.

**Contributors:** S. Adie and I. Harris designed the study. S. Adie, J. Naylor and R. Mittal acquired the data, which all authors analyzed.

**References**

Intraoperative culture positive allograft bone and subsequent postoperative infections: a retrospective review

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Background: Obtaining intraoperative cultures of allograft bone just before use in orthopedic procedures is standard practice in many centres; however, the association between positive cultures and subsequent surgical infections is unknown. Our study had 3 goals: to determine the prevalence of positive intraoperative allograft culture and subsequent infection; to determine if, in cases of subsequent infection, organisms isolated at reoperation were the same as those cultured from the allograft at the time of the index procedure; and to assess the costs associated with performing intraoperative allograft cultures.

Methods: In this retrospective case series, we obtained data on patients receiving allograft bone between 2009 and 2012. Patients receiving allograft with positive cultures were reviewed to identify cases of significant infection. Organisms isolated at reoperation were compared with the allograft culture taken at the time of implantation, and we performed a cost assessment.

Results: Of the 996 allograft bone grafts used, 43 (4.3%) had positive intraoperative cultures and significant postoperative infections developed in 2, requiring reoperation. Antibiotics based on culture results were prescribed in 24% of cases. Organisms cultured at the time of reoperation differed from those isolated initially. The cost of performing 996 allograft cultures was $169 320.

Conclusion: This series suggests that rates of positive intraoperative bone allograft culture are low, and subsequent infection is rare. In cases of postoperative infection, primary allograft culture and secondary tissue cultures isolated different organisms. Costs associated with performing cultures are high. Eliminating initial culture testing could save $42 500 per year in our health region.

Contexte : L’obtention de cultures d’allogreffes osseuses peropératoires juste avant une intervention orthopédique est une pratique standard dans de nombreux centres. Or, on ignore s’il y a un lien entre des résultats de cultures positifs et les infections chirurgicales subséquentes. Notre étude avait 3 objectifs : déterminer la prévalence des cultures d’allogreffes peropératoires positives et des infections subséquentes; déterminer si, dans les cas d’infections subséquentes, les agents pathogènes isolés lors d’une réintervention étaient les mêmes que dans les spécimens prélevés sur les allogreffes au moment des interventions initiales; évaluer les coûts associés à l’obtention des cultures d’allogreffes peropératoires.


Résultats : Parmi les 996 allogreffes osseuses effectuées, 43 (4,3 %) avaient des résultats positifs aux cultures peropératoires; des infections postopératoires significatives se sont déclarées dans 2 de ces cas et ont nécessité une réintervention. Des antibiotiques ont été prescrits en fonction des résultats des cultures dans 24 % des cas. Les agents pathogènes isolés en culture au moment de la réintervention étaient différents de ceux qui avaient été initialement isolés. Le coût des 996 cultures d’allogreffes s’est élevé à 169 320 $.

Conclusion : Cette série donne à penser que les taux de résultats de cultures d’allogreffes osseuses peropératoires positifs sont bas et que les infections subséquentes sont rares. Dans les cas d’infections postopératoires, les cultures des allogreffes primaires et les cultures tissulaires secondaires ont révélé la présence d’organismes pathogènes différents. Les coûts associés à la réalisation des cultures sont élevés. Éliminer les cultures initiales permettrait à notre région de santé d’économiser 42 500 $ par année.
The use of allograft bone has become increasingly common in orthopedic surgery, specifically in spinal fusion, revision arthroplasty and tumor reconstruction. Policies differ from country to country with respect to how allograft bone is processed and tested from the time of harvest to the time of implantation. In some centres the standard is to obtain a sample of the allograft bone intraoperatively for culture just before implantation as a quality control measure. The average positive intraoperative allograft bone culture rate reported in the literature ranges from 1.4% to 12%. Although some studies comment that cases of positive culture taken at the time of implantation went on to develop wound infections, most studies suggest that these positive cultures do not correlate with postoperative infections and that the organisms isolated in the postoperative infection are only rarely the same as those isolated in the intraoperative allograft culture. It is difficult to apply these results to all populations, as national policies for handling allograft bone differ.

Furthermore, there is no clear evidence to guide surgeons in dealing with positive results. Importantly, a positive culture from the graft obtained at the time of implantation often represents a contaminant and does not necessarily represent a graft infection. Some centres have instituted a protocol that treats all patients with a positive intraoperative culture with empiric antibiotics. One study found no significant postoperative infections related to positive intraoperative bone allograft cultures when patients with positive cultures were treated with 500 mg of Cefadroxil twice daily for 3 weeks; however, the authors stated there was little evidence for this protocol, and it was not compared with other regimens. Most centres do not have a treatment protocol for patients with positive allograft cultures, and practices range from providing no empiric antibiotic treatment in patients with positive intraoperative allograft cultures to providing empiric intravenous antibiotic therapy.

There is a paucity of evidence supporting the practice of obtaining intraoperative allograft culture before implantation and little consensus on how to treat patients with positive results. Few studies have examined whether organisms cultured from the initial allograft at transplantation correlate with those isolated in cases of subsequent postoperative infection. The impact of positive intraoperative allograft cultures is largely unknown and may not alter management. Results of intraoperative allograft cultures typically take days to be reported, often after the patient has been discharged home. In our centre, quality control is guided by The National Standard of Canada CAN/CSA: Tissues for Transplantation guidelines. The rate of positive intraoperative allograft bone culture has not been reported at our centre. Further, there is an added cost to the health care system to perform intraoperative allograft cultures. To our knowledge no cost assessment has been performed. If there is no association between positive intraoperative allograft culture and postoperative infection, potential health care dollars may be saved.

We sought to answer the following through this study: What is the prevalence of positive intraoperative allograft bone culture and subsequent postoperative infection at our centre? In cases of subsequent postoperative infection, are organisms isolated at reoperation the same as those cultured from the original allograft? What are the costs associated with performing intraoperative allograft cultures compared with the costs of treating subsequent postoperative infections?

**Methods**

**Study design**

Following approval from the ethics board, we carried out a retrospective review of patients receiving allograft bone at our centre between Jan. 1, 2009, and Dec. 31, 2012. Our regional transplant program database was used to identify all patients receiving allograft bone (structural or cancellous) in our health region during the study period. This yielded a sample size of 996 patients. Patients with positive intraoperative allograft bone cultures at the time of transplantation were identified and included for further analysis. These charts were obtained from health records and reviewed retrospectively for the first postoperative year. Patients with negative intraoperative allograft cultures were not reviewed. Patients with pre-existing infection before receiving allograft bone were excluded. No other exclusion criteria were used.

Patients with significant postoperative infection in the first postoperative year were identified. Significant infection was defined as requiring reoperation for infection or requiring a course of intravenous antibiotics for infection related to the original surgery. Patients with superficial wound erythema who did not require reoperation and patients receiving an outpatient course of oral antibiotics were not considered to have a significant postoperative infection, as these are unreliable indicators of infection and do not represent costly interventions or substantial patient harm. Treatment practices for positive intraoperative allograft cultures with antibiotics were recorded, as this is not standard at our centre and could influence the development of a postoperative infection. No differentiation between deep surgical site infection and graft infection were made, as these typically occur together.

We calculated the overall rate of intraoperative culture-positive allograft bone at the time of transplantation at our centre and compared it with reports from other centres. In cases of postoperative infection where new cultures were taken at the time of reoperation, we compared the results with the organisms found in the allograft culture obtained at the time of implantation. Finally, we assessed the costs...
associated with performing intraoperative allograft bone cultures, prescribing empiric antibiotic treatment for positive results and the treatment of postoperative infection.

**Bone bank protocol**

In our centre, the majority of bone allograft comes from the femoral heads of living donors receiving total hip arthroplasty and from deceased bone donors. The National Standard of Canada CAN/CSA: Tissues for Transplantation guides the retrieval process, processing and implantation process at our centre. Donors are screened for transmissible diseases, including hepatitis B and C, HIV and syphilis. Bone is retrieved in a sterile fashion and wrapped in sterile drapes. Two morsels of bone tissue from 2 separate locations of each graft are cultured at the time of retrieval by the operating room staff using new sterile instruments. Samples are not swabbed for culture, as this has been shown to be an ineffective means of identifying contamination. If these initial cultures are positive, the bone is discarded and is not used for transplantation. No further processing, antibiotic treatment, or irradiation takes place after retrieval. Bone is then stored in sterile containers at $-80^\circ$C and is kept for up to 5 years. If the bone is reprocessed for any reason, new cultures are taken, as this represents a potential source of contamination. Reprocessing is exceedingly uncommon at our centre, therefore this is rarely performed. The National Standard of Canada CAN/CSA: Tissues for Transplantation states that bone banks must either have a bioburden reduction protocol or obtain allograft samples for culture at the time of transplantation. As our centre does not have a bioburden reduction protocol, new allograft cultures are taken intraoperatively at the time of transplantation, just before its use. This is performed by the operating room staff in a sterile fashion with separate instruments before the graft comes into contact with the recipient. At all stages, cultures are performed for both aerobic and anaerobic organisms and for both rapid and slow-growing organisms. Allograft is thawed in the operating room at room temperature or in warmed sterile saline. No irrigation or antibiotic is added at this time. The result of this second culture taken just before transplantation is the point of interest for the present study.

**Results**

Between January 2009 and December 2012, 996 allograft bone grafts were used in our health region. Of these, 43 (4.3%) had a positive intraoperative culture and were included for analysis. Six patients were excluded based on predefined criteria — 5 because bone graft was used in the setting of a previous infection and 1 because both bone and tendon grafts were used with only the tendon graft having positive intraoperative cultures. This left 37 patients with allograft bone grafts for final analysis; 46% were men (Table 1). All patients received standard prophylactic antibiotics at the time of their index procedure. Empiric antibiotics based on a positive intraoperative allograft culture result were prescribed in 9 (24%) patients. Practices were heterogeneous among surgeons, with no treatment choice used more than once. From all allograft samples included in this analysis, 13 different organisms were isolated from intraoperative cultures. Table 2 illustrates cultured organisms and their respective incidences. *Staphylococcus epidermidis* was most commonly isolated (22%). In total 46% of positive cultures occurred in spine cases; 29% in revision arthroplasty cases; and 24% in other cases, such as trauma.

Two of the 37 (5.4%) patients in our study experienced a significant postoperative infection, both requiring reoperation. In each case, cultured organisms isolated at the time of reoperation and blood cultures differed from the original allograft culture. In the 2 cases of significant postoperative infection, the first patient received allograft bone for a lumbar spine fusion, which grew *Corynebacterium diphtheriae* at initial intraoperative culture. Cultures taken at the time of irrigation and débridement were positive for *S. epidermidis* and *Staphylococcus warneri*. The second patient received allograft bone for a posterior spinal fusion, which grew *Bacillus* at initial intraoperative culture. Subsequent cultures taken at the time of irrigation and débridement were positive for *S. epidermidis*. Neither patient received specific empiric antibiotic therapy; however, the second patient was on intravenous antibiotics (piperacillin/tazobactam, which has broad coverage) during the entire postoperative period for a separate infection (pneumonia) that developed postoperatively. Aside from these 2 patients, an additional 4 patients with positive intraoperative allograft cultures underwent reoperation for other reasons (revision procedures, hardware removal). None of these patients demonstrated clinical signs of infection at the time of reoperation.

The cost of performing an intraoperative culture at our centre is $170. The cost of performing 996 allograft bone cultures was therefore $169 320. Antibiotic choice affects the costs associated with empiric use in cases of positive intraoperative allograft cultures. Table 3 illustrates the cost per day associated with commonly prescribed antibiotics. In this series, treatment of positive allograft cultures varied from no antibiotics to short courses of oral antibiotics to longer courses of intravenous antibiotics (Table 1). The total cost for empiric antibiotics used in this study period was approximately $3500. Irrigation and débridement costs vary from anywhere from $1755 to $2646, depending on the area of the body. This includes the cost of the surgeon, nurses and anesthesiologist. Patients requiring irrigation and débridement typically receive a course of 6 weeks of intravenous antibiotics following surgery, which costs anywhere from $1602 to $3716, depending on the choice of antibiotic. On average, our centre uses 250 bone allografts per year. The
The annual cost of performing allograft cultures is therefore $42,500. The annual cost to our health care system associated with these cultures is greater when the use of empiric antibiotics is taken into account.

**Discussion**

This series demonstrates that the incidence of positive intraoperative allograft bone cultures is low and that subsequent postoperative infections are rare. Further, when postoperative infections occur, organisms isolated at reoperation differ from those isolated in the initial allograft culture. In a recent project, NOTIFY, bacterial transmission caused by a bone allograft was defined as having the same organism cultured from both the graft and the recipient. The rate of positive intraoperative bone allograft culture in our series was 4.3%, consistent with rates reported in other centres. Furthermore, subsequent postoperative infection following a positive intraoperative positive allograft culture was rare, occurring in 2 of

<table>
<thead>
<tr>
<th>Table 1. Patient characteristics</th>
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<td>42</td>
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CONS = coagulase-negative Staphylococcus aureus.
37 (5%) patients in our series. Importantly, during our 4-year study period, no postoperative infection could be linked to a positive allograft bone culture. Practices for dealing with positive cultures in our centre are inconsistent and are not based on conclusive evidence. Performing initial intraoperative cultures is costly, and in the majority of cases positive findings did not change clinical management, with 73% of patients receiving no empiric antibiotic. The cost of prophylaxis varies with antibiotic choice and health region, ranging from $1.92 per day to $88.49 per day. Postoperative infection does not appear to be linked to initial intraoperative allograft bone culture, and thus performing these cultures is unlikely to prevent cases of postoperative infection. Considering that organisms differed in cases of postoperative infection, outcomes of our cost assessment are not in favour of performing intraoperative allograft cultures. To our knowledge, no previous study has examined the costs associated with performing intraoperative allograft cultures. In Canada, several centres no longer perform intraoperative allograft cultures on a routine basis, although cultures may be requested by the treating physician. Instead, a bioburden reduction protocol must be in place. It is unclear if this is requested by the treating physician. Avoidance of infection is of the utmost importance. Postoperative infections in these cases are devastating complications and can be difficult to manage. Avoidance of infection is of the utmost importance.

Similar studies have focused on allograft bone used specifically in spine procedures. In a retrospective review by Barriga and colleagues, 22 of 189 bone allografts had positive intraoperative cultures, none of which went on to develop significant postoperative infections. Patients with positive intraoperative allograft cultures in that series were treated prophylactically with cefadroxile for 3 weeks, regardless of the organism cultured. The authors stated that this prophylactic regimen was not based on evidence, and they concluded that positive intraoperative allograft bone cultures were likely due to contamination either in the operating room or at the time of harvest, initially undetected. They recommend continuing the practice of obtaining intraoperative allograft bone cultures to identify patients suitable for antibiotics, but suggest that no other treatment is required to prevent infection.

In the retrospective study by Couture and Cabana of patients receiving bone graft for spine procedures, rates of infection between autograft and irradiated allograft bone were compared. They found no statistical difference in rates of positive intraoperative culture. They concluded that there was no evidence to suggest that a positive intraoperative allograft culture reliably predicts postoperative infection and called into question the cost benefit of this procedure. They did not correlate organisms cultured at reoperation with those obtained at the initial allograft culture and suggested that further research examining the utility of intraoperative allograft bone culture with larger sample sizes and adequate control groups is warranted.

There is limited literature assessing the utility of intraoperative allograft bone culture and treatment of a positive culture result. Previous studies are small, single-centre reviews, most of which concluded that cases of postoperative infection could not be clearly linked with positive intraoperative allograft bone cultures at initial surgery. In a retrospective study by Van de Pol and colleagues, 48 of 426 patients receiving allograft bone were found to have positive intraoperative cultures. Three of these patients went on to experience significant postoperative infections; however, only 1 patient was found to have the same organism isolated from the original allograft culture. The authors concluded that positive intraoperative allograft cultures represented contamination that was unlikely to cause subsequent postoperative infection and that intraoperative allograft bone culture were unnecessary.

### Table 2. Intraoperative allograft bone cultures

<table>
<thead>
<tr>
<th>Organism</th>
<th>Incidence, %</th>
</tr>
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<tr>
<td>Staphylococcus epidermidis</td>
<td>21</td>
</tr>
<tr>
<td>Coagulase-negative Staphylococcus species</td>
<td>21</td>
</tr>
<tr>
<td>Staphylococcus warneri</td>
<td>8</td>
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<tr>
<td>Staphylococcus capitis</td>
<td>8</td>
</tr>
<tr>
<td>Corynebacterium</td>
<td>11</td>
</tr>
<tr>
<td>Bacillus</td>
<td>16</td>
</tr>
<tr>
<td>Other</td>
<td>16</td>
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</table>

### Table 3. Daily antibiotic costs (Canadian)

<table>
<thead>
<tr>
<th>Medication</th>
<th>Cost/d, $</th>
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<tbody>
<tr>
<td>Cephalaxin</td>
<td>1.92</td>
</tr>
<tr>
<td>Cefazolin</td>
<td>38.16</td>
</tr>
<tr>
<td>Ceftriaxone</td>
<td>37.50</td>
</tr>
<tr>
<td>Piperacillin/tazobactam</td>
<td>64.44</td>
</tr>
<tr>
<td>Clindamycin</td>
<td>2.66</td>
</tr>
<tr>
<td>Trimethoprim/sulfamethoxazole</td>
<td>0.24</td>
</tr>
<tr>
<td>Vancomycin</td>
<td>88.49</td>
</tr>
</tbody>
</table>
Our results mirror these findings, with only 2 patients experiencing significant postoperative infections following positive allograft bone culture. Further supporting the conclusions of Van de Pol and colleagues, many of the organisms isolated from allograft cultures are known skin contaminants.

Limitations

This study has a number of limitations. First, the cases of patients with negative allograft cultures were not reviewed, and thus no statistical analysis was possible owing to a lack of a control group. Our aim in this series was to associate organisms found in postoperative infections to those of the intraoperative allograft culture taken at the time of implantation, not to compare infection rates in those with positive allograft cultures compared with those with negative cultures. Second, we could not control for heterogeneous practices in dealing with positive allograft cultures owing to the retrospective nature of this study. Although this practice may be costly, it did not result in differences in outcomes for patients in this series. Finally, postoperative infection following positive allograft cultures was a rare occurrence, observed in only 2 patients in this series. It may be difficult to draw conclusions from this small number; however, the fact that this occurrence was small shows that postoperative infections following positive allograft cultures are rare.

Conclusion

We found rates of positive intraoperative allograft bone cultures in our centre to be low and subsequent postoperative infections rare, calling the utility of intraoperative allograft cultures into question. In the vast majority of cases with positive allograft cultures, management was not changed. Patients receiving unnecessary antibiotics for positive allograft cultures represent an area of potential patient harm and unnecessary health care spending. In our entire study period, no case of postoperative infection could be clearly linked to a positive allograft culture. Obtaining these cultures is costly; we estimated yearly savings of $42 500 in our health region alone if cultures were eliminated. Other centres that have eliminated intraoperative allograft cultures instead perform alternative protocols for allograft treatment. Our series suggests that even in the absence of these various protocols, allograft cultures do not predict cases of postoperative infection. Further investigation of potential savings on a national level, taking into account various methods of allograft handling, would provide valuable additional information. Continued research in the form of a prospective multicentre trial would help to clarify which measures, if any, reduce postoperative infections as well as the potential impact of these cost savings.

Affiliations: From the Division of Orthopaedics, Department of Surgery, University of Saskatchewan, Saskatoon, Sask.

Competing interests: None declared.

Contributors: L. Sims and A. Woo designed the study. L. Sims acquired and analyzed the data, which P. Kulyk also analyzed. L. Sims and P. Kulyk wrote the article, which all authors reviewed and approved for publication.

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The burden of second hip fractures: provincial surgical hospitalizations over 15 years

Background: Second hip fractures account for up to 15% of all hip fractures. We sought to determine if the proportion of hip fracture surgeries for second hip fracture changed over time in terms of patient and fracture characteristics.

Methods: We reviewed the records of patients older than 60 years hospitalized for hip fracture surgery between 1990 and 2005 in British Columbia. We studied the proportion of surgeries for second hip fracture among all hip fracture surgeries. Linear regression tested for trends across fiscal years for women and men.

Results: We obtained 46,341 patient records. Second hip fracture accounted for 8.3% of hip fracture surgeries. For women the proportion of second hip fracture surgeries increased linearly from 4% to 13% with each age decade ($p = 0.001$) and across fiscal years ($p = 0.002$). In men the proportion of second hip fracture surgeries was 5% for each age decade between the ages of 60 and 90 years across fiscal years, increasing to 8% for men older than 90 years across fiscal years ($p = 0.20$). These sex-specific trends were similar for both pertrochanteric and transcervical fracture types.

Conclusion: Second hip fracture surgeries account for an increasing proportion of hip fracture surgeries and may require more health care resources to minimize poorer reported outcomes. Future research should determine whether more health care resources are required to manage these patients and optimize their outcomes.

Contexte : Les secondes fractures de la hanche représentent jusqu’à 15 % de la totalité des fractures de la hanche. Nous avons tenté de déterminer si la proportion de chirurgies de seconde fracture de la hanche avait évolué au fil du temps sur le plan des caractéristiques des patients et des fractures.

Méthodes : Nous avons examiné les dossiers des patients de 60 ans et plus qui avaient été hospitalisés pour une chirurgie de fracture de la hanche entre 1990 et 2005, en Colombie-Britannique. De ce total, nous avons ensuite déterminé le nombre de chirurgies de seconde fracture de la hanche. L’analyse de régression linéaire a déterminé les tendances au cours des années financières pour les femmes et les hommes.

Résultats : Nous avons obtenu 46 341 dossiers de patient. Les secondes fractures de la hanche représentaient 8,3 % de la totalité des chirurgies de fracture de la hanche. Chez les femmes, la proportion de seconde fracture de la hanche augmentait de façon linéaire de 4 % à 13 % pour chaque tranche d’âge de 10 ans ($p = 0,001$) et sur l’ensemble des années financières ($p = 0,002$). Chez les hommes, la proportion de chirurgies de seconde fracture de la hanche était de 5 % pour chaque tranche d’âge de 10 ans entre 60 et 90 ans et sur l’ensemble des années financières, et augmentait à 8 % pour les hommes de plus de 90 ans sur l’ensemble des années financières ($p = 0,20$). Ces tendances selon le sexe étaient similaires tant pour les fractures pertrochantériennes que pour les fractures transcervicales.

Conclusion : Les chirurgies de seconde fracture de la hanche représentent une proportion croissante de la totalité des chirurgies de fracture de la hanche et pourraient nécessiter davantage de ressources en soins de santé pour minimiser les résultats moins bons signalés. Les recherches futures devraient déterminer s’il faut davantage de ressources de soins de santé pour la prise en charge de ces patients et l’optimisation de leurs résultats.
In 2014 the incidence of hip fracture was 521 per 100 000 in Canada. This translated to approximately 22 000 admissions to acute care, of which 90% of patients underwent surgery. Each hip fracture carries an estimated direct health care cost of $27 000 (Canadian). In fact, hip fractures are estimated to account for 72% of the total cost of fractures. Resource allocation for hip fracture surgeries are often based on analyses for first hip fractures alone by excluding patients who presented with a history of prior fracture. However, previous reports indicate that second hip fractures account for up to 15% of all hip fractures. These second hip fractures are associated with poorer postoperative outcomes, including complications, transitions to long-term care and mortality.

Omsland and colleagues reported that the number of patients surviving first hip fracture surgery increased over 10 years. The risk of second hip fracture persists for at least 10 years after the first hip fracture. Therefore, increased survival after a first hip fracture should lead to an increase in second hip fractures. Yet, it is unknown whether the proportion of patients undergoing hip fracture surgery for second hip fracture changed over time. It is also unknown whether patient and fracture characteristics changed over time. The primary objective of this study was to determine if the proportion of surgeries for second hip fracture changed over 15 years of follow-up in British Columbia, Canada. We also sought to estimate the proportion of second hip fracture over 15 years of follow-up by characteristics of patients and their fractures.

Methods

Data sources

We retrieved all records of hospitalizations for hip fracture surgery from Apr. 1, 1985, to Mar. 31, 2005, in British Columbia. The data for this study were obtained from the Hospital Separations Database from the Ministry of Health Services of BC, a portion of the Canadian Institute for Health Information Discharge Abstract Database. This database is a linkable, patient-oriented database that captures administrative information on patient demographics, health care and health services for all British Columbia residents. Each hospitalization record has an admission date, separation date, most responsible diagnosis, primary diagnosis, postadmission comorbidity diagnosis, level of care, and patient sex and date of birth. Diagnoses were coded according to the International Classification of Diseases (ICD), 9th Revision (ICD-9), and surgical treatments were coded according to the Canadian Classification of Diagnostic, Therapeutic, and Surgical Procedures. Although the province of British Columbia began using the ICD 10th revision (ICD-10) in 2001–2002, the data were converted back to ICD-9 for uniformity. The University of British Columbia ethics board approved our study.

Inclusion/exclusion criteria

A total of 74 940 records of hospitalization for hip fracture surgery during the study period were retrieved. We excluded 2298 records of potentially pathological hip fractures by identifying patients with at least 1 hospitalization record that was cancer-related (most responsible diagnosis ICD-9 code 140–239, or diagnosis type 162, 174, 185, 189, 203, 196–198). A further 5708 records that were complication-related (most responsible diagnosis 996–999), orthopedic aftercare–related (most responsible diagnosis V57, V58, V63-V68, V71) or that had levels of care other than acute (level of care code D, E, I, L, R, or S) were also excluded.

Construction of care episodes

A hip fracture care episode was defined as the surgical management of a hip fracture from admission to discharge from hospital. Multiple records of hip fracture with readmission within 1 day were considered hospital transfers.

Table 1. Characteristics of 46 341 episodes of hip fracture in British Columbia, Canada, 1990–2004

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>First (n = 42 475)</th>
<th>Second (n = 3866)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>30 588 (72.0)</td>
<td>3119 (80.7)</td>
</tr>
<tr>
<td>Men</td>
<td>11 262 (26.5)</td>
<td>693 (17.9)</td>
</tr>
<tr>
<td>Unknown</td>
<td>625 (1.5)</td>
<td>54 (1.4)</td>
</tr>
<tr>
<td><strong>Age, yr</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>60–69</td>
<td>4069 (9.6)</td>
<td>197 (5.1)</td>
</tr>
<tr>
<td>70–79</td>
<td>12 105 (28.5)</td>
<td>813 (21.0)</td>
</tr>
<tr>
<td>80–89</td>
<td>19 476 (45.9)</td>
<td>1938 (50.1)</td>
</tr>
<tr>
<td>≥ 90</td>
<td>6825 (16.1)</td>
<td>918 (23.7)</td>
</tr>
<tr>
<td><strong>Fracture subtype</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pertrochanteric</td>
<td>19 907 (46.9)</td>
<td>2013 (52.1)</td>
</tr>
<tr>
<td>Transcervical</td>
<td>22 486 (52.9)</td>
<td>1853 (47.9)</td>
</tr>
<tr>
<td>Unknown</td>
<td>82 (0.2)</td>
<td>0 (0)</td>
</tr>
<tr>
<td><strong>Fiscal period of discharge</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1990–1995</td>
<td>15 626 (36.8)</td>
<td>1293 (33.4)</td>
</tr>
<tr>
<td>1996–1999</td>
<td>11 580 (27.3)</td>
<td>1083 (28.0)</td>
</tr>
<tr>
<td>2000–2004</td>
<td>15 269 (35.9)</td>
<td>1490 (38.5)</td>
</tr>
<tr>
<td><strong>Hospital length of stay, wk</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 1</td>
<td>8707 (20.5)</td>
<td>576 (14.9)</td>
</tr>
<tr>
<td>1–2</td>
<td>13 199 (31.1)</td>
<td>1293 (33.4)</td>
</tr>
<tr>
<td>≥ 2</td>
<td>20 569 (48.4)</td>
<td>1997 (51.7)</td>
</tr>
</tbody>
</table>

*Data were obtained from the Hospital Separations Database from the Ministry of Health Services of BC, a portion of the Canadian Institute for Health Information Discharge Abstract Database.

†Fiscal year is from April to March.
and treated as a single episode. Of the 66,934 records of hospitalization, 59,523 care episodes were constructed. Of these, 1371 care episodes were excluded: 761 that occurred within 90 days and were related to the preceding care episode, 399 with a length of stay of 3 days or less, 140 with patients younger than 60 years as a condition of our data request, and 71 related to a third or later hip fracture.

Care episodes related to first and second hip fractures were identified for each patient using the unique provincial health numbers. To reduce the possibility of classifying a second hip fracture as a first hip fracture, we adopted a “wash-out” and “look back” strategy. Hip fracture surgeries performed between Apr. 1, 1985, and Mar. 31, 1990, were excluded to prevent misclassification. For patients presenting with hip fracture from Apr. 1, 1990, onwards, records from Apr. 1, 1985, were reviewed for previous hip fracture admissions. These 2 rules led to the exclusion of 11,877 hip fracture cases. The final cohort comprised 46,341 patients aged 60 years or older with hip fracture care episodes between Apr. 1, 1990, and Mar. 31, 2005. We then designated the earliest hip fracture care episode as the first hip fracture and the next hip fracture care episode as the second hip fracture.

### Statistical analysis

We compared characteristics of first and second hip fracture surgeries, including the patient’s sex, age at hip fracture, and subtype of hip fracture. Two subtypes of hip fracture were defined by diagnosis: transcervical fractures (ICD-9 codes 820.0, 820.1, 820.8 and 820.9) and pertrochanteric fractures (ICD-9 codes 820.2 and 820.3). Hip fractures of unspecified type (ICD-9 codes 820.8 and 820.9) were classified as transcervical fractures to account for the change in coding from ICD-9 to ICD-10 in 2001.

We studied the proportions of second hip fracture surgeries among all hip fracture surgeries. These proportions were estimated by sex, across age groups, by fracture type, and across fiscal years. The proportion of pertrochanteric subtype among second hip fractures was higher than among first hip fractures, indicating a significant difference in the care provided to patients with second hip fractures.

### Table 2. Number (and proportion) of second hip fractures by age and hip fracture subtype for women*

<table>
<thead>
<tr>
<th>Fiscal year*</th>
<th>60–69</th>
<th>70–79</th>
<th>80–89</th>
<th>≥ 90</th>
<th>All age groups</th>
<th>60–69</th>
<th>70–79</th>
<th>80–89</th>
<th>≥ 90</th>
<th>All age groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>4/208</td>
<td>(1.9)</td>
<td>13/581</td>
<td>(2.2)</td>
<td>37/748</td>
<td>(4.9)</td>
<td>24/295</td>
<td>(8.1)</td>
<td>78/1832</td>
<td>(4.3)</td>
</tr>
<tr>
<td>1991</td>
<td>3/189</td>
<td>(1.6)</td>
<td>17/596</td>
<td>(2.9)</td>
<td>33/828</td>
<td>(4.0)</td>
<td>22/318</td>
<td>(6.9)</td>
<td>75/1929</td>
<td>(3.9)</td>
</tr>
<tr>
<td>1992</td>
<td>4/198</td>
<td>(2.0)</td>
<td>17/620</td>
<td>(2.7)</td>
<td>32/907</td>
<td>(3.5)</td>
<td>28/328</td>
<td>(8.5)</td>
<td>81/2053</td>
<td>(3.9)</td>
</tr>
<tr>
<td>1993</td>
<td>4/174</td>
<td>(2.3)</td>
<td>25/631</td>
<td>(4.0)</td>
<td>44/948</td>
<td>(4.6)</td>
<td>22/359</td>
<td>(6.1)</td>
<td>95/2112</td>
<td>(4.5)</td>
</tr>
<tr>
<td>1994</td>
<td>4/172</td>
<td>(1.7)</td>
<td>24/636</td>
<td>(3.8)</td>
<td>61/1013</td>
<td>(6.0)</td>
<td>19/327</td>
<td>(5.6)</td>
<td>107/2148</td>
<td>(5.0)</td>
</tr>
<tr>
<td>1995</td>
<td>4/159</td>
<td>(2.5)</td>
<td>22/629</td>
<td>(3.5)</td>
<td>55/1023</td>
<td>(5.4)</td>
<td>31/376</td>
<td>(8.2)</td>
<td>112/2187</td>
<td>(6.1)</td>
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<td>1996</td>
<td>5/169</td>
<td>(3.0)</td>
<td>20/857</td>
<td>(3.0)</td>
<td>66/1089</td>
<td>(5.1)</td>
<td>24/956</td>
<td>(6.7)</td>
<td>105/2271</td>
<td>(4.6)</td>
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<td>(1.3)</td>
<td>22/612</td>
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<td>58/1112</td>
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<td>30/384</td>
<td>(7.8)</td>
<td>112/2267</td>
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<td>3/165</td>
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<td>15/589</td>
<td>(2.5)</td>
<td>74/1149</td>
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<td>27/481</td>
<td>(5.9)</td>
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<td>(5.0)</td>
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<td>(2.5)</td>
<td>14/601</td>
<td>(2.3)</td>
<td>68/1190</td>
<td>(5.7)</td>
<td>35/403</td>
<td>(8.7)</td>
<td>121/2356</td>
<td>(5.1)</td>
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<td>20/617</td>
<td>(3.2)</td>
<td>65/1149</td>
<td>(5.7)</td>
<td>40/423</td>
<td>(9.5)</td>
<td>128/2349</td>
<td>(5.4)</td>
</tr>
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<td>(2.4)</td>
<td>21/625</td>
<td>(3.4)</td>
<td>65/1284</td>
<td>(5.1)</td>
<td>28/441</td>
<td>(6.3)</td>
<td>118/2518</td>
<td>(4.7)</td>
</tr>
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<td>2002</td>
<td>2/131</td>
<td>(1.5)</td>
<td>14/551</td>
<td>(2.5)</td>
<td>50/1176</td>
<td>(4.3)</td>
<td>36/484</td>
<td>(7.4)</td>
<td>102/2342</td>
<td>(4.4)</td>
</tr>
<tr>
<td>2003</td>
<td>4/172</td>
<td>(2.3)</td>
<td>17/596</td>
<td>(2.9)</td>
<td>61/1213</td>
<td>(5.0)</td>
<td>48/540</td>
<td>(8.9)</td>
<td>130/2521</td>
<td>(5.2)</td>
</tr>
<tr>
<td>2004</td>
<td>3/185</td>
<td>(1.6)</td>
<td>20/564</td>
<td>(3.5)</td>
<td>51/1241</td>
<td>(4.1)</td>
<td>40/488</td>
<td>(8.5)</td>
<td>114/2458</td>
<td>(4.6)</td>
</tr>
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<td>(2.0)</td>
<td>281/9105</td>
<td>(3.1)</td>
<td>810/16068</td>
<td>(5.0)</td>
<td>454/5963</td>
<td>(7.6)</td>
<td>1597/33707</td>
<td>(4.7)</td>
</tr>
</tbody>
</table>

*Data were obtained from the Hospital Separations Database from the Ministry of Health Services of BC, a portion of the Canadian Institute for Health Information Discharge Abstract Database.

†Fiscal year is from April to March.
compared between sexes using the $\chi^2$ test. We used linear regression to test for linear trends across age decades and fiscal years for men and women.


**RESULTS**

Between Apr. 1, 1990, and Mar. 31, 2005, 46 341 hip fracture surgeries occurred among patients aged 60 years and older in British Columbia, Canada. One in 12 hip fracture surgeries was for a second hip fracture (8.3%, 95% confidence interval [CI] 8.1–8.6).

There were differences in the distributions of fracture type, age and sex between first and second hip fractures (Table 1). More patients had pertrochanteric fractures at the second than the first hip fracture surgery (52% v. 47%), more patients were older than 80 years at the second than the first hip fracture surgery (74% v. 62%), and a greater proportion of patients at the second than the first hip fracture surgery were women (81% v. 72%).

The proportion of surgeries for second hip fracture changed during the study period. This proportion was higher in women (9.3%, 95% CI 8.9–9.6) than men (5.8%, 95% CI 5.4–6.2). For women the proportion increased significantly ($p = 0.002$) from 7.4% ($n = 135$) in 1990 to 9.0% ($n = 220$) in 2004 (Table 2). For men the proportion did not increase significantly ($p = 0.20$) but varied from 3.7% ($n = 24$) in 1990 to 5.3% ($n = 47$) in 2004 (Table 2).

For women the proportion of second hip fracture surgeries increased linearly with each age decade from 4% to

![Graph showing proportion of second hip fractures by fiscal year and age among women and men.](image)

*Fig. 1. Proportion of second hip fractures by fiscal year and age at the time of fracture among women and men. Horizontal lines represent average annual proportion of second hip fractures for each age group. A significant linear trend for increasing proportion of second hip fractures by fiscal year and age was observed for women ($p = 0.002$) but not men ($p = 0.20$). Data were obtained from the Hospital Separations Database from the Ministry of Health Services of BC, a portion of the Canadian Institute for Health Information Discharge Abstract Database.*
13% \( (p = 0.001) \) and across fiscal years (Fig. 1). In men the proportion of second hip fracture surgeries was 5% for each age decade between the ages of 60 and 90 years across fiscal years, increasing to 8% for men older than 90 years across fiscal years \( (p = 0.20; \) Fig. 1). These sex-specific trends were similar for both pertrochanteric and transcervical fracture types (Table 2 and Table 3).

**Discussion**

One in 12 hip fracture surgeries performed during the study period was for a second hip fracture. This proportion increased over 15 years of follow-up in British Columbia, Canada. Older women accounted for the increasing proportion of second hip fracture surgeries over time.

We previously reported that among survivors of a first hip fracture the risk of second hip fracture persists for at least 10 years.\(^{23}\) Here we demonstrate that this risk led to an increase in the proportion of second hip fracture surgeries over time. In keeping with earlier literature we found that second hip fractures account for 8.3% of all hip fracture surgeries.\(^{28−31}\) We also found that patients presenting with a second hip fracture are more likely to be older, more likely to be women, and more likely to have pertrochanteric fractures than patients presenting with a first hip fracture.\(^{28−31}\) There was an increase in the proportion of hip fracture patients undergoing surgery for a second hip fracture over time. The proportion of women undergoing surgery for second hip fracture grew from 8% to 10% over the 15 fiscal years, whereas the proportion of men remained stable at 6%. Considering aging in combination with higher mortality for men following hip fracture, there may have been fewer men than women susceptible to a second hip fracture.\(^{12,23}\)

**Table 3. Number (and proportion) of second hip fractures by age and hip fracture subtype for men**

<table>
<thead>
<tr>
<th>Fiscal year†</th>
<th>Pertrochanteric, age, yr</th>
<th>All age groups</th>
<th>Transcervical, age, yr</th>
<th>All age groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>2/115 (1.7)</td>
<td>3/228 (1.3)</td>
<td>6/240 (2.5)</td>
<td>11/666 (1.7)</td>
</tr>
<tr>
<td>1991</td>
<td>2/105 (1.9)</td>
<td>2/201 (1.0)</td>
<td>9/236 (3.8)</td>
<td>7/1619 (2.7)</td>
</tr>
<tr>
<td>1992</td>
<td>3/113 (2.7)</td>
<td>5/230 (2.2)</td>
<td>9/278 (3.2)</td>
<td>20/705 (2.8)</td>
</tr>
<tr>
<td>1993</td>
<td>4/122 (3.3)</td>
<td>7/237 (3.0)</td>
<td>11/281 (3.9)</td>
<td>23/730 (3.2)</td>
</tr>
<tr>
<td>1994</td>
<td>6/110 (5.5)</td>
<td>13/228 (5.7)</td>
<td>7/328 (2.1)</td>
<td>30/745 (4.0)</td>
</tr>
<tr>
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<td>3/124 (2.4)</td>
<td>8/215 (3.7)</td>
<td>7/316 (2.2)</td>
<td>23/747 (3.1)</td>
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<tr>
<td>1996</td>
<td>0/119 (0.0)</td>
<td>112/379 (3.8)</td>
<td>13/344 (4.3)</td>
<td>28/835 (3.4)</td>
</tr>
<tr>
<td>1997</td>
<td>6/96 (6.3)</td>
<td>4/246 (1.6)</td>
<td>8/238 (2.4)</td>
<td>24/769 (3.1)</td>
</tr>
<tr>
<td>1998</td>
<td>5/111 (4.5)</td>
<td>6/269 (2.2)</td>
<td>8/379 (2.4)</td>
<td>8/101 (7.9)</td>
</tr>
<tr>
<td>1999</td>
<td>4/109 (3.7)</td>
<td>5/248 (2.0)</td>
<td>9/969 (2.4)</td>
<td>10/810 (7.9)</td>
</tr>
<tr>
<td>2000</td>
<td>4/96 (4.2)</td>
<td>7/259 (2.7)</td>
<td>16/384 (4.2)</td>
<td>17/2122 (7.4)</td>
</tr>
<tr>
<td>2001</td>
<td>4/114 (3.5)</td>
<td>14/266 (5.3)</td>
<td>12/265 (3.3)</td>
<td>12/3473 (3.9)</td>
</tr>
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<td>2002</td>
<td>3/102 (2.9)</td>
<td>8/263 (3.0)</td>
<td>14/404 (5.1)</td>
<td>1/1269 (0.9)</td>
</tr>
<tr>
<td>2003</td>
<td>4/137 (2.9)</td>
<td>4/293 (1.4)</td>
<td>16/387 (4.1)</td>
<td>9/1389 (6.5)</td>
</tr>
<tr>
<td>2004</td>
<td>4/113 (3.5)</td>
<td>7/258 (2.7)</td>
<td>9/965 (2.5)</td>
<td>7/1478 (4.8)</td>
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<td>All years</td>
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<td>104/3720 (2.8)</td>
<td>154/5014 (3.1)</td>
<td>376/11956 (3.1)</td>
</tr>
</tbody>
</table>

*Data were obtained from the Hospital Separations Database from the Ministry of Health Services of BC, a portion of the Canadian Institute for Health Information Discharge Abstract Database.

†Fiscal year is from April to March.
Poorer postsurgical outcomes are seen following second hip fracture than first hip fracture.15,28 Second hip fracture is associated with excess mortality above that anticipated for an increase in age.21 Excess mortality after hip fracture surgery is associated with factors inherent to the patient and complications of their injury and treatment.44,45 To prevent complications and death, patients with second hip fractures may require a more aggressive treatment approach and more health care resources than patients with a first hip fracture.16 For those who survive, patients with a second hip fracture are less likely to regain prefracture function and more likely to transition to long-term care than patients with a first hip fracture.20

We previously reported that the risk of a second hip fracture is similar for men and women who survive after a first hip fracture.23 However, more men than women die following first hip fracture.32 Here, we demonstrate that women account for a higher proportion of second hip fracture surgeries than men. Further, similar to Omsland and colleagues,13 we note these women were older, as from age 60–90 years the proportion of second hip fracture surgeries relative to all hip fracture surgeries increased linearly with each age decade.

We conducted a secondary analysis of hospitalization records with a limited number of variables for adjustment. Data on hip fractures sustained before 1985 were not available. To avoid misclassifying first fractures as second ones, we use a “wash-out” strategy by excluding cases performed from 1985 to 1990, expecting that this would account for most second fractures. A second hip fracture may have been misclassified as a first hip fracture; however, the probability of misclassifying a hip fracture decreases with time after known first hip fracture.13 Data on the type of surgery were not available. Arthroplasty is more commonly prescribed for patients with transcervical hip fractures.37 Arthroplasty influences the risk of death with greater blood loss, infections and anesthetic complications than internal fixation.18,19 However, there were fewer transcervical hip fractures among patients undergoing surgery for second hip fractures in our study. We demonstrate an increasing proportion of hip fracture surgeries for second hip fracture. Data on health care resource utilization were not available. Furthermore, the data did not provide any indication of osteoporosis therapy.

**Conclusion**

The results of our study indicate that second hip fractures accounted for 8.3% of all hip fracture surgeries in British Columbia between 1990 and 2005. Over 15 years this proportion increased linearly for women and remained stable in men. Future research should determine whether more health care resources are required to manage these patients and optimize their outcomes.

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**Competing interests:** As above for P. Guy and K. Sheehan. No other competing interests declared.

**Contributors:** P. Guy, B. Sobolev and K. Lefaivre designed the study, and collected and analyzed the data, which L. Kuramato and K. Sheehan also analyzed. K. Sheehan wrote the article, which all authors reviewed and approved for publication.

**References**


Publication outcomes for research presented at a Canadian surgical conference

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Background: The failure of investigators to publish research in peer-reviewed journals following acceptance at a national or international meeting can lead to significant publication biases in the literature. Our objective was to evaluate the abstract to manuscript conversion rate for abstracts presented at the Canadian Society for Vascular Surgery (CSVS) annual meeting and to evaluate the conversion rate for CSVS-awarded research grants.

Methods: We searched for authors of abstracts accepted at the CSVS Annual Meeting (2007–2013) and recipients of CSVS research awards (2005–2013) on Scopus and PubMed databases to identify related publications.

Results: We identified 84 publications from 188 research abstracts (45%) and 17 publications from 39 research grants (44%). The mean time to publication was 1.8 years and the mean impact factor was 2.7. Studies related to endovascular therapies demonstrated a trend toward a higher rate of publication relative to open surgical therapies (64 [56%] v. 37 [27%]). Additionally, we observed a similar trend in research grant topics related to endovascular therapies relative to open surgical therapies (9 [67%] v. 8 [38%]). Finally, CSVS research grant recipients who subsequently published had a significantly higher h-index at the time of receipt than those who had not published.

Conclusion: The CSVS annual meeting’s abstract to publication conversion rate is comparable to that of its Canadian peers as well as to other medical specialties; however, a substantial publication gap remains. We identified several potential areas that may help to improve the effectiveness of CSVS research grants.

Contexte : Le fait que des chercheurs ne publient pas leurs recherches dans des revues évaluées par les pairs après acceptation de leur résumé à un congrès national ou international peut entraîner des biais de publication importants dans la littérature scientifique. Notre but était d’évaluer le taux de conversion de résumé à manuscrit pour les résumés présentés au congrès annuel de la Société canadienne de chirurgie vasculaire (SCCV) ainsi que le taux de conversion dans le cas des subventions de recherche accordées par la SCCV.


Résultats : Nous avons relevé 84 publications à partir de 188 résumés de recherche (45 %) ainsi que 17 publications liées à 39 subventions de recherche (44 %). Le délai moyen de publication était de 1,8 année et le facteur d’impact moyen, de 2,7. Les études sur les thérapies endovasculaires avaient un taux de publication plus élevé comparativement à celles sur les traitements chirurgicaux ouverts (64 [56 %] c. 37 [27 %]). De plus, nous avons observé une tendance similaire lorsque le sujet des recherches subventionnées était lié aux thérapies endovasculaires comparativement aux traitements chirurgicaux ouverts (9 [67 %] c. 8 [38 %]). Enfin, les récipiendaires de subventions de recherche de la SCCV qui publiaient par la suite avaient un indice h beaucoup plus élevé au moment de recevoir la subvention que les chercheurs qui n’avaient pas publié.

Conclusion : Le taux de conversion de résumé à publication du congrès annuel de la SCCV est comparable à celui de ses pairs au Canada et à celui d’autres spécialités médicales. Il reste néanmoins une lacune importante au niveau de la publication. Nous avons cerné plusieurs aspects susceptibles d’améliorer l’efficacité des subventions de recherche de la SCCV.
One of the primary goals of investigative research is the dissemination of information.1 The first opportunity to achieve this is often at a national or international scientific meeting. Although these meetings serve to provide critical appraisal and often helpful critique of the presented work, they cannot achieve the same rigorous peer review that comes with publication in a peer-reviewed journal.2,3 There is a well-documented gap between acceptance of an abstract at a scientific meeting and its subsequent publication in a peer-reviewed journal.4–6 This failure to convert conference abstracts to peer-reviewed publications results in a publication bias that can in turn result in a duplication of effort and wasted resources.7,8

A wealth of studies documenting the rates of publication following abstract submission exists, and such studies have often been used as a marker of conference quality both within a particular specialty and across specialties.3,6,8–12 The most recent systematic review6 reports a weighted mean publication rate following a conference presentation of 44.5%; however, the publication rates for individual conferences can vary substantially (8%–81%). With respect to vascular surgery, the Vascular Society of Great Britain and Ireland Annual Meeting of 2001 and 2002 reported mean publication rates of 59.4%, whereas the Canadian Cardiovascular Congress has reported mean publication rates of 24.1%.10,11

The primary objective of the present study was to determine the rates of publication in an indexed, peer-reviewed journal following abstract acceptance for the Canadian Society of Vascular Surgery (CSVS) annual meetings from 2005 to 2013. Our secondary objective was to determine the publication rate following receipt of a CSVS research grant. Finally, we evaluated rates of publication in relation to the study subject matter, journal impact factor and senior author affiliation.

**Methods**

**Inclusion criteria**

All abstracts accepted for a podium presentation at the CSVS annual meetings between 2007 and 2013 were included in the primary analysis. Abstracts were identified from abstract books and published conference proceedings. We recorded the author names and affiliations, publication dates and abstract titles.

As part of the secondary objective, we recorded the names of CSVS research grant recipients and their corresponding project titles. The CSVS research grants included the Cook Research Award for Endovascular Therapy, the Gore Research Award, the John L. Provan Education Award and the National Student Research Awards. This information was provided by the CSVS for the years 2005–2013. As a comparison group, we also collected information for grants administered by 2 similar societies: the Canadian Association of General Surgeons (CAGS) Research Fund Grants (2005–2013) and the Society of Vascular Surgery (SVS) Seed Grants (2012–2013). These data were published on their respective society websites.13,14

**Publication search strategy**

To determine if the abstract or research grant resulted in a subsequent publication, we conducted a detailed literature search using the Scopus, MEDLINE, and PubMed databases for the period between January 2002 and June 2016. We successively searched authors beginning with the first and last author within the Scopus database to identify a publication related to the abstract. If the search of the Scopus database was unsuccessful, we searched the MEDLINE and PubMed databases using author names and appropriate keywords. If a publication was identified, we recorded the date of publication, journal of publication, topic category and senior author h-index. We obtained the journal impact factor from the Thomson Reuters Journal Citation Reports.

**Statistical analysis**

As appropriate, we used a Student t test or 1-way analysis of variance (ANOVA) to compare continuous variables and the χ² test to compare categorical variables. All p values were 2-sided, and we considered results to be significant at p < 0.05.

**Results**

**Publication rates of podium presentations**

Between 2007 and 2013, 184 abstracts were accepted for a podium presentation. The mean number of podium presentations per year was 26. The geographic distribution of institutional affiliations of the authors of accepted abstracts is outlined in Table 1, with the majority of abstracts coming from Ontario (59%), Quebec (16%) and British Columbia (17%). Only 9 of the 184 abstracts (5%) were submitted by authors from nonacademic centres, as defined by an affiliation with a University with an accredited vascular training program.

<table>
<thead>
<tr>
<th>Provincial affiliation</th>
<th>No. of abstracts</th>
<th>No. (%) of publications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ontario</td>
<td>109</td>
<td>44 (40)</td>
</tr>
<tr>
<td>Quebec</td>
<td>31</td>
<td>17 (55)</td>
</tr>
<tr>
<td>British Columbia</td>
<td>18</td>
<td>8 (44)</td>
</tr>
<tr>
<td>Saskatchewan</td>
<td>7</td>
<td>2 (28)</td>
</tr>
<tr>
<td>Alberta</td>
<td>4</td>
<td>2 (50)</td>
</tr>
<tr>
<td>Manitoba</td>
<td>3</td>
<td>1 (33)</td>
</tr>
<tr>
<td>Nova Scotia</td>
<td>1</td>
<td>0 (0)</td>
</tr>
<tr>
<td>International</td>
<td>15</td>
<td>10 (67)</td>
</tr>
</tbody>
</table>

Table 1. Number of accepted abstracts and corresponding publications by provincial affiliation
The pooled rate for abstract conversion to a peer-reviewed publication was 45% (Fig. 1A). The highest publication rate was in 2012 (61%), and the lowest publication rate was in 2009 (37%); however, there was no significant difference in publication rates across the years evaluated. There was no significant difference in publication rates across provinces (Table 1); however, there was a trend toward increased rates of publication of abstracts from internationally affiliated authors (67%) compared with Canadian authors (43%). Additionally, abstracts receiving the Josephus C. Luke Award for best abstract presented at the annual meeting were more likely to result in conversion to a peer-reviewed publication (6 [66%]).

The mean time to publication following presentation at the annual meeting was 1.8 ± 0.13 years (Fig. 1B). Two manuscripts were published prior to presentation at the CSVS annual meeting. Based on these data, the study cut-off time of 3 years would capture 89% of publications in the final year of the study. Abstracts were published in 31 different journals with a mean impact factor of 2.7 (Table 2). Most were published in the Journal of Vascular Surgery (25 [30%]), followed by the Canadian Journal of Surgery (10 [12%]), Vascular and Endovascular Surgery (7 [8.3%]) and the European Journal of Vascular and Endovascular Surgery (6 [7.1%]). We sorted the presented abstracts into 7 broad categories: endovascular aortic therapies, open aortic surgery, peripheral vascular disease, venous disease and vascular access, carotid disease, education and patient safety. There was a trend toward higher rates of publication of studies evaluating endovascular aortic therapies versus open aortic therapies (56% v. 27%; Fig. 2).

**Publication rates of CSVS research grants**

Between 2005 and 2013, 39 grants were awarded, resulting in a pooled publication rate of 44% (Fig. 3). The Cook Endovascular Research Award had the highest publication rate (67%), and the National Student Research Award had the lowest publication rate (36%). The primary target journals for publication of research receiving a CSVS grant are listed in Table 3. The majority of grant recipients were affiliated with Ontario institutions (64%), but there was no significant difference in publication rate among Canadian provinces.

The CSVS research grants were associated with lower publication rates overall than the CAGS Research Fund Grants (24 [83%]) and the SVS Seed Grants (6 [66%]); however, the difference was not statistically significant. Additionally, grant recipients who subsequently published in a peer-reviewed journal had a significantly higher h-index at the time of grant receipt (Fig. 4B).

**DISCUSSION**

Publication in a scientific journal after abstract presentation at a scientific meeting is an important step in the widespread dissemination of research findings. We found that 44% (n = 187) of abstracts accepted for podium presentation at CSVS annual meetings were subsequently published in journals with a mean impact factor of 2.7. Abstracts that received the Josephus C. Luke award for best clinical or basic research abstract had a relatively higher publication rate (6 [66%]). Finally, the overall publication rate following receipt of a CSVS research award was 44% (n = 39).

As mentioned previously, rates of publication following acceptance of an abstract at a scientific meeting can vary substantially both within and among specialties. The only other report of a national vascular meeting was Bhasin and Scott’s report on the publication rates of the Vascular Society of Great Britain and Ireland Annual meetings.

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**Fig. 1.** (A) Number of abstracts accepted for oral presentation at the Canadian Society for Vascular Surgery (CSVs) annual meetings per year relative to the number of abstracts resulting in publication. (B) Cumulative percentage of published abstracts over time.
Table 2. Target journal for abstract publication

<table>
<thead>
<tr>
<th>Journal</th>
<th>No. of publications</th>
<th>Impact factor (2015)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Journal of Vascular Surgery</td>
<td>25</td>
<td>3.5</td>
</tr>
<tr>
<td>Canadian Journal of Surgery</td>
<td>10</td>
<td>1.5</td>
</tr>
<tr>
<td>Vascular and Endovascular surgery</td>
<td>7</td>
<td>0.8</td>
</tr>
<tr>
<td>European Journal of Vascular and Endovascular Surgery</td>
<td>6</td>
<td>2.9</td>
</tr>
<tr>
<td>Annals of Vascular Surgery</td>
<td>5</td>
<td>1.0</td>
</tr>
<tr>
<td>Vascular</td>
<td>3</td>
<td>0.6</td>
</tr>
<tr>
<td>American Journal of Surgery</td>
<td>2</td>
<td>2.4</td>
</tr>
<tr>
<td>Journal of Endovascular Therapy</td>
<td>2</td>
<td>3.1</td>
</tr>
<tr>
<td>Journal of Vascular Ultrasound</td>
<td>2</td>
<td>NA</td>
</tr>
<tr>
<td>Canadian Journal of Emergency Medicine</td>
<td>1</td>
<td>1.1</td>
</tr>
<tr>
<td>Canadian Medical Association Journal</td>
<td>1</td>
<td>6.7</td>
</tr>
<tr>
<td>Clinical Kidney Journal</td>
<td>1</td>
<td>NA</td>
</tr>
<tr>
<td>Hemodialysis International</td>
<td>1</td>
<td>2.0</td>
</tr>
<tr>
<td>International Journal of Vascular Medicine</td>
<td>1</td>
<td>1.5</td>
</tr>
<tr>
<td>Journal of Applied Biomaterials and Functional Materials</td>
<td>1</td>
<td>1.5</td>
</tr>
<tr>
<td>Journal of Biomaterials Applications</td>
<td>1</td>
<td>2.8</td>
</tr>
<tr>
<td>Journal of Biomechanical Engineering</td>
<td>1</td>
<td>1.8</td>
</tr>
<tr>
<td>Journal of Biomechanics</td>
<td>1</td>
<td>2.4</td>
</tr>
<tr>
<td>Journal of Biomedical Materials</td>
<td>1</td>
<td>3.4</td>
</tr>
<tr>
<td>Journal of Evaluation in Clinical Practice</td>
<td>1</td>
<td>1.1</td>
</tr>
<tr>
<td>Journal of Long-Term Effect of Medical Implants</td>
<td>1</td>
<td>NA</td>
</tr>
<tr>
<td>Journal of Patient Safety</td>
<td>1</td>
<td>1.5</td>
</tr>
<tr>
<td>Journal of Research in Medical Sciences</td>
<td>1</td>
<td>0.7</td>
</tr>
<tr>
<td>Journal of Surgical Research</td>
<td>1</td>
<td>2.1</td>
</tr>
<tr>
<td>Journal of Vascular and Interventional Radiology</td>
<td>1</td>
<td>2.6</td>
</tr>
<tr>
<td>Lancet</td>
<td>1</td>
<td>44.0</td>
</tr>
<tr>
<td>Scientific Reports</td>
<td>1</td>
<td>5.2</td>
</tr>
<tr>
<td>The Surgeon</td>
<td>1</td>
<td>1.1</td>
</tr>
<tr>
<td>Vascular Health Risk Management</td>
<td>1</td>
<td>NA</td>
</tr>
<tr>
<td>Vascular Medicine</td>
<td>1</td>
<td>1.4</td>
</tr>
<tr>
<td>Wilderness and Environmental Medicine</td>
<td>1</td>
<td>1.2</td>
</tr>
<tr>
<td>NA = not available.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Abstract topic Published total  Rate  95% CI  Weight

<table>
<thead>
<tr>
<th>Abstract topic</th>
<th>Published total</th>
<th>Rate</th>
<th>95% CI</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Endovascular aortic therapies</td>
<td>36  64</td>
<td>0.56</td>
<td>[0.43–0.69]</td>
<td>33.6%</td>
</tr>
<tr>
<td>Other</td>
<td>4   8</td>
<td>0.50</td>
<td>[0.16–0.84]</td>
<td>4.2%</td>
</tr>
<tr>
<td>Peripheral vascular disease</td>
<td>16  34</td>
<td>0.47</td>
<td>[0.30–0.65]</td>
<td>18.2%</td>
</tr>
<tr>
<td>Venous disease/access</td>
<td>6   13</td>
<td>0.46</td>
<td>[0.19–0.75]</td>
<td>7.0%</td>
</tr>
<tr>
<td>Education and patient safety</td>
<td>8   21</td>
<td>0.38</td>
<td>[0.18–0.61]</td>
<td>11.2%</td>
</tr>
<tr>
<td>Carotid</td>
<td>4   11</td>
<td>0.36</td>
<td>[0.11–0.69]</td>
<td>5.9%</td>
</tr>
<tr>
<td>Open aortic surgery</td>
<td>10  37</td>
<td>0.27</td>
<td>[0.14–0.44]</td>
<td>19.8%</td>
</tr>
<tr>
<td>Summary</td>
<td>84  188</td>
<td>0.45</td>
<td>[0.37–0.52]</td>
<td>100%</td>
</tr>
</tbody>
</table>

Fig. 2. Influence of abstract topic on rate of publication. ($\chi^2$, $p = 0.20$). CI = confidence interval.
Abstract topic | Published total | Rate  | 95% CI  | Weight |
--- | --- | --- | --- | --- |
Cook Endovascular Research Award | 6 9 | 0.67  | [0.30–0.93] | 31.4% |
Gore Research Award | 3 8 | 0.38  | [0.09–0.75] | 34.2% |
John L Provan Award | 3 8 | 0.38  | [0.09–0.75] | 25.6% |
National Student Research Award | 5 14 | 0.36  | [0.13–0.65] | 15.9% |
Summary | 17 39 | 0.44  | [0.28–0.60] | 100% |

Fig. 3. Publication rate following receipt of a Canadian Society for Vascular Surgery (CSVS) research grant. CI = confidence interval.

<table>
<thead>
<tr>
<th>Abstract topic</th>
<th>Published total</th>
<th>Rate</th>
<th>95% CI</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cook Endovascular Research Award</td>
<td>6 9</td>
<td>0.67</td>
<td>[0.30–0.93]</td>
<td>31.4%</td>
</tr>
<tr>
<td>Gore Research Award</td>
<td>3 8</td>
<td>0.38</td>
<td>[0.09–0.75]</td>
<td>34.2%</td>
</tr>
<tr>
<td>John L Provan Award</td>
<td>3 8</td>
<td>0.38</td>
<td>[0.09–0.75]</td>
<td>25.6%</td>
</tr>
<tr>
<td>National Student Research Award</td>
<td>5 14</td>
<td>0.36</td>
<td>[0.13–0.65]</td>
<td>15.9%</td>
</tr>
</tbody>
</table>

Table 3. Target journal following receipt of CSVS Research Grant

<table>
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<tr>
<th>Journal</th>
<th>No. of publications</th>
<th>Impact factor (2015)</th>
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</thead>
<tbody>
<tr>
<td>Journal of Vascular Surgery</td>
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</tr>
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<td>Vascular</td>
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<td>0.6</td>
</tr>
<tr>
<td>Canadian Journal of Surgery</td>
<td>2</td>
<td>1.5</td>
</tr>
<tr>
<td>Journal of Biomechanical Engineering</td>
<td>1</td>
<td>1.8</td>
</tr>
<tr>
<td>Journal of Long-term Effects of Medical Implants</td>
<td>1</td>
<td>NA</td>
</tr>
<tr>
<td>Clinical and Investigative Medicine</td>
<td>1</td>
<td>1.2</td>
</tr>
<tr>
<td>The Surgeon</td>
<td>1</td>
<td>1.1</td>
</tr>
<tr>
<td>European Journal of Vascular and Endovascular Surgery</td>
<td>1</td>
<td>2.9</td>
</tr>
<tr>
<td>Annals of Vascular Surgery</td>
<td>1</td>
<td>1.0</td>
</tr>
<tr>
<td>Journal for Vascular Ultrasound</td>
<td>1</td>
<td>NA</td>
</tr>
</tbody>
</table>

CSVS = Canadian Society for Vascular Surgery; NA = not available.

Fig. 4. Comparison of publication rates between the Canadian Society for Vascular Surgery (CSVS; n = 39), the Canadian Association of General Surgeons (CAGS; n = 24) and the Society of Vascular Surgery (SVS; n = 6) grants.
Although this was a relatively small data set representing only 2 consecutive years and 106 abstracts, the reported publication rate was 59.4% in journals with a mean impact factor of 3.5. On the other hand, the reported publication rate following the Canadian Cardiovascular Congresses from 2006 to 2010 and representing 3565 abstracts was only 24.1% in journals with a mean impact factor of 5.2. This suggests a substantial variation among conferences within the vascular surgery specialty. Several large meta-analyses evaluating publication rates following abstract acceptance suggest that the mean publication rate across all specialties and meetings is 44.5%. The publication rate of 45% reported for the CSVS in this study is similar to that in reports from conferences spanning many specialties; however, it also suggests Canadian surgeons and trainees must strive to close this publication gap. Although abstract topic was not a significant predictor of publication in this data set, there was a trend for endovascular topics to have higher rates of publication than open surgical topics, with publication rates of 56% and 27%, respectively. A similar trend was also seen among publication rates following receipt of a CSVS research grant, in which the Cook Endovascular Research Award had a subsequent publication rate of 67% relative to the open surgical topics of the Gore Research Award, which had a publication rate of 38%. This trend toward lower publication rates for open surgical topics may in part be explained by decreased interest both from key journals and surgeons in light of the dramatic increase in the use of endovascular techniques during the study time period.

We expected to see a higher publication rate following receipt of a CSVS research grant. Compared with either the CAGS Research Fund Grants or the SVS Seed Grants, which had publication rates of 88% and 66%, respectively, the CSVS research grants had a lower overall publication rate of 44%. There are several potential reasons for this discrepancy. The first may be that CSVS research award applications are assessed solely based on the merit of the proposed research project, whereas both the CAGS Research Fund Grants and the SVS Seed Grants include an assessment of the applicant’s research and academic history. In support of this possibility, we noted that grant recipients who subsequently published their study results had a significantly higher h-index at the time of receipt than those who did not publish their study results. This may highlight the importance of assessing an applicant’s research history and/or research potential in conjunction with the merit of the overall research proposal. The second major difference between the CSVS research grants and its societal counterparts is the relative monetary value of the award, which may also influence the quality, size and ultimately the ability to publish a proposed research project. The CSVS awards have a monetary value of $5000 compared with $10 000 and $15 000 for the CAGS Research Fund and SVS Seed Grant, respectively.

**Limitations**

The publication rate determined in the present study represents the minimum true publication rate for several reasons. First, authors were not personally surveyed in regards to publication or reasons for not publishing. As such, any research articles that were not indexed in Scopus, MEDLINE, or PubMed would not have been captured with our search strategy. Second, the timing of this study allowed for a 3-year timeframe between the final abstract acceptance and our literature search. Previous studies have demonstrated that 88% of full-text manuscripts are published within 3 years of presentation at a scientific meeting. Similarly, extrapolating from the results of this study, 90% of the captured articles were published at the 3-year time point, with a mean time to publication of 1.8 years. This may explain the relative dip in publication rate for the 2013 conference year. Finally, as conference abstracts often represent preliminary research it is possible that a small subset of abstracts were published with a title sufficiently different than that of the abstract and thus would not have been captured by our search strategy.

**CONCLUSION**

We found that 44% of both abstracts presented at CSVS annual meetings and receiving CSVS research grants were subsequently published in peer-reviewed journals. Although this finding is representative of the published literature on this topic, our study highlights potential areas for future improvement. Most notably, the inclusion of an assessment of research productivity may in turn increase the effectiveness of the CSVS research grants in promoting quality research publications.

**Affiliations**: Both authors are from the Division of Vascular Surgery, Peter Munk Cardiac Centre, Toronto General Hospital, University Health Network, University of Toronto, Toronto, Ont.

**Competing interests**: None declared.

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

**References**


Utilizing the physician assistant role: case study in an upper-extremity orthopedic surgical program

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Background: Shortages with resources and inefficiencies with orthopedic services in Canada create opportunities for alternative staffing models and ways to use existing resources. Physician assistants (PAs) are a common provider used in specialty orthopedic services in the United States; however, Canada has limited experience with PAs. As part of a larger demonstration project, Alberta Health Services (AHS) implemented 1 PA position in an upper-extremity surgical program in Alberta, Canada, to demonstrate the role in 4 areas: preoperative, operative, postoperative and follow-up care.

Methods: A mixed-methods evaluation was conducted using semi-structured interviews (n = 38), health care provider (n = 28) and patient surveys (n = 47), and 2 years of clinic data on new patients. Data from a double operating room experiment detailed expected versus actual times for 3 phases of surgery (pre, during, post).

Results: Preoperatively, the PA prioritizes patient referrals for surgery and redirects patients to alternative care. In the second year with the PA in place, there was an increase in total new patients seen (113%). Postoperatively, the PA attended rounds on 5 surgeons’ patients and handled follow-up care activities. Health care providers and patients reported that the PA provided excellent care. Findings from the operating room showed that the preparation time was greater than expected (38.6%), whereas the surgeon time (20.6%) and postsurgery time (37.2%) was less than expected.

Conclusion: After 24 months the PA has become a valuable member of the health care team and works across the continuum of orthopedic care. The PA delivers quality care and improves system efficiencies.

Contexte : Le manque de ressources et les inefficacités des services d’orthopédie au Canada créent des possibilités pour de nouveaux modèles de dotation et de mise à contribution des ressources existantes. Aux États-Unis, les adjoints au médecin sont des fournisseurs de soins courants dans les services spécialisés d’orthopédie comparativement au Canada qui en fait une utilisation limitée. Dans le cadre d’un grand projet de démonstration, Alberta Health Services (AHS) a créé un poste d’adjoint au médecin dans un programme de chirurgie des membres supérieurs en Alberta, au Canada, afin de démontrer le rôle de l’adjoint au médecin à 4 étapes des soins : préopératoire, opératoire, postopératoire et suivi.

Méthodes : Une évaluation avec méthodes mixtes a été effectuée au moyen d’entrevues semi-structurées (n = 38), de sondages auprès de fournisseurs de soins (n = 28) et de patients (n = 47), et de données des nouveaux patients de la clinique sur 2 ans. Les données d’une expérience en salle d’opération double indiquaient le temps prévu et le temps réel de 3 étapes des chirurgies (pré, per et postopératoire).

Résultats : À l’étape préopératoire, l’adjoint au médecin a établi la priorité des patients référés en chirurgie et redirigé les patients vers d’autres soins. Lors de la deuxième année de l’adjoint au médecin, nous avons observé une augmentation du nombre de nouveaux patients accueillis (113 %). À l’étape postopératoire, l’adjoint au médecin a participé aux tournées auprès des patients de 5 chirurgiens et s’est occupé des activités liées aux soins de suivi. Les fournisseurs de soins et les patients ont signalé l’excellence des soins de l’adjoint au médecin. Les résultats de la salle d’opération ont révélé un temps de préparation plus élevé que prévu (38.6 %), alors que le temps de chirurgie (20.6 %) et le temps postchirurgical (37.2 %) étaient inférieurs aux prévisions.

Conclusion : Après 24 mois, l’adjoint au médecin est devenu un membre valorisé de l’équipe de soins qui travaille à toutes les étapes du continuum des soins orthopédiques. L’adjoint au médecin fournit des soins de qualité et améliore l’efficacité du système.
Orthopedic services are often burdened with shortages in resources and system inefficiencies owing to the high volume of patients who may or may not need surgery. Long wait lists for consultation, delays in precise diagnosis and management, and increasing numbers of outpatients can impact the continuum of care. One way to deal with wait times and increase access to orthopedic services is to use the workforce more efficiently. This can be done by modifying existing practice patterns and/or using alternative interprofessional staffing models. The use of physician assistants (PAs) is an opportunity to look at alternative providers, which could benefit orthopedic surgery. Physician assistants have worked in surgical roles since the 1970s in the United States. In the United States, orthopedics is the third most common specialty area practised by PAs, with 25% of PAs practising in a surgical subspecialty capacity. In Canada, PAs have been introduced in several provinces, but have not been steadily employed across the country.

In 2012, Alberta Health Services (AHS) initiated the Physician Assistant Demonstration Project, where 12 PAs were introduced into various health care settings to determine where best to deploy the role. This study examines the role of 1 PA in a subspecialized upper-extremity surgical program at a peripheral hospital. The program sees inpatients and outpatients and provides care for trauma and degenerative conditions of the shoulder, elbow, wrist and hand. Surgical assistants (SAs) and surgical extenders (SEs) have worked with the program. Surgical assistant shortages are perceived, but the role attends only to operative duties; SEs were used for postsurgical and evening on-call care, but that role no longer exists. The PA role is an opportunity to improve services and fill provider gaps in 4 areas: screening of patients preoperatively, assisting in operating room (OR) care, aiding in the aftercare of surgery, and attending to postdischarge follow-up care. The objectives of this study were to describe the role of the PA in the upper-extremity surgical program; describe the role of the PA in an OR study; and show the impact of the PA role on patients, providers and the system.

**METHODS**

We used data from 2 sources: data from the formal evaluation of the PA demonstration project, and data from an OR experiment conducted with the orthopedics group.

**Evaluation of the PA demonstration project**

We used a mixed-methods approach for the evaluation. Data involved semistructured interviews and surveys collected over 24 months of PA position implementation. For this program, we interviewed surgeons, the PA and other health care providers at 4 times using semistructured interview guides. Questions focused on the PA role, supervision and mentorship responsibilities, PA integration into the team, development of the PA role over time and impact of the PA role on patient care and services. Interviewers obtained consent to audio-record interviews, which lasted 10–40 minutes and were conducted over the telephone. Interviewers took notes and analyzed data based on the guide and emergent information.

We asked health care providers and patients to complete surveys about their perceptions and experiences with the PA. The health care provider (28-items) and the patient (13-item) surveys involved 5-point Likert-type responses. An overall item with a 10-point response option asked patients to rate the quality of care received from the PA. Open-ended questions allowed all respondents to elaborate on the benefits, challenges, or suggested improvements of the role. Data from the outpatient clinic (e.g., number of new patients) were used as part of the evaluation. Descriptive statistics were used to calculate survey and clinic data.

**Data from the OR experiment**

The PA participated with 1 of the orthopedic surgeons in a double room experiment (e.g., 2 concurrently run ORs) to maximize the number of surgeries in a day and reduce the surgeon’s time spent outside of the surgical procedures (e.g., preparation and postsurgical time) during the first year of the program (2014). Data were collected for expected (estimated) and actual (observed) preparation time, surgical time and postsurgical time in minutes. Preparation time included getting the room (set-up) and patients (positioning) ready for surgery. Surgeon time referred to the time the surgeon was in the OR, including completion of the safe surgical checklists and surgical procedures. The postsurgery time included closing the patients’ incisions, recovering the patients and moving the patients out of the OR. The same orthopedic surgeon attended to patients scheduled in 2 ORs on the same day for routine surgeries, including carpal tunnel surgery, isolated acromioclavicular resection and bankart lesion/glenoid labrum repair for shoulder dislocation. Surgeries were selected that would not account for more than 50% of the time the patient was in the OR.

The same orthopedic surgeon attended to 8 patients scheduled in 2 operating rooms for routine surgeries. The surgical team in room 1 consisted of 1 orthopedic surgeon, 1 anesthesiologist, 2 registered nurses (RNs), 1 respiratory therapist, 0.5 RN floater and 1 physician SA. The surgical team in room 2 consisted of 1 orthopedic surgeon, 1 anesthesiologist, 1 RN, 2 respiratory therapists, 0.5 RN floater and 1 PA. The PA was able to assist the surgical team to increase the surgeon's capacity. The AHS quality improvement department forwarded data from the double room experiment. The PA demonstration project was an AHS quality improvement project and underwent a second opinion ethics review to meet ethical standards.
RESULTS

Over 24 months, evaluators conducted a total of 38 inter-
views with surgeons and health care providers and col-
lected surveys from 28 health care providers and
47 patients in the upper-extremity surgical program.
Results are structured into the 4 areas of care where the
PA works: preoperative, OR, postoperative and follow-up
care. Preoperative care entails the PA consulting with
patients in the clinic before the decision to have surgery.
Operative care entails the PA attending to details of care in
the OR (e.g., room set-up, patient positioning, surgical
activities). Postoperative and follow-up care consist of the
PA caring for patients on the inpatient units after surgery
and following up with outpatients in the clinic.

Preoperative care

The PA works with the primary supervising surgeon in
the clinic for approximately 1 day out of the work week.
The PA conducts a substantial amount of screening;
history taking; physical exams; interpreting diagnostic
imaging; discussing treatment options, including the risks
involved with surgical procedures and/or rehabilitation;
booking ORs; and teaching. The PA triages patient con-
sultations, resulting in expedited treatment for those with
urgent needs through reduced wait times from referral to
consultation. Prior to the establishment of the PA posi-
tion, the surgeon prioritized patients in batches, which
could lead to delays. The PA conducts most activities
without direct supervision; however, the surgeon confirms
patients’ treatment options and examinations completed
by the PA. Patients are generally assigned to the PA for
more routine activities, but may also be assigned based on
the surgeon’s time (e.g., busy with another patient).

Data compiled on the number of total new consults for
preoperative patients seen in the clinic of the supervising
surgeon with the assistance of the PA are shown in Table 1
and Table 2. The PA began work in January, 2014. Table 1
shows a 6-month comparison of total new patients seen
before and after PA position implementation. On average, a
30% increase in the number of patients seen was noticed in
the first year. Table 2 shows a 6-month comparison of total
new patients seen from the first and second year after PA
position implementation. On average, a 113% increase was
noticed as the PA became more proficient.

Operating room

For approximately 2 days a week the PA takes the role of an
SA in the OR, which is 50% of his overall time. The PA
may also be asked to assist with on-call surgeries during his
regularly scheduled shift. The PA’s integration into the OR
went well, as providers understand the role. Interviewees
discussed the need for additional OR help because there is
a lack of SAs. The SA role was said to be “essential to the
unit”; thus unit staff appreciate that the PA is a consistent
person in the OR who knows each surgeon’s way of oper-
ating. This is noteworthy because the “surgeons are
extremely picky about the setup of the rooms.” In general,
the PA attends to shoulder injuries (e.g., instability and
hardware irritation) and other upper-extremity issues, such
as carpal tunnel, and humerous bone and acromioclavicular
joint issues. Throughout the project, the PA has been able
to acquire skills in a graduated manner through training
from the supervising surgeon, who is skilled in surgical ed-
ucation. For example, the PA no longer needs direct super-
vision when closing a skin incision; however, supervision
occurs while the PA fixes ligament repairs. The surgeon
decides when the PA’s skill level has advanced. Most direct
supervision occurs with complicated procedures. The PA’s
skills improved over time, and it is now common that he
“preps and closes with patients in OR.”

Double room experiment

The intent of the double room experiment was to maximize
the surgeon’s capacity with the assistance of other provid-
ers. The surgeon was available only during the surgeon
time and was absent for the pre- and postsurgery times.
Table 3 depicts the findings of the expected versus actual
preparation, surgical and postsurgical times. The findings
show that the actual preparation time was 38.6% greater
than expected, the actual surgeon time was 20.6% less than
expected and the actual postsurgery time was 37.2% less
than expected. The 8 surgeries were expected to take
604 minutes, but took 498 minutes in total; thus, 2 hours
were saved. Doubling the number of surgeries in a day also allowed the surgeon to attend to outpatients on a day that would have typically been scheduled for surgical patients.

**Postoperative care**

The PA takes on some duties of the SA and SE roles within the hospital. For example, the SA only assists in surgery; the role does not take on administrative tasks (e.g., postoperative orders) or attend to patients postoperatively. Health care providers initially viewed the PA role as similar to the SA role, but they anticipated the PA would eventually function beyond an SA role by taking on duties of the SE role (e.g., attending to inpatients’ needs). The SE would attend rounds on patients after hours and attend to issues with vital signs or pain control, write histories, or obtain consent from patients. Unit staff said the SE role was missed because the SE had been available after hours.

The PA sees approximately 60%–70% (or 6–15) of all inpatients postoperatively, which frees up the surgeons for complex patients and administrative work. The PA addresses issues by attending rounds on patients for 5 surgeons twice per day (morning and late afternoon). This reduces calls to surgeons and fills the gap of the SE role to some extent. The PA also attends to in-hospital consultations, which improves the consultation process; writes up paperwork for transfer orders; makes care arrangements; and coordinates and organizes surgical patients in a timely manner.

The PA is restricted from giving verbal and written orders to other health care providers without cosignature and verification from a supervising physician. This inhibits full integration with postoperative surgical units. However, the PA acts as a liaison between the surgeons and unit staff; communication is fairly fluid between the PA and other providers, considering the role restriction (e.g., unable to discharge patients). Staff will contact the PA first with any patient concerns. The PA will assess the situation and consult the appropriate surgeon if unable to make recommendations or treat patients independently.

### Follow-up outpatient care

One day a week the PA treats patients in the outpatient clinic; patients either are in need of postoperative follow-up care or care as a new consult through the orthopedic consult line. Postoperatively, patients may access follow-up care multiple times within the year after surgery. Consultant patients include those who do not need surgery, but need conservative management for conditions such as fractures or lacerations. Follow-up appointments are booked with both the PA and surgeon, which increases the number of new consults that can be seen. The surgeon is now able to see new consults much more easily than before the PA’s participation. The surgeon and PA are able to provide better care, and more time is spent per patient, as clinic flow is improved.

### Survey results

#### Provider survey

Table 4 shows that the majority of item means were 4.00 and above, suggesting that providers “agree” or “strongly agree” that the PA is a collaborative member of the team. Items with means below 3.00 were negatively worded.

Open-ended comments from providers were positive. One provider commented that it “makes the team more efficient when you have a consistent surgical assistant.” Another commented that the PA was good for helping the nursing team with changeovers, understanding the needs of the surgeon and helping them with it, and decreasing the pressure of nurses.

#### Patient survey

The average age of patients who completed the survey was 52 years, and 53% were men. Table 5 shows that all patients positively responded to the PA role, with all responses being “strongly agree.” In addition, patients rated the care they received from the PA on a scale from 0 to 10, with 10 being the best care possible; patients rated the care as the best or nearly the best, with an overall

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**Table 3. 2014 expected versus actual times in minutes for pre, during and post–orthopedic surgery**

<table>
<thead>
<tr>
<th>Procedure</th>
<th>PTE</th>
<th>APT</th>
<th>% Deviation</th>
<th>STE</th>
<th>AST</th>
<th>% Deviation</th>
<th>PSTE</th>
<th>APST</th>
<th>% Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carpal tunnel</td>
<td>11</td>
<td>12</td>
<td>9.1%</td>
<td>21</td>
<td>8</td>
<td>-61.9%</td>
<td>28</td>
<td>9</td>
<td>-67.9%</td>
</tr>
<tr>
<td>Isolated AC resection</td>
<td>9</td>
<td>14</td>
<td>55.6%</td>
<td>31</td>
<td>14</td>
<td>-54.8%</td>
<td>32</td>
<td>23</td>
<td>-28.1%</td>
</tr>
<tr>
<td>Bankhart/glenoid</td>
<td>14</td>
<td>12</td>
<td>-14.3%</td>
<td>36</td>
<td>38</td>
<td>5.6%</td>
<td>32</td>
<td>25</td>
<td>-21.9%</td>
</tr>
<tr>
<td>Bankhart/glenoid</td>
<td>14</td>
<td>22</td>
<td>57.1%</td>
<td>36</td>
<td>32</td>
<td>-11.1%</td>
<td>30</td>
<td>22</td>
<td>-26.7%</td>
</tr>
<tr>
<td>Bankhart/glenoid</td>
<td>14</td>
<td>14</td>
<td>0.0%</td>
<td>36</td>
<td>32</td>
<td>-11.1%</td>
<td>32</td>
<td>29</td>
<td>-9.4%</td>
</tr>
<tr>
<td>Bankhart/glenoid</td>
<td>14</td>
<td>25</td>
<td>78.6%</td>
<td>36</td>
<td>31</td>
<td>-13.9%</td>
<td>32</td>
<td>18</td>
<td>-43.8%</td>
</tr>
<tr>
<td>Bankhart/glenoid</td>
<td>14</td>
<td>18</td>
<td>28.6%</td>
<td>36</td>
<td>37</td>
<td>2.8%</td>
<td>32</td>
<td>19</td>
<td>-40.6%</td>
</tr>
<tr>
<td>Carpal tunnel</td>
<td>11</td>
<td>23</td>
<td>109.1%</td>
<td>21</td>
<td>9</td>
<td>-57.1%</td>
<td>32</td>
<td>12</td>
<td>-62.5%</td>
</tr>
<tr>
<td>Totals</td>
<td>101</td>
<td>140</td>
<td>38.6%</td>
<td>253</td>
<td>201</td>
<td>-20.6%</td>
<td>250</td>
<td>157</td>
<td>-37.2%</td>
</tr>
</tbody>
</table>

AC = acromioclavicular; APT = actual preparation time; APST = actual postsurgery time; AST = actual surgeon time; PTE = preparation time expected; PSTE = postsurgery time expected; STE = surgeon time expected.
mean of 9.65. Open-ended comments from patients were generally positive, with many appreciating the extra time the PA spends with them. One patient commented:

The PA is a great addition to the health care system. He was able to answer a lot of my questions and further explain the doctor’s diagnosis. He was also a sounding board for the doctor and together discussed the problem and care in front of me and gave me further information.

Another patient commented:

As the doctor is usually busy, it is essential to have the visitation from the PA. The attention to detail and the effort to address concern and questions was quite evident. He helped to afford a level of comfort with the issues, and the preparations helped to make the time spent with the doctor more effective. A very valuable role, and I feel an essential function. [The PA] was excellent.

Table 4. Mean ratings on health care provider survey

<table>
<thead>
<tr>
<th>Item</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 I have a good understanding of the PA role.</td>
<td>4.03</td>
</tr>
<tr>
<td>2 I have a good understanding of which patients are suitable for management by the PA.</td>
<td>4.00</td>
</tr>
<tr>
<td>3 The PA has the knowledge to provide appropriate care to the assigned patient group.</td>
<td>4.28</td>
</tr>
<tr>
<td>4 The PA has the skills to provide appropriate care to the assigned patient group.</td>
<td>4.11</td>
</tr>
<tr>
<td>5 The PA is an integral part of the team.</td>
<td>4.46</td>
</tr>
<tr>
<td>6 The PA draws on the expertise of other members of the team.</td>
<td>4.53</td>
</tr>
<tr>
<td>7 There is a great deal of joint planning for patients on our team.</td>
<td>4.07</td>
</tr>
<tr>
<td>8 The PA treats patients with courtesy and respect.</td>
<td>4.75</td>
</tr>
<tr>
<td>9 The PA listens carefully to patients.</td>
<td>4.71</td>
</tr>
<tr>
<td>10 The PA explains things in ways patients can understand.</td>
<td>4.60</td>
</tr>
<tr>
<td>11 The PA follows up with patients’ questions and comments.</td>
<td>4.62</td>
</tr>
<tr>
<td>12 The PA follows standard processes that affect patient safety.</td>
<td>4.46</td>
</tr>
<tr>
<td>13 The PA always reviews patient records before treating a patient.</td>
<td>4.39</td>
</tr>
<tr>
<td>14 The PA always updates patient charts/documents after seeing a patient.</td>
<td>4.25</td>
</tr>
<tr>
<td>15 The PA contributes to the flow of information to patients and families.</td>
<td>4.42</td>
</tr>
<tr>
<td>16 The PA contributes to patient rounds.</td>
<td>4.14</td>
</tr>
<tr>
<td>17 The PA never conducts activities that he hasn’t been trained to do.</td>
<td>4.18</td>
</tr>
<tr>
<td>18 The PA is available to staff throughout the day to assess patients.</td>
<td>4.21</td>
</tr>
<tr>
<td>19 The PA always notifies a physician when a patient’s condition is abnormal.</td>
<td>4.48</td>
</tr>
<tr>
<td>20 The PA works cooperatively with members of the team.</td>
<td>4.82</td>
</tr>
<tr>
<td>21 The PA has improved access to care.</td>
<td>4.40</td>
</tr>
<tr>
<td>22 The PA has reduced patients’ time spent waiting for a provider.</td>
<td>4.00</td>
</tr>
<tr>
<td>23 The PA contributes to my job satisfaction.</td>
<td>4.10</td>
</tr>
<tr>
<td>24 The PA contributes to stress in my role.</td>
<td>2.50</td>
</tr>
<tr>
<td>25 The PA is readily available to provide service to patients.</td>
<td>4.03</td>
</tr>
<tr>
<td>26 I trust the PA’s decisions.</td>
<td>4.32</td>
</tr>
<tr>
<td>27 I have concerns with the PA with respect to team functioning.</td>
<td>1.71</td>
</tr>
<tr>
<td>28 I can discuss challenging issues with care team members on this unit.</td>
<td>4.03</td>
</tr>
</tbody>
</table>

PA = physician assistant.

Table 5. Mean ratings on patient survey

<table>
<thead>
<tr>
<th>Item</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 The PA introduced himself as a PA.</td>
<td>4.80</td>
</tr>
<tr>
<td>2 The PA explained the role to me.</td>
<td>4.76</td>
</tr>
<tr>
<td>3 The PA treated me with courtesy and respect.</td>
<td>4.89</td>
</tr>
<tr>
<td>4 The PA listened to my concerns.</td>
<td>4.93</td>
</tr>
<tr>
<td>5 The PA took the time to explain my condition in a manner that I could understand.</td>
<td>4.91</td>
</tr>
<tr>
<td>6 The PA took time to follow up on my questions and comments.</td>
<td>4.87</td>
</tr>
<tr>
<td>7 The PA explained what was going to be performed.</td>
<td>4.84</td>
</tr>
<tr>
<td>8 The PA is informed of my plan of care.</td>
<td>4.82</td>
</tr>
<tr>
<td>9 The PA was comfortable speaking with me.</td>
<td>4.91</td>
</tr>
<tr>
<td>10 The PA is a valuable member of the care team.</td>
<td>4.87</td>
</tr>
<tr>
<td>11 The PA’s knowledge has contributed to the quality of my care.</td>
<td>4.82</td>
</tr>
<tr>
<td>12 The PA has contributed skills to the quality of my care.</td>
<td>4.82</td>
</tr>
</tbody>
</table>

PA = physician assistant.
**Discussion**

**Preoperative clinic**

The PA is very helpful in the preoperative clinic with prioritizing patient referrals for surgery and redirecting patients to alternative care. Wait times for consultation with the surgeon decreased, and access increased with the total of new patients seen with the help of the PA. Focusing the PA’s time for referral and office consultation helps to improve patient access to orthopedic services. Literature suggests that elective surgeries are often given low prioritization or urgency; however, the patient’s symptom severity may not justify low urgency for surgical care. Physical, psychological and social consequences of delayed elective surgeries have been well documented, including exacerbation of the disorder, emotional distress, altered relationships and loss of work. Thus, waiting for elective surgery may involve a prolonged period of suffering from symptoms. A partial solution to this problem is prioritizing patients on waiting lists to reduce the overall burden of delay, which can be accomplished by the PA taking on the patient referral prioritization process.

Several studies have suggested that the majority of patients seeing orthopedic surgeons do not actually receive surgery. This means that surgeons spend a considerable amount of time providing expertise for diagnosis and management of musculoskeletal injuries, arthritis and other conditions, which could be reduced with the help of the PAs. Because the PAs understand presurgical expectations, disease processes, treatment algorithms, surgical procedures and techniques, and rehabilitative expectations and protocols, consistent communication of information from the orthopedic team is relayed to patients. Often the PA has more time to answer questions and concerns than the surgeon.

**Operating room**

The OR is the most resource-intensive unit in the hospital, where targeted clinical efficiencies are warranted. Physician assistants can improve orthopedic surgical care in the OR for patients by attending to patient positioning, draping and wound closure. In this study, the PA in the double room experiment helped to maximize the surgeon’s capacity. The surgeon did not attend to the preparation time (patient positioning, room set-up) and spent less time operating and dealing with postoperative care (closing incision, room cleaning, and set-up for the next patient). The time saved in surgery could be partially explained by selecting the most stable patients for the experiment. However, reducing the surgeon’s transitions from routine to effortful tasks may have reduced drifting or automatic thinking that occurs during the more routine parts of surgery (e.g., prepping and closing). This allowed the surgeon to use focused and purposeful attention and effort during surgeries, which may have decreased the surgical times. Because surgeries were conducted concurrently, the surgeon was able to leave during the postsurgical time to start surgery on the next patient, while the PA closed the first patient and cleaned up the room. This reduced the surgeon’s postsurgical time. Overall, the duties of the PA role in the OR reduced recorded surgical times, allowing for maximum patient throughput. By allowing the PA to take on certain OR duties and assist with procedures, the surgeon saved 2 hours of time, or 15 minutes per patient. If surgeons could double the amount of surgeries per day, maximum patient throughput could be obtained. Similarly, in a Canadian arthroplasty program, the surgeon saved approximately 50 minutes per patient or 815 hours of surgeon time per year. Furthermore, PAs can reduce costs by freeing up SAs (who are typically family physicians) to attend to primary care patients.

Canadian orthopedic surgeons spend one-third of their time operating, thus they are not used to their full capacity. Access to the OR for surgical care is the main limiting resource for orthopedic services. The double OR set-up is not commonly practised in Canada owing to the availability of resources and OR time. In the event that OR time can be increased, using an additional OR, rearranging existing resources, and/or using PAs as SAs can substantially increase surgical volumes and decrease wait times. Otherwise, efficiencies outside the OR can be found, as other health care providers could support two-thirds of the surgeons’ time spent outside of the OR.

**Postoperative care**

Physician assistants can assist with postsurgical care by attending to orders, notes, daily rounds, discharge summaries and prescriptions. Since the SE role no longer exists on units, the PA is a valuable resource for unit staff. However, the PA was restricted from reaching full potential on inpatient units; the PA was unable to take the SE duties, such as discharging patients, attending to patients after hours and writing independent orders. The Council of the College of Physicians and Surgeons of Alberta grants PAs the ability to work under a regulated professional as an unregulated provider. As such, physicians and PAs can negotiate the level of autonomy in clinical decision-making and prescribing of certain medications that the supervising physician would normally prescribe. In Canada, there is a lack of regulation for PAs, restricting their ability to work to their full potential.

**Outpatient follow-up care**

The PA is a consistent provider along the care pathway who assists with questions or concerns from preoperative, operative, postoperative and follow-up care; this
improves patient satisfaction. Patients reported excellent care from the PA, mainly owing to the extra care and attention they received from the PA. Although the PA has a limited role in follow-up outpatient care, the role could be used more in this area. Although outpatient clinic appointments are made in advance, surgeons often are delayed, which can hold up the patient schedule. This may decrease patient satisfaction and strain staff. The PA could be used in this area to improve scheduling of certain types of patients and fill in when the surgeon is behind schedule. The PA could attend to repeat patients returning for review of their progress with limited direction from the surgeon.

**Conclusion**

The PA role was successfully implemented along the care pathway for the upper-extremity orthopedics program after 24 months. Surgeons, health care providers and patients were all pleased with the quality of care offered by the PA, making the PA a valuable addition to the health care team. The PA was able to take on duties in all aspects of care to fill workforce shortages at the hospital and improve system efficiencies. There remain areas where the PA role could expand after 24 months, such as taking on more focused and complicated procedures, increasing responsibilities in postoperative and follow-up care (e.g., prescribing authority and discharge orders), and improving efficiencies in the system (e.g., assisting more surgeons). Research on workload analysis would offer a more comprehensive understanding of how to optimize roles.

This study was part of a larger project on using PAs in Alberta, Canada. Additional PAs could assist this group or others; however, Alberta does not have a steady supply of PAs to be employed in the health care system. Provincially, offering relocation allowance, guaranteed terms for those willing to move to Alberta, and clear payment and reporting structures for PAs could improve recruitment and ongoing management and funding of the role. Alternatively, a PA education program could be developed in Alberta to increase the number of trained PAs.

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**Affiliations:** From Workforce Research & Evaluation, Alberta Health Services, Calgary, Alta., (Hepp, Suter); Provincial Medical Affairs, Alberta Health Services, Calgary, Alta., (Nagy, Knorren); and the Division of Orthopaedics, Department of Surgery, University of Alberta, Edmonton, Alta. (Bergman).

**Competing interests:** None declared.

**Contributors:** S. Hepp, E. Suter and J. Bergman designed the study. S. Hepp, D. Nagy and T. Knorren acquired the data, which S. Hepp and E. Suter analyzed. S. Hepp and E. Suter wrote the article, which all authors reviewed and approved for publication.

**References**

Simultaneous resection of primary colorectal cancer and synchronous liver metastases: a population-based study

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Background: Simultaneous resection of primary colorectal cancer (CRC) and synchronous liver metastases (LM) is gaining interest. We describe management and outcomes of patients undergoing simultaneous resection in the general population.

Methods: All patients with CRC who underwent surgical resection of LM between 2002 and 2009 were identified using the population-based Ontario Cancer Registry and linked electronic treatment records. Synchronous disease was defined as having resection of CRCLM within 12 weeks of surgery for the primary tumour.

Results: During the study period, 1310 patients underwent resection of CRCLM. Of these, 226 (17%) patients had synchronous disease; 100 (44%) had a simultaneous resection and 126 (56%) had a staged resection. For the simultaneous and the staged groups, the mean number of liver lesions resected was 1.6 and 2.3, respectively ($p < 0.001$); the mean size of the largest lesion was 3.1 and 4.8 cm, respectively ($p < 0.001$); and the major hepatic resection rate was 21% and 79%, respectively ($p < 0.001$). Postoperative mortality for simultaneous cases at 90 days was less than 5%. Five-year overall survival and cancer-specific survival for patients with simultaneous resection was 36% (95% confidence interval [CI] 26%–45%) and 37% (95% CI 25%–50%), respectively. Simultaneous resections are common in the general population. A more conservative approach is being adopted for simultaneous resections by limiting the extent of liver resection. Postoperative mortality and long-term survival in this patient population is similar to that reported in other contemporary series.

Conclusion: Compared with a staged approach, patients undergoing simultaneous resections had fewer and smaller liver metastases and underwent less aggressive resections. One-third of these patients achieved long-term survival.

Contexte : La résection simultanée des cancers colorectaux primitifs et des métastases hépatiques synchrones suscitent de plus en plus d’intérêt. Nous décrivons la prise en charge et les résultats de patients de la population générale ayant subi une résection simultanée.

Méthodes : Tous les patients atteints d’un cancer colorectal ayant bénéficié d’une résection chirurgicale des métastases hépatiques entre 2002 et 2009 ont été identifiés au moyen du Registre des cas de cancer de l’Ontario en population générale et des dossiers électroniques associés sur le traitement. La maladie synchrone a été définie comme le fait d’avoir subi une chirurgie de résection des métastases hépatiques du cancer colorectal dans les 12 semaines de la chirurgie de la tumeur primitive.

Résultats : Pendant la période de l’étude, 1310 patients ont subi une résection des métastases hépatiques du cancer colorectal. Sur ce nombre, 226 (17 %) patients présentaient une maladie synchrone; 100 (44 %) patients ont subi une résection simultanée et 126 (56 %) patients ont subi une résection en 2 temps. Dans les groupes des résections simultanées et des résections en 2 temps, le nombre moyen de lésions hépatiques réséquées était de 1,6 et de 2,3, respectivement ($p < 0,001$); la taille moyenne de la lésion la plus importante était de 3,1 et de 4,8 cm, respectivement ($p < 0,001$) et le taux de résection hépatique majeure était de 21 % et de 79 %, respectivement ($p < 0,001$). La mortalité postopératoire après résection simultanée à 90 jours était inférieure à 5 %. La survie globale à 5 ans et la survie par cause des patients avec résection simultanée étaient de 36 % (intervalles de confiance [IC] de 95 %, 26 %–45 %) et de 37 % (IC 95 %, 25 %–50 %), respectivement. Les résections simultanées sont courantes au sein de la population générale. On commence à adopter une approche plus conservatrice pour les résections simultanées en limitant l’étendue de la résection hépatique. La mortalité postopératoire et la survie à long terme de cette population de patients sont semblables à celles signalées dans d’autres séries récentes.

Conclusion : Comparativement à l’approche en 2 temps, les patients avec résections simultanées présentaient moins de métastases hépatiques et des métastases de plus petite taille, et les résections pratiquées étaient moins agressives. Le tiers de ces patients ont obtenu une survie à long terme.
The management of patients with primary colorectal cancer (CRC) and synchronous liver metastases (LM) remains a challenge for the multidisciplinary team. Several studies have demonstrated inferior survival for these patients compared with those who present with metachronous disease.1–4 For patients with resectable CRC with synchronous disease, consideration must be given to surgical resection of the primary cancer, the hepatic metastases, administration of systemic chemotherapy and, in the case of those with rectal cancer, radiotherapy. Although each of these treatments is critical in the comprehensive management of these patients, the optimal timing and sequence of each modality remains controversial.

Complete surgical removal of the primary tumour and all liver metastases is the only potentially curative treatment option. This can be performed as a single operation with combined colorectal and liver resection or as a staged approach. The traditional approach has been to resect the primary tumour, followed often by systemic chemotherapy, then liver resection in the absence of disease progression. More recently, with improvements in perioperative care and anesthesia as well as advances in imaging and liver surgery, this approach has been challenged with several studies demonstrating comparable safety and outcome with a simultaneous surgical strategy.5–12 Combining both resection of the primary malignancy and the hepatic metastases avoids the morbidity of a second major operation, theoretically lowers the risk of disease dissemination and allows for timely completion of adjuvant therapies. Although a simultaneous approach appears feasible, the literature supporting this strategy is derived largely from high-volume single centres and multi-institutional case series. Therefore, it is unclear to what extent this surgical strategy is being performed in the general population and whether comparable outcomes are being realized. Population-based studies can be useful in addressing these questions by describing practice and outcomes achieved in routine clinical practice. To our knowledge, there are only 2 population-based studies concerning simultaneous resection for synchronous CRCLM. One study13 used Medicare data to examine long-term outcomes in all patients undergoing hepatic resection for CRCLM. The analysis was limited to patients aged 65 years or older, and patients undergoing simultaneous colon and liver resection were a small subgroup of the larger cohort. The other study14 used the National Inpatient Sample and provided data on postoperative outcomes only; it did not address any long-term outcomes. We performed a population-based study to describe management of synchronous CRCLM and the short- and long-term outcomes associated with simultaneous resection in routine clinical practice.

Methods

Study design and population

This is a population-based, retrospective cohort study to describe the management and outcome of resected CRCLM in the Canadian province of Ontario, Canada. Ontario has a population of approximately 13.5 million people and a single-payer universal health insurance program. The study population included all patients with CRC who underwent liver resection between 2002 and 2009. We used the Ontario Cancer Registry (OCR) to identify all incident cases of CRC in Ontario diagnosed between 1996 and 2009. We then identified all cases of liver resection performed between 2002 and 2009. The OCR does not capture diagnoses of second CRCs. As such, patients who underwent liver resection more than 6 years after the initial CRC diagnosis were excluded, because those cases would likely represent recurrence of a second primary cancer. Patients with histology other than adenocarcinoma were excluded. To minimize misclassification of liver metastases we also excluded patients with a second primary liver, biliary or pancreatic cancer. Details on the extent of liver metastases was not available in the existing data sources; for this reason we obtained surgical pathology reports for all potentially eligible patients. Patients with evidence of metastatic CRC as per the liver resection pathology report were included. Synchronous disease was defined as having resection of CRCLM within 12 weeks of surgery for the primary tumour. The research ethics board of Queen’s University approved our study protocol.

Data sources and linkage

The OCR is a passive, population-based cancer registry that captures diagnostic and demographic information on at least 98% of all incident cases of cancer in the province of Ontario.15 It also provides information about vital status and cause of death. Records of hospitalization from the Canadian Institute for Health Information (CIHI) provided information about surgical interventions; these records are known to be complete.16 Provincial physician billing records from the Ontario Health Insurance Plan (OHIP), treatment records (Activity Level Reporting [ALR]) from regional cancer centres and provincial records of chemotherapy delivery (New Drug Funding Program [NDFP] and Ontario Drug Benefits [ODB]) were used to identify chemotherapy use. Incident cases of CRC identified from the OCR were linked to other electronic administrative health databases at the Institute of Clinical and Evaluative Sciences (ICES). We obtained surgical pathology reports from the OCR. A team of trained data abstractors reviewed the pathology reports and entered information about extent of disease and surgical procedure into an electronic database.
Measures and outcomes

We classified comorbidity using the Charlson Index, modified for administrative data based on all noncancer diagnoses recorded during any hospital admission within the 5 years before surgery. Preoperative chemotherapy was defined as chemotherapy given within 16 weeks before resection of CRCLM; postoperative chemotherapy was defined as treatment initiated within 16 weeks after surgery for CRCLM. Postoperative mortality for staged cases was determined from the date of liver resection. Length of stay for staged group was based on the sum of colon and liver resection. Overall (OS) and cancer-specific survival (CSS) were determined from the time of liver resection. To account for possible cause of death miscoding, CSS included death from any cancer. Complete information about vital status in the OCR was available up to Dec. 31, 2012; cause of death was available up to Dec. 31, 2010.

Statistical analysis

We used the $\chi^2$ test to compare proportions between study groups. We determined OS and CSS using the Kaplan–Meier method. Factors associated with OS/CSS were evaluated using the Cox proportional hazards regression model. We considered results to be significant at $p < 0.05$. All analyses were performed using SAS software version 9.3 (SAS Institute).

RESULTS

Study population

Using linked administrative data sets, we identified 1711 potentially eligible patients who underwent surgical resection of CRCLM during the study period (Fig. 1). Surgical pathology reports were available for 1443 (84%) patients; 133 (9%) of these reports indicated that the procedure did not include resection of CRCLM. Of the remaining 1310 potential cases, 226 (17%) patients were identified as having synchronous disease; 100 (44%) underwent a simultaneous resection, whereas 126 (56%) had a staged resection. Characteristics of patients with simultaneous and staged resections of CRCLM are shown in Table 1. Age, sex and comorbidity were comparable between the groups. Patients undergoing simultaneous resections received more neoadjuvant chemotherapy ($p = 0.017$), but both groups had similar rates of adjuvant chemotherapy ($p = 0.09$).

Surgical and pathological characteristics

Details regarding the surgical procedures and pathological findings are shown in Table 2. Patients undergoing simultaneous resections were less likely to undergo a major liver resection (21% v. 79%, $p < 0.001$). The most frequent liver procedure performed in the simultaneous cohort was a wedge resection; among staged cases the most common procedure was a lobectomy. The size of the largest lesion (3.1 cm v. 4.8 cm, $p < 0.001$) was significantly smaller and the number of metastases resected (1.6 v. 2.3, $p < 0.001$) was significantly lower in the simultaneous cohort.

Surgical and pathological data for the primary tumour were available for 80 (80%) patients in the simultaneous group and 81 (64%) patients in the staged group. The simultaneous cohort was more likely to have right-sided primary tumours (29% v. 9%, $p = 0.001$), had more advanced primary tumours than staged patients with higher T3/4-stage (60% v. 50%, $p = 0.19$) and had more node-positive tumours (56% v. 48%, $p = 0.039$).

Table 3 describes the type of hepatic resection and the location of the primary CRC tumour for patients in the simultaneous group. The most frequent procedure performed was a wedge resection regardless of the location of the primary malignancy. Major liver resections were performed more commonly for right-sided than left-sided primary cancers, and none were completed for rectal primary cancers.

Outcomes

Short- and long-term outcomes of the study population are shown in Table 4. For illustrative purposes, outcomes are also shown for patients who underwent staged resection. Patients undergoing a single simultaneous resection had a significantly shorter mean length of stay than patients requiring 2 separate procedures in the staged group (13 v. 16 d, $p < 0.001$). Median OS and CSS for the simultaneous patients was 40 and 43 months, respectively; 5-year OS and CSS was 36% (95% confidence interval [CI] 26%–45%) and 37% (95% CI 25%–50%), respectively. Factors associated with survival for patients treated with a simultaneous approach to CRCLM are shown in Table 5. Age and extent of surgical resection were associated with OS and CSS.

Discussion

Our study provides insight into the management and outcomes of patients in the general population with synchronous CRCLM who undergo simultaneous resection. We found that simultaneous resections are common in routine clinical practice. Compared with those who underwent a staged approach, patients who underwent simultaneous resections had fewer and smaller liver metastases, and received less aggressive resections. Postoperative mortality in the simultaneous resection group was in an acceptable range, and one-third of patients achieved long-term survival.

To our knowledge, there is only 1 other population-based report specific to patients undergoing simultaneous
resection of synchronous CRCLM. Abbott and colleagues\textsuperscript{14} used the National Inpatient Sample to evaluate short-term outcomes in a contemporary cohort to determine if simultaneous resection is a safe approach. Mortality for simultaneous resections was 3.5\%, and average length of stay was 10.9 days, which is comparable to our findings (< 5\% and 13 d, respectively). Consistent with our findings, Abbott and colleagues found that the majority of patients who underwent a simultaneous procedure underwent a right colectomy and liver wedge resection. These data suggest that a more conservative approach is being adopted for simultaneous resections in the general population by limiting the extent of liver resection.

The rationale for performing colorectal and liver resections separately relates to the perceived increased perioperative risk with simultaneous resections. Indeed, earlier studies reported higher mortality with combined colon and liver resections.\textsuperscript{11,18,19} However, these reports are based on procedures performed in the 1990s, when liver resections were not as safe as they are now. In fact, more recent studies consistently report comparable mortality between simultaneous and staged resections\textsuperscript{7–9,12,20–24} ranging from 0\% to 3.5\%. In the present study, 30- and 90-day mortality from simultaneous resection was < 2\% and < 5\%, respectively, which is similar to that reported in most contemporary series.

A simultaneous approach has the advantage of shorter overall length of stay in hospital. This has been shown consistently in the literature\textsuperscript{7,9,12,20,22,24–26} and in our study. Even in studies where morbidity was significantly higher in

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**Fig. 1.** Identification of patients with colorectal cancer (CRC) who underwent resection of liver metastases (LM) in Ontario between 2002 and 2009. Dx = diagnosis; HPB = hepatopancreatobiliary.
the simultaneous group, the overall length of stay in this group was still shorter. The magnitude of this advantage may not be as marked nowadays given the more recent implementation of “fast-track surgery” and “enhanced recovery after surgery” in colorectal surgery.

Several reports have described long-term survival of patients who undergo simultaneous resection of primary CRC and synchronous liver metastases. In these series, 5-year OS for simultaneous resections ranged from 29% to 55%; our results suggest that comparable outcomes are achieved in routine practice. We report outcomes of patients who underwent staged resections for illustrative purposes only. We purposefully did not undertake comparative analyses of outcome for a simultaneous versus staged approach, because such an analysis would be fraught with several methodological limitations, which could bias the results in both directions. For instance, a staged approach offers the advantage of time between the 2 operations to allow for subclinical metastases to become detectable, either within the liver or extrahepatically. Theoretically, this would result in better tumour clearance at the time of hepatic resection and would allow for better patient selection by identifying patients who would not benefit from hepatic resection. Based on this concept, comparative analyses might suggest a survival benefit to a staged approach. Conversely, as seen in our data, patients undergoing a staged resection may have more advanced liver metastases, precluding them from consideration of a simultaneous approach. This selection bias may result in comparative outcomes that favour a simultaneous approach. Another possibility is that patients who underwent simultaneous resections actually had more advanced liver disease and that the initial simultaneous resection represented the first of 2 planned liver resections for complete

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**Table 1. Characteristics of patients with synchronous colorectal cancer liver metastases who underwent hepatic resection in Ontario between 2002 and 2009 (n = 226)**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>All cases n = 226</th>
<th>Simultaneous n = 100</th>
<th>Staged n = 126</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age, yr</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20–49</td>
<td>37 (16)</td>
<td>15 (15)</td>
<td>22 (17)</td>
</tr>
<tr>
<td>50–59</td>
<td>61 (27)</td>
<td>24 (24)</td>
<td>37 (29)</td>
</tr>
<tr>
<td>60–69</td>
<td>80 (35)</td>
<td>36 (36)</td>
<td>44 (35)</td>
</tr>
<tr>
<td>70–79</td>
<td>35 (15)</td>
<td>16 (16)</td>
<td>&lt; 20 (&lt; 20)</td>
</tr>
<tr>
<td>≥ 80</td>
<td>13 (6)</td>
<td>9 (9)</td>
<td>&lt; = 5 (&lt; 5)</td>
</tr>
<tr>
<td><strong>Age, mean [range], yr</strong></td>
<td>61 [20–87]</td>
<td>62 [22–87]</td>
<td>60 [20–83]</td>
</tr>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>124 (55)</td>
<td>54 (54)</td>
<td>70 (56)</td>
</tr>
<tr>
<td>Female</td>
<td>102 (45)</td>
<td>46 (46)</td>
<td>56 (44)</td>
</tr>
<tr>
<td><strong>Chemotherapy</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neoadjuvant</td>
<td>47 (21)</td>
<td>28 (28)</td>
<td>19 (15)</td>
</tr>
<tr>
<td>Between colon and liver</td>
<td>—</td>
<td>—</td>
<td>7 (6)</td>
</tr>
<tr>
<td>Adjuvant</td>
<td>145 (64)</td>
<td>58 (58)</td>
<td>87 (69)</td>
</tr>
<tr>
<td><strong>Charlson Comorbidity Index score</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>195 (86)</td>
<td>87 (87)</td>
<td>108 (86)</td>
</tr>
<tr>
<td>1</td>
<td>23 (10)</td>
<td>&lt; 10 (&lt; 10)†</td>
<td>&lt; 15 (&lt; 15)†</td>
</tr>
<tr>
<td>≥ 2</td>
<td>8 (4)</td>
<td>&lt; 6 (&lt; 5)†</td>
<td>&lt; 6 (&lt; 5)†</td>
</tr>
</tbody>
</table>

*Unless indicated otherwise.†As per institutional policy cells < 6 cases are suppressed.

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**Table 2. Surgical procedure and pathological characteristics of patients with synchronous colorectal cancer liver metastases who underwent hepatic resection in Ontario between 2002 and 2009 (n = 226)**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Simultaneous n = 100</th>
<th>Staged n = 126</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Extent of liver resection</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Major (≥ 3 segments)</td>
<td>21 (21)</td>
<td>99 (79)</td>
</tr>
<tr>
<td>Minor (&lt; 3 segments)</td>
<td>78 (79)</td>
<td>26 (21)</td>
</tr>
<tr>
<td><strong>Type of liver resection†</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wedge</td>
<td>77 (77)</td>
<td>43 (34)</td>
</tr>
<tr>
<td>Bisegmentectomy</td>
<td>20 (17)</td>
<td>&lt; 12 (&lt; 10)</td>
</tr>
<tr>
<td>Lobectomy</td>
<td>18 (15)</td>
<td>77 (49)</td>
</tr>
<tr>
<td>Extended lobectomy</td>
<td>&lt; 6 (&lt; 6)§§</td>
<td>22 (14)</td>
</tr>
<tr>
<td>Unstated</td>
<td>&lt; 6 (&lt; 6)§§</td>
<td>&lt; 6 (&lt; 6)§§</td>
</tr>
<tr>
<td><strong>Liver metastases</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of lesions resected‡</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean [range]</td>
<td>1.6 [1–12]</td>
<td>2.3 [1–13]</td>
</tr>
<tr>
<td>Median [IQR]</td>
<td>1 [1–2]</td>
<td>2 [1–3]</td>
</tr>
<tr>
<td>Largest liver lesion resected, cm§</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean [range]</td>
<td>3.1 [0–32]</td>
<td>4.8 [0–82]</td>
</tr>
<tr>
<td><strong>Margin status¶</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R0</td>
<td>75 (75)</td>
<td>112 (91)</td>
</tr>
<tr>
<td>R1</td>
<td>&lt; 10 (&lt; 10)§§</td>
<td>11 (9)</td>
</tr>
<tr>
<td>R2</td>
<td>&lt; 6 (&lt; 6)§§</td>
<td>0 (0)</td>
</tr>
<tr>
<td><strong>Primary colorectal cancer</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T stage††</td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1–T2</td>
<td>&lt; 6 (5)</td>
<td>11 (9)</td>
</tr>
<tr>
<td>T3–T4</td>
<td>60 (60)</td>
<td>63 (50)</td>
</tr>
<tr>
<td>N stage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N+</td>
<td>56 (56)</td>
<td>61 (49)</td>
</tr>
<tr>
<td>N–</td>
<td>&lt; 25 (&lt; 25)§§</td>
<td>21 (17)</td>
</tr>
<tr>
<td>NX</td>
<td>&lt; 6 (&lt; 6)§§</td>
<td>0 (0)</td>
</tr>
<tr>
<td><strong>Laterality‡‡</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td>29 (29)</td>
<td>11 (9)</td>
</tr>
<tr>
<td>Left</td>
<td>51 (51)</td>
<td>70 (56)</td>
</tr>
</tbody>
</table>

*IQR = interquartile range.†Unless otherwise indicated.†A patient may have had more than 1 resection; the denominator is the total number of resections.‡Nine patients excluded owing to missing data.§Eight patients excluded owing to missing data.¶Twenty-three patients excluded owing to missing data.**Fewer than 6 patients excluded owing to missing data.††Margin status for the liver resection was available for 84/100 (84%) of the simultaneous cases and 123/126 (98%) of the staged cases.‡‡Pathological data for the primary tumour were available for 80/100 (80%) of the simultaneous cases and 82/126 (65%) of the staged cases.§§As per institutional policy cells (< 6 cases) are suppressed.
tumour clearance. For these reasons we feel that comparative survival analyses of simultaneous versus staged resection of CRCLM would not provide meaningful or accurate information.

**Limitations**

Although our study provides data regarding the management and outcome of simultaneous compared with staged resections in a contemporary population-based cohort, certain methodological limitations require mention. Although the electronic data sources used in this study describe general aspects of disease, treatment and outcome for all patients in the province, detailed information related to postoperative complications and various factors that influenced surgeons to select a simultaneous approach versus a staged approach for individual patients is not available. In addition, given the time-based definition of synchronous disease, some patients who underwent a staged resection would have been inadvertently excluded from this analysis because their liver resection was performed 12 weeks after resection of the primary tumour. We also do not have detailed information regarding the burden of metastatic disease, and were were only able to describe the extent of disease based on what was resected. Despite these limitations a major strength of this study is the large, unselected study population without the single-institution biases based on referral patterns and surgical volume. As a result, the outcomes more accurately reflect what is being achieved in routine clinical practice.

### Table 3. Type of hepatic resection and location of primary colorectal tumour of patients with simultaneous resection of primary colorectal cancer and liver metastases in Ontario between 2002 and 2009, % (n = 100)*

<table>
<thead>
<tr>
<th>Resection</th>
<th>Right colon</th>
<th>Left colon</th>
<th>Rectal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major resection</td>
<td>38</td>
<td>14</td>
<td>0</td>
</tr>
<tr>
<td>Minor resection</td>
<td>24</td>
<td>14</td>
<td>18</td>
</tr>
<tr>
<td>Wedge resection</td>
<td>38</td>
<td>71</td>
<td>82</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

*Data available for 79 cases

### Table 4. Short- and long-term outcomes of patients with synchronous colorectal cancer liver metastases who underwent hepatic resection in Ontario between 2002 and 2009 (n = 226)

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Simultaneous n = 100</th>
<th>Staged n = 126</th>
</tr>
</thead>
<tbody>
<tr>
<td>30-d mortality†</td>
<td>&lt; 6 (&lt; 2)§</td>
<td>&lt; 6 (&lt; 3)§</td>
</tr>
<tr>
<td>90-d mortality†</td>
<td>&lt; 6 (&lt; 5)§</td>
<td>&lt; 6 (&lt; 3)§</td>
</tr>
<tr>
<td>Length of stay, mean/median, d‡</td>
<td>13/9</td>
<td>16/14</td>
</tr>
<tr>
<td>OS, median [IQR], mo</td>
<td>40 [32–48]</td>
<td>61 [46–85]</td>
</tr>
<tr>
<td>CSS, median [IQR], mo</td>
<td>43 [35–53]</td>
<td>53 [45–73]</td>
</tr>
<tr>
<td>5-year OS (95% CI)</td>
<td>36% [26%–45%]</td>
<td>51% [41%–60%]</td>
</tr>
<tr>
<td>5-year CSS (95% CI)</td>
<td>37% [25%–50%]</td>
<td>46% [35%–57%]</td>
</tr>
</tbody>
</table>

CI = confidence interval; CSS = cancer-specific survival; IQR = interquartile range; OS = overall survival.

### Table 5. Factors associated with CSS and OS among patients with synchronous colorectal cancer liver metastases treated with simultaneous resection in Ontario between 2002 and 2009 (n = 100*)

<table>
<thead>
<tr>
<th>Covariate</th>
<th>Multivariate analysis</th>
<th>Multivariate analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5-year CSS</td>
<td>HR (95%CI)</td>
</tr>
<tr>
<td>Patient-related</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age, yr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 65</td>
<td>55%</td>
<td>Ref</td>
</tr>
<tr>
<td>65–74</td>
<td>21%</td>
<td>2.18 (1.04–4.56)</td>
</tr>
<tr>
<td>≥ 75</td>
<td>0%</td>
<td>2.79 (1.12–6.96)</td>
</tr>
<tr>
<td>Charlson Comorbidity Index score</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>41%</td>
<td>Ref</td>
</tr>
<tr>
<td>≥ 1</td>
<td>0%</td>
<td>1.60 (0.63–4.08)</td>
</tr>
<tr>
<td>Disease-related</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean no. of lesions</td>
<td>0.58</td>
<td>0.005</td>
</tr>
<tr>
<td>&gt; 1</td>
<td>40%</td>
<td>Ref</td>
</tr>
<tr>
<td>≥ 1</td>
<td>36%</td>
<td>1.23 (0.59–2.4)</td>
</tr>
<tr>
<td>Mean size largest lesion, cm</td>
<td>0.13</td>
<td>0.15</td>
</tr>
<tr>
<td>&lt; 5</td>
<td>36%</td>
<td>Ref</td>
</tr>
<tr>
<td>≥ 5</td>
<td>37%</td>
<td>2.03 (0.61–5.10)</td>
</tr>
<tr>
<td>Treatment-related</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extent of surgical resection</td>
<td>0.038</td>
<td>0.027</td>
</tr>
<tr>
<td>Minor (&lt; 3 segments)</td>
<td>32%</td>
<td>Ref</td>
</tr>
<tr>
<td>Major (&gt; 3 segments)</td>
<td>57%</td>
<td>0.31 (0.10–0.94)</td>
</tr>
</tbody>
</table>

CI = confidence interval; CSS = cancer-specific survival; HR = hazard ratio; OS = overall survival.

*Seven cases excluded from analysis owing to unavailable data (number lesions, lesion size, extent of surgical resection).
CONCLUSION

Simultaneous resection of synchronous CRCLM is common in routine clinical practice. Compared with patients who underwent a staged approach, patients who underwent simultaneous resections had fewer and smaller liver metastases and received less aggressive resections. Simultaneous resection of the primary tumour and CRCLM in the general population appears to be safe, and a substantial proportion of patients will achieve long-term survival.

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Competing interests: None declared.

Contributors: S. Nanji, W. Mackillop and C. Booth designed the study. All authors acquired and analyzed the data. S. Nanji and C. Booth wrote the article, which all authors reviewed and approved for publication.

References

Endoscopic mucosal resection for high-grade dysplasia and intramucosal carcinoma: a Canadian experience

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Background: Endoscopic mucosal resection (EMR) is increasingly being used as a first-line treatment for Barrett esophagus (BE) with high-grade dysplasia (HGD) and intramucosal adenocarcinoma (IMC). We reviewed our experience with endoscopic treatment of BE with HGD and IMC at our institution with respect to eradication rates, complications and long-term recurrence.

Methods: We performed a single-centre retrospective review of all patients referred between October 2010 and August 2014 for EMR with dysplastic BE or IMC. We performed EMR using a cap-fitted endoscope, and the procedure was repeated every 3 months until eradication or progression of disease.

Results: A total of 28 patients were identified: 16 with dysplastic BE (14 HGD, 1 low-grade dysplasia, 1 intermediate dysplasia) and 12 with IMC. Complete eradication of HGD was achieved in 11 of 14 (79%) patients. Three of 12 (25%) patients initially referred with suspected IMC were found to have invasive adenocarcinoma on EMR. Eradication was successful in 8 of 9 (89%) patients with true IMC, with 1 patient progressing to salvage esophagectomy. Complications occurred in 2 of 28 (7%) patients; both had esophageal strictures managed with dilatation. Median duration of follow-up was 371 days.

Conclusion: Our experience supports the safety of EMR as a first-line treatment for patients with BE with dysplasia and IMC in early short-term follow-up.

Contexte : La mucosectomie endoscopique est de plus en plus utilisée en première intention pour l’œsophage de Barrett avec dysplasie de haut grade (DHG) et pour l’adénocarcinome intramuqueux. Nous avons passé en revue notre expérience du traitement endoscopique de l’œsophage de Barrett avec DHG et de l’adénocarcinome intramuqueux dans notre établissement aux plans des taux d’éradication, des complications et des récurrences à long terme.


Résultats : En tout, 28 patients ont été recensés : 16 présentaient un œsophage de Barrett dysplasique (14 DHG, 1 dysplasie de bas grade, 1 dysplasie intermédiaire) et 12 présentaient un adénocarcinome intramuqueux. Une éradication complète de la DHG a été obtenue chez 11 patients sur 14 (79 %). Chez 3 patients sur 12 (25 %) initialement adressés pour un adénocarcinome intramuqueux, la mucosectomie a révélé un adénocarcinome envahissant. Huit patients sur 9 (89 %) atteints d’un adénocarcinome intramuqueux avéré ont subi le traitement d’éradication avec succès, et 1 patient a dû subir une esophagectomie de sauvetage. Des complications sont survenues chez 2 patients sur 28 (7 %) ; les 2 patients ont présenté des sténoses œsophagiennes corrigées par dilatation. La durée médiane du suivi a été de 371 jours.

Conclusion : Notre expérience confirme l’innocuité de la mucosectomie endoscopique comme traitement de première intention chez les patients présentant un œsophage de Barrett dysplasique ou un adénocarcinome intramuqueux dans le contexte d’un suivi à court terme.
The incidence of esophageal adenocarcinoma is increasing 2% per year.\(^1\) The most clinically important risk factor for the development of esophageal adenocarcinoma is Barrett esophagus (BE), a premalignant change from normal esophageal squamous epithelium to metaplastic columnar epithelium-containing goblet cells resulting from gastroesophageal reflux.\(^2\) Endoscopic surveillance of BE is the standard of care to identify development of dysplasia. The development of dysplasia further enhances the risk of progression to adenocarcinoma.

The management of BE with high-grade dysplasia (HGD) is controversial. Multiple guidelines exist with respect to the management of HGD.\(^3,4\) Traditionally, the main options were endoscopic surveillance or eradication of HGD through surgical resection of the esophagus. There has been some controversy about the risk of progression of HGD to adenocarcinoma during surveillance. Some studies have reported a relatively high risk of progression,\(^5\) whereas other larger studies have argued that “low-risk” HGD lesions can be safely managed with endoscopic surveillance.\(^6,7\) Conversely, the surgical option, an esophagectomy, remains a complex and morbid operation.\(^8\)

Novel targeted endoscopic techniques, such as endoscopic mucosal resection (EMR) and radiofrequency ablation, are associated with lower morbidity and should be considered.\(^9\) Complete eradication of dysplasia can be achieved with these techniques in up to 96% of patients.\(^9-12\) We previously argued that a balanced approach should be taken: selected patients with HGD can be followed closely with endoscopic surveillance and EMR of any nodular lesions, followed by radiofrequency ablation for long segments as required.\(^13\) At our centre, thoracic surgery and surgical endoscopists work collaboratively to select appropriate patients for endoscopic eradication therapy.

Endoscopic mucosal resection can also be used to diagnose and treat selected patients with intramucosal adenocarcinoma (IMC) and is now considered first-line therapy for discrete unifocal IMC.\(^14\) As a resection technique, EMR yields a pathology specimen that can be used to diagnose local submucosal invasion. In the absence of invasion, IMC can be adequately treated with EMR and continued regular surveillance endoscopy. Successful curative resection rates of IMC with EMR have been in the range of 57%–96%.\(^15,16\)

In the present study, we sought to review our experience with endoscopic treatment of BE with HGD and IMC at our institution with respect to eradication rates, complications and long-term recurrence.

**Methods**

Patients were identified from a pre-established prospectively collected endoscopic procedures database (Clinical Outcomes Research Initiative [CORI]). We obtained research ethics board approval. We performed a search using “esophagogastro-duodenoscopy” as procedure in conjunction with the keywords “Barrett’s esophagus” and “malignancy.” Results were then manually searched to identify patients who underwent EMR between October 2010 and August 2014. Follow-up data were retrospectively collected from electronic records for endoscopy, imaging, operative and pathology reports; ambulatory clinic reports; and the last documented hospital visit.

The EMR procedure was performed using the Duette Multi-Band Mucosectomy device (Cook Medical). Dysplastic lesions were identified with a combination of location of prior biopsy sites, mucosal and vascular pattern abnormalities, and narrow band imaging. We used a cap-fitted endoscope to aspirate and band the selected mucosal area, followed by a snare resection supplemented with electrocautery according to the manufacturer’s instructions. We used this technique to resect all lesions that appeared dysplastic, either as a single specimen or in a piecemeal fashion to achieve complete gross resection.

We then reviewed pathology specimen results, and follow-up was determined depending on the findings. In the presence of invasive adenocarcinoma, the patient was referred for consideration of esophagectomy. In margin-negative IMC and HGD, patients were followed with endoscopy at 3-month intervals with repeat EMR of any suspicious lesions until there was eradication of all dysplastic mucosa, followed by an endoscopic surveillance regimen with 4-quadrant biopsies. In the presence of persistent long-segment BE, radiofrequency ablation was performed with a BarrX catheter after resection of discrete lesions amenable to EMR.

**Results**

We identified 28 consecutive patients undergoing EMR. Sixteen patients were referred with BE with dysplasia, and 12 were referred with IMC. Five of the patients referred for BE with dysplasia were eventually referred for radiofrequency ablation. Twenty patients were men and 8 were women. The mean age of patients was 67 (range 49–86) years. The median duration of follow-up was 371 days. A summary of patient results is shown in Figure 1.

**Barrett esophagus with dysplasia**

Of the 28 patients with BE referred for EMR, 14 patients had HGD, 1 patient had low-grade dysplasia (LGD), and 1 had intermediate dysplasia. Of those, 11 patients had biopsy-proven complete eradication of dysplasia. These results were achieved after a median of 1 (range 1–2) EMR session; the patients were followed for a median of 175 days and underwent a median of 3 endoscopy sessions, including the initial EMR sessions.

At final follow-up, 6 of these 11 patients had normal squamous epithelium on biopsy. These patients were
followed for a median of 193 days, receiving a median of 1 (range 1–2) EMR session and 3.5 (range 2–5) total endoscopy sessions. Three of these patients were referred for radiofrequency ablation, as they had long-segment BE.

At follow-up, 5 of these 11 patients had BE with no evidence of dysplasia on random biopsy. However, this patient subgroup has the shortest follow-up at a median of 121 days, receiving a median 2 (range 1–2) EMR sessions and 2 (range 2–4) total endoscopy sessions. Their follow-up is ongoing, with the intention of complete eradication of BE.

Three patients referred for EMR management of HGD did not achieve eradication of dysplasia. One patient died of unrelated acute lymphoblastic leukemia after a single EMR session. One patient had a single EMR session revealing HGD, and then surveillance endoscopy revealing BE without dysplasia followed by LGD on the last 2 sessions. In spite of persistent LGD on biopsy, this patient has been followed with close endoscopic surveillance for almost 4 years, and there has been no recurrent nodular disease. One patient has been followed with serial endoscopy and EMR over a period of 1.6 years, having received 4 EMR sessions and 2 surveillance endoscopy sessions during this time. Unfortunately, this patient has had persistent biopsies showing HGD. This patient had severe refractory reflux and, in the interim of endoscopic follow-up, underwent antireflux surgery. At the last surveillance endoscopy, pathological review confirmed BE with HGD, but the disease was limited to a discrete unifocal area. Endoscopic surveillance continues, with consideration of radiofrequency ablation.

**Intramucosal adenocarcinoma**

Twelve patients referred for EMR management had IMC. Three of these patients were referred for consideration of esophagectomy after a single EMR session, based on pathology results compatible with invasive disease. One
patient had prohibitive comorbidities that precluded surgery and died of their disease. Two patients went on to esophagectomy. Final pathology on surgical specimen was T3N1 and T0N1, respectively.

One patient was eventually found to have invasive adenocarcinoma on EMR specimen after 6 endoscopy sessions spread over a period of 1.3 years. Initial EMR pathology was IMC. Subsequent EMR specimens showed HGD. The sixth EMR session showed invasive adenocarcinoma, and the patient was referred for esophagectomy. Final pathology from their esophagectomy showed no evidence of invasive adenocarcinoma, but a background of HGD.

Eight of the 12 patients referred for IMC had complete R0 resections with no endoscopic evidence of recurrence after a median of 1 (range 1–3) EMR session. These patients were followed for a median of 4.5 endoscopy sessions over a median of 1.6 years of follow-up. Six of 8 patients had normal squamous esophageal mucosa on random biopsy at the last documented surveillance. Two patients had evidence of BE without dysplasia at the last biopsy. For both patients, routine surveillance endoscopy is ongoing.

Complications

There were no perforations, and no patients experienced postoperative bleeding requiring repeat intervention. Strictures developed in 2 patients, who had 2 and 3 EMR sessions for HGD, respectively. Both patients were treated successfully with a single balloon dilatation.

Discussion

Results from our experience are consistent with those of other series of endoscopic management of HGD. In our cohort referred for HGD, 11 of 14 (79%) patients had complete eradication of dysplasia. Although 2 patients have persistent dysplasia, HGD and LGD, they have been followed over the course of 570 and 1170 days, respectively, with close endoscopic surveillance and have shown no evidence of disease progression.

For patients referred for IMC, we achieved complete eradication of neoplasia in 8 of 9 (91%) patients.

Four patients were referred for consideration of esophagectomy in a fashion that did not affect oncologic outcome. Three of these 4 patients were immediately referred based on endoscopic appearance of submucosal invasion and corresponding pathologic confirmation of invasive adenocarcinoma. These were appropriate, timely referrals, as the 2 patients who underwent esophagectomy had evidence of nodal disease; final pathology was T3N1 and T0N1. One of these 4 patients had a delayed diagnosis of invasive adenocarcinoma after 6 endoscopy sessions over 466 days; however, the carcinoma detected after this time was an early curable carcinoma in situ.

Patients selected for our endoscopic management program had discrete unifocal nodules amenable to complete endoscopic resection. However, they must adhere to rigorous endoscopic surveillance. Our experience adds to the evidence that close endoscopic follow-up will detect progression of disease in a timely fashion.

Endoscopic ultrasonography was not used as a screening tool for patients selected for endoscopic management. This is consistent with other studies documenting the limited accuracy of endoscopic ultrasonography in staging early IMC and HGD.

Radiofrequency ablation was offered selectively to patients with long-segment BE after nodular regions were pathologically assessed by EMR. We chose to refer these patients for ablation, as serial EMR of long-segment BE has been associated with a higher rate of postoperative strictures, ranging from 37%–86%,12,19 A recent systematic review comparing serial EMR with EMR plus radiofrequency ablation for eradication of BE with HGD or IMC revealed similar rates of eradication of neoplasia (94.9% v. 93.4%, respectively) and metaplasia (79.6% v. 73.1%) at the expense of a significantly higher rate of structuring (33% v. 10%).20

Esophageal varices are a potential comorbidity limiting the ability to safely perform EMR. Although our series did not capture this scenario, case reports have described preoperative transjugular intrahepatic portosystemic shunt to decrease portal pressure to diminish varices, allowing for EMR. An alternative approach is band ligation of nodular regions of HGD or IMC, with biopsy as opposed to resection. The disadvantage of this technique is the lack of documentation of negative margin status.

Limitations

Limitations of our study include the retrospective nature of the data, which limits our interpretation of the potential long-term results. Despite a median follow-up of more than a year, there was significant heterogeneity in the follow-up data, as a group of patients was still actively undergoing endoscopic therapy for BE. This limited number of patients may not capture rare but potentially important complications, such as post-EMR bleeding or delayed stricturing. Also, the candidate patient population must be motivated and able to adhere to strict follow-up, as complete resolution with EMR may take several sessions, depending on the extent of the BE.

Conclusion

Endoscopic mucosal resection demonstrated safe management of this high-risk population of patients with BE with HGD and IMC. The lone patient in the IMC group who had a delayed diagnosis of invasive esophageal cancer actually turned out to have only in situ cancer.
Two patients in the HGD group have persistent dysplasia but have undergone close endoscopic surveillance for a long time period (570 and 1170 d, respectively) with no progression of disease. Complications were minor (structure), and were readily treated with endoscopic therapy.

Our multidisciplinary experience supports that endoscopic management can be safely performed as first-line treatment for patients with BE with dysplastic changes and also for selected patients with IMC.

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Competing interests: C. Li declares having received an educational grant from Medtronic Canada Inc. for the period July 2015 to June 2016. No other competing interests declared.

Contributors: D. Yamashita and J. Ellsmere designed the study. D. Yamashita, C. Li and J. Ellsmere acquired the data, which all authors analyzed. D. Yamashita, C. Li and J. Ellsmere wrote the article, which all authors reviewed and approved for publication.

References

The utility of thyroid ultrasonography in the management of thyroid nodules

Background: Ultrasoundography for thyroid nodules is one of the most common imaging tests performed in the general population. Details from ultrasound reports guide biopsies and surgery. This study quantifies the completeness of these reports based on Thyroid Imaging and Reporting System (TI-RADS) criteria and considers their utility in predicting malignant disease.

Methods: We retrospectively reviewed ultrasound reports for 329 thyroidectomy patients and extracted data elements using the TI-RADS criteria: nodule size, echogenicity, margins, vascularity, solid/cystic composition and the presence or absence of microcalcifications and the halo sign. We assessed the reports to determine whether individual or multiple criteria were associated with malignancy.

Results: More than 97% of reports document nodule size; however, more than 90% of the reports noted only 3 or fewer of the 6 remaining TI-RADS criteria. The presence of microcalcifications was the most sensitive marker of malignancy (> 90%), whereas the documentation of irregular margins was the most specific indicator of malignancy (88%). Overall it was clear that microcalcifications, hypoechoicinity, irregular margins and solid nodules were significantly more likely to be found in malignant neoplasms; their absence predicted benign disease. Because so few reports consistently documented all criteria, the overall ability of thyroid ultrasonography to discriminate between lower- and higher-risk nodules is limited.

Conclusion: Although the accuracy of thyroid ultrasonography is good, few ultrasound reports contain the necessary information, as defined by TI-RADS, to predict malignancy and guide management. When reported, microcalcifications and/or irregular margins are the best predictors of malignancy.
The increasing prevalence of thyroid nodules presents an important challenge to physicians who treat thyroid cancer.\(^1\)\(^–\)\(^3\) Palpation, the traditional means to identify thyroid nodules has been supplanted by ultrasonography; some studies have shown that more than half of all ultrasounds reveal nodular disease.\(^4\)\(^,\)\(^5\) More than 90% of all nodules represent benign disease, but because most nodules persist and rarely regress completely, the pre-eminent question facing physicians is how to use ultrasonography to identify and treat thyroid nodules.\(^6\)\(^,\)\(^7\) More than 30 studies in the last year alone have examined the utility of thyroid nodule ultrasonography to predict malignancy based on different features.\(^8\)\(^,\)\(^7\)\(^–\)\(^9\) In a recent meta-analysis, Brito and colleagues\(^1\)\(^1\) documented substantial heterogeneity across studies; the typical reporting schemes for thyroid ultrasounds are unclear, as is the practical utility of using ultrasounds to perform risk stratification of thyroid nodules.\(^1\)\(^1\)

The Thyroid Imaging and Reporting System (TI-RADS) was developed to provide a minimum common data set for standardized risk stratification of thyroid nodules.\(^7\)\(^,\)\(^12\)\(^–\)\(^15\) For a thyroid ultrasound report to conform to TI-RADS it must include the following nodule characteristics: marked hypoechogenicity, taller-than-wide shape, microcalcifications, irregular margins and solid component in addition to size.\(^2\)\(^,\)\(^15\)\(^–\)\(^17\) First used by Horvath and colleagues,\(^1\)\(^4\) the TI-RADS system is analogous to the standardization of breast imaging by which categories defining risk of malignancy are used as part of the synaptic reporting scheme for assessments.\(^1\)\(^5\) In a recent prospective study, mirroring the results of previous retrospective analyses, the risk of thyroid malignancy was found to be 0% in TI-RADS categories 1 and 2, 0.64% in category 3, 4.76% in category 4A, 66.67% in category 4B, 83.33% in category 4C and 100% in category 5.\(^8\) Since this initial work, the process has become generally accepted, with the American College of Radiology further defining the appropriate vocabulary. The European Thyroid Association (ETA), American Thyroid Association (ATA) and the American Association of Endocrinologists (AACE) endorse the use of ultrasonography to stratify nodules into low, intermediate, and high risk of malignancy.\(^1\)\(^5\)

The reality facing many physicians is that the reporting of thyroid ultrasounds originates from multiple sites and is dictated by physicians of varying experience, practice volumes and styles of documentation.\(^9\)\(^,\)\(^18\)\(^–\)\(^20\) There is very little research on the content of the actual ultrasound reports that radiologists provide to physicians. Thus, the value of ultrasound reports, regardless of whether they have used the TI-RADS reporting scheme or not, remains unclear. In a cohort of patients from a single endocrine surgery referral centre that treats both benign and malignant thyroid disease, we assessed the completeness of ultrasound reports against the TI-RADS criteria and then correlated the ultrasound findings with the final pathology.

**METHODS**

We performed a retrospective study comprising patients from a single surgical referral centre (at the University of Alberta) who had been assessed for thyroid surgery between January 2009 and December 2013. Permission to conduct this study was granted by the Health Research Ethics Board of Alberta (ethics approval #HREBA.CC-16–0359). We included patients who met the following criteria: they were assessed only for thyroid nodular pathology, had an ultrasound report within 18 months of referral, did not have previous neck or thyroid surgery, were older than 18 years, and underwent surgery that allowed for pathologic confirmation of the index nodule assessed by ultrasonography. We excluded patients in whom the ultrasound failed to detect a discrete lesion that was sonographically discernible; patients in whom no ultrasound was completed, or whose ultrasound report was dated more than 12 months before surgery; patients with a family history of thyroid cancer, as defined by 2 or more first-degree relatives; patients exposed to high-dose radiation either inadvertently or as part of medical treatment; and patients with subsequent pathology results revealing lymphoma.

Patients with complete ultrasound reports and final pathology were then included in the review, in which we assessed each report for inclusion of nodule size, macro- or microcalcifications, echogenicity, margins, halo sign, vascularity, and solid or cystic components. For the purposes of this study, a thyroid nodule was defined as a discrete lesion sonographically distinguishable from surrounding parenchyma. Internal components were recorded only if there was an explicit report of solid, cystic, or mixed components, and final analysis was carried out for any nodule with an explicit report of “solid” structure. Hypoechogenicity was recorded only if it was specifically noted or if a direct comparison was made to surrounding parenchyma or strap muscle. Microcalcifications were included if reported and/or if distinguished from macrocalcifications. Internal vascularity, halo sign or absence of a halo, and irregular margins were recorded only if it was specifically reported to be either present or absent. Size was always recorded.

**Statistical analysis**

Statistical analyses were performed using the 2-tailed Student t test for unpaired samples, with equal variance. We assessed the correlations using the Fisher exact test for tables and Spearman rank correlation for continuous variables. Statistical tests were 2-tailed, and we considered results to be significant at \( p < 0.05 \). We used descriptive statistics to present the study variables. Means and standard deviations are reported for the continuous variables, and frequencies and percentages are reported for categorical variables. We calculated likelihood ratios in view of the prevalence of disease, as defined histologically in our cohort or as defined theoretically based on...
the literature. We computed the following measures of test accuracy for each variable along with 95% confidence intervals (CIs): sensitivity, specificity, positive likelihood ratio and negative likelihood ratio. All statistical analyses were conducted using SPSS software version 15.

RESULTS

In total, 455 patients had been assessed for thyroid surgery during the study period. Of these, we excluded 66 patients owing to failure of the ultrasound to detect a discrete lesion that was sonographically discernible, 47 patients in whom no ultrasound was completed or whose report was dated more than 12 months before surgery, 5 patients with a family history of thyroid cancer, 5 patients who were exposed to high-dose radiation and 3 patients whose subsequent pathology results revealed lymphoma, leaving a final cohort of 329 patients. The demographic and clinical characteristics of the cohort are described in Table 1. As expected, there were significantly more women than men in our cohort, and the mean age of patients was 54 years. The size of the nodules assessed in men was slightly larger than in women, but the difference was not significant \( (p = 0.24) \). Approximately 42% of the nodules were malignant, and the difference in size between benign and malignant neoplasms was not significant \( (p = 0.11) \). Approximately 11% of specimens also exhibited incidental microcarcinomas on final pathology. The most common carcinoma was papillary thyroid cancer. Benign disease results were dominated by the pathologic description of multinodular goitre, followed by Hashimoto thyroiditis, follicular adenoma and hyperplasia.

The number of documented variables in the ultrasound reports describing the thyroid nodules was assessed and collated for all of the reports. We used the TI-RADS criteria to show what a complete ultrasound report should include: nodule size, echogenicity, vascularity, halo, margins and the presence or absence of microcalcifications. We interpreted the absence of any comment regarding individual criteria as not assessed rather than as a negative result. More than 97% of all reports commented on nodule size, but the descriptions of the other 6 criteria were much more varied. Figure 1 shows the number of reported criteria as a function of benign or malignant neoplasms. Nearly 40% of all reports examined included 1 or no criterion beyond a description of size. The overall distribution of reported scoring criteria did not vary significantly between benign and malignant nodules, and fewer than 10% of all reports described 4 or more criteria other than size. In terms of individually reported criteria, the percentage of reports with a comment was as follows: solid or cystic (51.8%), echogenicity (50.8%), vascularity (31.6%), microcalcifications (28.1%), irregular margins (14.7%), and halo sign (4.5%). There were no associations among the different reporting criteria. We checked for linkages, postulating that the presence of microcalcifications, for example, may trigger more detailed analysis regarding margins or other ultrasound features; however, we did not identify any associations \( (p = 0.22) \). In addition, neither patient age \(< 45\ yr\ v.\ > 45\ yr,\ p = 0.29\) nor sex \( (p = 0.45) \) correlated with the number of ultrasound features reported.

Using the variables reported, we assessed the correlation between the presence or absence of the 6 TI-RADS criteria and malignancy in the index lesion. As shown in Table 2, the presence of microcalcifications was noted in approximately 20% of reports, and the percentage of those reports correlating with malignancy was 31% compared with a
correlation of approximately 14% with benign neoplasms ($p = 0.044$). Similarly the description of a hypoechoic nodule ($p = 0.005$) or a solid nodule ($p = 0.004$) was significantly more likely to be identified in malignant neoplasms than in benign tumours. Interestingly the documentation of irregular margins demonstrated by far the highest discrepancy, more than 8-fold greater in malignant neoplasms than in benign disease ($p = 0.021$). Descriptions of vascularity ($p = 0.44$) and the presence or absence of a halo ($p = 0.99$) around the nodule were not linked to benign or malignant neoplasms pathologically. It is important to note that a significant proportion of benign nodules exhibited features concerning for malignancy, including microcalcifications and hypoechoigenicity, both of which were identified in 1 of every 7 benign nodules. In addition, the percentage of malignant specimens was 32% for nodules less than 2 cm and 28% for nodules greater than 2 cm. The number of reporting criteria did not vary based on nodule size ($p = 0.27$).

Based on the prevalence of malignancy in this cohort, we defined the sensitivity and specificity of the individual ultrasound features and their likelihood ratios (whether positive or negative) in relation to predicting or ruling out malignant disease. The results are outlined in Table 3. The presence of microcalcifications was the single most sensitive predictor of malignancy at just over 90%, with a positive likelihood ratio of 1.6 and a negative likelihood ratio of 0.2. The most specific indicator for a malignancy was irregular margins, with a positive likelihood ratio of 3.1 but a substantially larger CI (Table 3). The other criteria varied in sensitivity and specificity between 24% and 81% and typically exhibited broad CIs below and above 1. As most reports noted 1–3 features, we examined the utility of multiple ultrasound features to predict malignancy. For reports documenting 2 features, either microcalcifications and hypoechoigenicity or microcalcifications and irregular margins in a single nodule, the positive likelihood ratios were 5.2 and 1.7, respectively. Considering the number of reported features as a predictive measure, we found that reports containing at least 3 criteria yielded a positive likelihood ratio of 1.1 and a negative likelihood ratio of 0.9. Thus, the number of features reported did not reflect an increased risk of malignancy. Adjusting for prevalence between 0.5%, 5% and 50% did not substantially alter the likelihood ratios for the analysis. Although we intended to use the data to assess the reports as a function of the TI-RADS scoring system, so few reports documented 4 or more criteria that this was not possible. However, our calculated sensitivity and specificity values for the reported criteria are similar to those reported in the literature, including the study by Brito and colleagues, indicating that the TI-RADS scheme likely would be useful in risk stratification in low- and high-volume Canadian centres. Of note, we examined the geographical location (urban v. rural centres) of ultrasound reporting; there was no difference in the number of criteria reported ($p = 0.58$), nor were there significant variations in the sensitivity or specificity for individual ultrasound features.

**DISCUSSION**

In the present assessment of ultrasound reports for thyroid nodules we found that the typical report comments on size and 1 or 2 other criteria, such as echogenicity and solidity. Less than 30% of reports comment on 2 or more criteria beyond size. The number of reported criteria was not linked to the presence of malignant or benign neoplasms. The most common features reported (just over 50%) were

| Table 2. Correlation between ultrasound features and malignancy in the index lesion |
|-----------------------------------|-----------------|-----------------|------------------|------------------|
| Ultrasound feature                | Overall positive, % | Benign lesion, % | Malignant lesion, % | $p$ value |
| Microcalcifications               | 20.5             | 14.2            | 30.7             | 0.044          |
| Hypoechoic                       | 20.1             | 14.6            | 32.9             | 0.005          |
| Irregular margins                | 5.6              | 1.8             | 14.7             | 0.021          |
| Intranodular vascularity         | 23.3             | 21.9            | 26.1             | 0.44           |
| Halo sign                        | 2.9              | 3.2             | 1.1              | 0.99           |
| Primarily solid                  | 34.0             | 28.8            | 46.6             | 0.004          |

| Table 3. Sensitivity and specificity of ultrasound features and their likelihood ratios in relation to predicting or ruling out malignant disease |
|---------------------------------------------|-----------------|-----------------|------------------|------------------|
| Ultrasound feature                          | Sensitivity, %  | Specificity, %  | Positive likelihood ratio (95% CI) | Negative likelihood ratio (95% CI) |
| Microcalcifications                          | 90.4            | 43.0            | 1.6 (1.2–2.1)    | 0.2 (0.1–0.6)    |
| Hypoechoic                                   | 62.5            | 72.6            | 2.2 (1.8–2.8)    | 0.5 (0.4–0.7)    |
| Irregular margins                            | 36.8            | 87.5            | 3.1 (1.7–5.7)    | 0.7 (0.5–1.0)    |
| Intranodular vascularity                     | 77.7            | 24.2            | 1.0 (0.9–1.2)    | 0.9 (0.6–1.4)    |
| Halo sign                                    | 46.0            | 42.8            | 0.8 (0.6–1.1)    | 1.2 (1.0–1.5)    |
| Primarily solid                              | 81.1            | 45.6            | 1.5 (1.3–1.7)    | 0.4 (0.3–0.7)    |

CI = confidence interval.
echogenicity and solidity. There were no associations among reporting criteria; for example, the presence of microcalcifications did not trigger targeted comments about any other factor. This was true for all of the criteria. Malignant neoplasms were more likely to exhibit microcalcifications, hypoechoogenicity and irregular margins, and they were more likely to be primarily solid; however, a substantial fraction of benign tumours (14–29%) exhibited similar features. Consequently, the sensitivity and specificity of individual criteria were limited. Microcalcifications were the most sensitive marker of malignancy (90%); irregular margins were the most specific marker (88%). It should be noted that the interpretation of microcalcifications on images can be confused with the presence of echogenic foci secondary to colloid, and this may have decreased the specificity.12 No marker had both sensitivity and specificity exceeding 63%, and consequently the positive likelihood ratio varied between 0.8 and approximately 3.0 in the presence of individual markers. Of the reports that included any 2 criteria, including microcalcifications, echogenicity, irregular margins or solidity, the combined positive likelihood ratio increased to 5.2. To our knowledge, no study has previously investigated the reporting criteria of ultrasonographic images in a non-specialized setting or assessed their predictive value as a means to guide management of thyroid nodules. The typical ultrasound report provides limited information beyond the size of the nodule. However, the reported sensitivity and specificity values in our study correlate with those observed in our cohort.3–12,13 The most recent studies examining TI-RADS, both prospectively and retrospectively, allow for a clear distinction between malignant and benign nodules in the vast majority of cases when all scoring criteria are applied.8,10,11,15 Kwak and colleagues15 used a simplified reporting scheme that required reporting the presence of the following criteria: solid component, hypoechoogenicity, microlobulated or irregular margins, microcalcifications, and taller-than-wide shape. The benefit of this reporting scheme as opposed to earlier versions of TI-RADS was that it required fewer technical assessments than the original 12 criteria.14 In fact, even the presence of any 2 factors of microcalcifications, hypoechoogenicity, solidity, or irregular margins in the TI-RADS scoring system increases the risk of malignancy to 20%–50%, depending on the study. Conversely, the absence of these findings indicates that the risk of malignancy is 2% or less.8,10,11,15 We observed that the calculated sensitivity and specificity values obtained as a measure of the accuracy of ultrasound assessment were also consistent with the literature.

We believe that the TI-RADS system is applicable to our population, and the accuracy of ultrasound reports that include all the criteria is sufficient to predict the rate of malignancy.14,17,21,27,28 “The proper application of this system would benefit most from the use of standardized synoptic reporting tools that have been embraced by the surgical community as well as pathologists. In varied settings, including thyroid cancer and pancreatic cancer, synoptic reporting has been examined by international studies and validated as a method for capturing clinical data and improving patient outcomes.29–31 Technological advances have made ultrasonography more accessible, and surgeon-directed assessments are now significantly more likely to drive interventions.32,33 In fact, the lack of standardized reporting is driving the increased uptake of ultrasonography among surgeons owing to the varied quality of reports, and this trend is accelerating.33 Ultimately, the combined utilization of synoptic reports with a standardized data system such as TI-RADS could better target those individuals suitable for fine-needle aspiration biopsies and ultimately surgical intervention. This could minimize the current anxiety around thyroid carcinoma and create a more cost-effective assessment pathway for thyroid nodular disease.

Limitations

In applying our findings there are some limitations to consider. The most significant factor may be the disproportionately high malignancy rate in the patient population referred to our centre. This may be a reflection of the fact that patients observed in the community may tend to have smaller tumours, may be older or may lack evidence of other concerning ultrasound features, such as microcalcifications; these patients may not be referred for subsequent investigation and management. Certain patient criteria, such as younger age or smaller nodule size, may also have favoured a more conservative approach that did not include referral for further assessment. However, using varied prevalence rates accepted in the literature for thyroid malignancy in the general population (5%–12%), our likelihood ratios did not change significantly.1,4,27 One strength of our study is the inclusion of final pathology, which ultimately has the biggest impact on patient management and outcomes. While individual assessments of sensitivity and specificity could vary, our results are qualitatively similar to those documented in studies that examined individual ultrasound features and the likelihood of malignancy in both urban and rural settings.14,17,25,27,28 We acknowledge that there may be differences in the capabilities of individual ultrasonography machines that may limit in some form the reports provided. Finally, this was a retrospective assessment, and over the timeframe of the study there have been upgrades in technology and changes in ultrasonography protocol in different institutions. Despite these changes, ultrasound reports for the most recent 100 thyroid nodule referrals in 2016 still documented only a mean number of reporting features consistent with those observed in our cohort.
CONCLUSION

Although the accuracy of thyroid ultrasonography is good, few ultrasound reports contain the necessary information, as defined by TI-RADS, to predict malignancy and guide management. When reported, microcalcifications and/or irregular margins are the best predictors of malignancy.

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References

The adequacy of hepatopancreatobiliary training: How does operative exposure and perceived readiness in fellowship translate into subsequent practice?

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The knowledge currently required for surgical subspecialty practice has clearly exceeded the training capacity of most general surgery residencies. Concomitant expansion of nonsurgical treatments and the increasing complexity of operations have further limited the operative experience of residents and subsequently their confidence to operate independently. The educational impact of resident work hours and autonomy restrictions also remains uncertain.1 Most concerning is the lack of confidence to operate independently that has been reaffirmed as a common trait among general surgery graduates seeking postresidency subspecialty training.2 In this setting, fellowship programs offer an additional opportunity to improve operative skills, encourage autonomy and build confidence at the subspecialty level before starting independent practice. Improved clinical outcomes for complex operations performed at high-volume centres and growing public demands for safety have further propelled the phenomenon of surgical subspecialization. Currently, more than 80% of general surgery residents pursue postresidency subspecialty training.1

Over the last 3 decades, expansion in the scope and complexity of hepatopancreatobiliary (HPB) surgery has resulted in significant improvements in postoperative outcomes. As a result, the importance of dedicated fellowship training for HPB surgery is now well established, and the definition of formal program requirements has been actively pursued by a collaboration of the 3 distinct accrediting bodies within North America. Although major advances have been made in defining minimum case volume requirements, qualitative assessment of the operative experience remains challenging. Our research collaborative (HPB Manpower and Education Study Group) has previously explored the perceived case volume adequacy of core HPB procedures within fellowship programs. We conducted a 1-year follow-up survey targeting the same cohort to investigate the association between operative case volumes and comfort performing HPB procedures within initial independent practice.
cohort of fellows from our index study (Fellowship Council-accredited HPB programs in the 2013/2014 academic year), with the objective of understanding the association between operative case volumes and comfort performing HPB procedures within initial independent practice. Survey methodology interrogated 4 domains (demographics, education, practice profile, surgical experience) within 13 core HPB procedures. Our follow-up survey yielded a 91% (19/21) response rate. The mean age of respondents was 36 (range 33–43) years. Respondents had either just completed their first year of practice (11/19), or their second year of fellowship (8/19).

**First year of independent practice**

All 11 former HPB fellows reported affiliation with an academic institution. Eight are employed in university teaching hospitals (7 with full-time and 1 with part-time academic appointments), and 3 work in community hospitals with a general surgery residency. The average workload exceeds 60 hours per week for most (8/11) and comprises clinical care and surgery (68% [55%–90%]), research (12% [10%–25%]), teaching (9% [5%–20%]), and administrative activities (7% [5%–20%]). All former fellows had a practice mixture beyond isolated HPB surgery: combined with elective general surgery (4/11), acute care surgery (4/11) and liver transplantation (2/11). Reported specialty-specific practice encompassed 39% liver (10%–50%), 39% pancreas (20%–80%) and 18% biliary (10%–30%) pathologies. Most respondents (7/11) were not part of an HPB-specific call schedule, though only 4 participants did not work as part of an HPB group. Dedicated research time involved clinical research (6/11), basic science research (1/11), or both (4/11).

**Case volumes**

With the exception of open distal pancreatectomies and radical cholecystectomies, average case volumes were lower as an attending surgeon than as a fellow (Table 1). Case volumes for chronic pancreatitis were low during both training and the first year of practice. Hilar cholangiocarcinoma resections, pancreatic necrosectomy, drainage procedures, and celiac plexus blockade also remained infrequent.

**Comfort level performing HPB procedures**

Comfort in independently performing core HPB procedures was most often reported for intraoperative ultrasonography (IOUS; 100%), hepaticojejunostomy (100%), open (100%) and laparoscopic (94%) distal pancreatectomy, minor hepatectomy (94%), pancreaticoduodenectomy (94%), radical cholecystectomy (87%), drainage procedures for pancreatic pseudocysts (87%) and major hepatectomy (67%). Presence of a senior HPB surgeon, either as the primary surgeon or assistant, was considered necessary for hilar resection (73% of respondents), celiac plexus blockade (67%), and surgery for chronic pancreatitis (47%; Fig. 1). These comments are very interesting given the first survey observation that fellows often underestimate their adequacy of case volumes (major hepatectomies, pancreaticoduodenectomies and laparoscopic distal pancreatectomies) as well as their ability to operate independently (minor hepatectomies, hilar cholangiocarcinomas, celiac plexus blockade) when compared with program directors. Procedures for chronic pancreatitis deserve special mention. Previously reported low case volumes remained in this updated survey, and opinions about the comfort–volume association were mixed. This topic

| Table 1: The mean number of core HPB procedures performed during fellowship training compared with the first year of independent practice |
|------------------------------------------|--------|--------|
| Procedure                               | Fellow | Staff  |
| Major hepatectomy                        | 46     | 8      |
| Minor hepatectomy                        | 31     | 15     |
| Pancreaticoduodenectomy                  | 42     | 12     |
| Open distal pancreatectomy               | 5      | 8      |
| Laparoscopic distal pancreatectomy       | 15     | 4      |
| Drainage procedure for pancreatic necrosis | 8   | 1      |
| Surgery for chronic pancreatitis         | 2      | 2      |
| Pancreatic necrosectomy                  | 8      | 1      |
| Radical cholecystectomy                  | 5      | 6      |
| Hepaticojejunostomy                      | 21     | 3      |
| Resection of hilar cholangiocarcinoma    | 11     | 1      |
| Celiac plexus block                      | < 1    | < 1    |
| IOUS                                     | 144    | 27     |
| Complex biliary reconstruction           | 6      | 4      |

HPB = hepatopancreatobiliary; IOUS = intraoperative ultrasonography.
Fig. 1. Comfort level performing critical steps of core hepatopancreatobiliary (HPB) procedures during the first year of independent practice. DP = distal pancreatectomy; H-J = hepatico-jejunostomy; IOUS = intraoperative ultrasonography.

Fig. 2. Perceived impact of case volumes during fellowship training on comfort performing core hepatopancreatobiliary (HPB) procedures during the first year of independent practice. DP = distal pancreatectomy; H-J = hepatico-jejunostomy; IOUS = intraoperative ultrasonography.
remains a challenge for HPB educators, given that sound surgical judgment for pancreatitis can be extremely complex, more challenging than pancreatic oncology, and often reliant on high-volume exposure as well as a profound understanding of the disease. Laparoscopic distal pancreatectomies displayed a low (< 50%) reported rate of “good or excellent” case volume, but a high degree of preparedness during fellowship training. This updated survey confirms a high degree of comfort performing laparoscopic distal pancreatectomies, with 80% of respondents performing them independently and an additional 13% feeling comfortable enough to teach it to junior residents. These findings do not follow the trends identified for all other procedures and therefore reflect a relative degree of perceived technical simplicity. This is likely a direct result of mastery of the open procedure with a subsequent extrapolation to the laparoscopic methodology. It is also interesting to note that the structured exposure to IOUS in recent years within the FC/AHPBA-accredited fellowship programs (including curricular requirements via an IOUS course) has improved both case volumes and the experience of graduating fellows (high use and comfort by junior staff).

### VOLUME–COMFORT ASSOCIATION

Most respondents (83%) believed case volume during training significantly affected their operative comfort level during initial independent practice. This volume–comfort association was most often reported for major hepatectomy (92%), hilar resection (77%), pancreaticoduodenectomy (69%) and minor hepatectomy (69%; Fig. 2). For less frequently performed procedures (celiac plexus blockade and pancreatitis interventions), operative volume during training was not perceived to significantly impact comfort. Hilar lesions deserve additional comment given that less than 40% of fellows reported “good or excellent” exposure in our previous study. Because resectable hilar lesions are relatively rare malignancies, gaining high-volume exposure is unlikely to occur across all training programs. Despite the reality that much can be learned and transposed from other operations, such as major hepatectomies, hilar dissections and complex biliary reconstructions, surgical educators must continue to develop alternative approaches to teaching these complex procedures.

### OTHER CONSIDERATIONS

The number of HPB fellowship programs in North America was perceived to be excessive by 57% of respondents. All respondents believed they were adequately prepared during fellowship training, and half felt their goals were “completely” achieved: clinical expertise (100%), technical expertise (93%), development of a professional network (64%) and improved employability (43%). After the first year of practice, 42% were “very satisfied,” and 50% were “somewhat satisfied” in their jobs. While joining a group, half reported no issues with the transition, but adjustment to group practice was described as an obstacle not anticipated during training. Other hurdles encountered when entering practice included the logistics of billing and of setting up a practice. Suggested improvements in HPB fellowship training included greater autonomy while operating (suggested by 86%), discrete rotations at high-volume centres for specific diseases (64%) and a formal examination at the end of the fellowship (64%). In contrast to general surgery residency training, respondents reported a low interest (14%) in operative simulation to address areas of low preparedness and comfort.

### CONCLUSION

Our updated survey reaffirms the importance of case volumes in developing fellows’ confidence across a wide range of operative procedures encompassed by HPB surgery. Appropriate confidence to operate independently, successful placement of former fellows in academic HPB positions and overall perception of accomplishment of training goals are reassuring findings that support ongoing efforts to elevate the quality of HPB fellowship programs within North America.

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The University Health Network and the University of Toronto are conducting a search for a full-time academic plastic and reconstructive surgeon. The starting date of this position is beginning from July 2017.

The successful candidate will join a team of plastic and reconstructive surgeons with a focus on vascularized composite allograft transplantation and oncologic reconstructive surgery. The successful candidate must have completed specialized fellowship training in reconstructive microsurgery. Full commitment to academic activity is required.

The successful candidate must have a strong basic science research track record matching the clinical focus of the position that has resulted in a Ph.D. degree. Basic science research skills are important to suit the future growth plans for the division.

The candidate would support the ongoing teaching activities at the undergraduate and postgraduate and CEPD levels at the University of Toronto.

The candidate must be eligible for the academic appointment of Assistant Professor in the Faculty of Medicine, University of Toronto. Candidates must be eligible for certification with the RCPSC and licensure with CPSO.

Interested candidates should forward a letter of interest, a copy of their CV and the name of three referees by April 15, 2017 to:

Stefan O.P. Hofer, M.D., Ph.D., FRCS(C)
Chief Division of Plastic Surgery
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200 Elizabeth Street, 8N-865
Toronto, Ontario, Canada M5G 2C4
Email stefan.hofer@uhn.ca

The University Health Network and the University of Toronto are strongly committed to diversity within their communities, and especially welcome applications from visible minority group members, women, Aboriginal persons, persons with disabilities, members of sexual minority groups and others who may contribute to further diversification of ideas.

All qualified candidates are encouraged to apply; however, Canadians and permanent residents will be given priority.

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SURGICAL INTENSIVIST

Division of General Surgery and the Critical Care Program
University Health Network, University of Toronto

The Division of General Surgery and the Critical Care Medicine Program at the University Health Network and the University of Toronto are inviting applications for a full time faculty position as an Academic Surgical Intensivist at the level of Assistant Professor. The effective date of this position is July 1, 2017.

The successful candidate will support the clinical programs and academic mission of University Health Network, an academic institution fully-affiliated with the University of Toronto. The University Health Network is comprised of the Toronto General Hospital, Toronto Western Hospital, Princess Margaret Cancer Centre and the Toronto Rehabilitation Institute. UHN is recognized internationally for excellence in patient care, innovation, research and education.

The successful candidate must have completed a residency program in general surgery and have FRCS(C) qualification, as well as Royal College sub-specialty training in Critical Care Medicine or equivalent. He/She must hold, or be eligible for, licensure with the College of Physicians and Surgeons of Ontario. Strong academic credentials are essential. He/She will hold, or plan to obtain, a graduate degree (Masters or PhD). The candidate will have demonstrated outstanding technical skills, the ability to work within a multidisciplinary team and to teach trainees at all levels. The successful candidate must also have strong interpersonal and communication skills and thrive within collaborative and interdisciplinary programs involving multiple specialties.

There are 25 faculty in the Division of General Surgery. Surgical practice at UHN is diverse and challenging. UHN is internationally recognized for surgical oncology, transplantation and minimally invasive surgery. In the Division of General Surgery, responsibilities will include general surgery call at the attending staff level, practical and didactic teaching of general surgery junior and senior residents, as well as general surgery fellows. This position entails 20 to 30 hours of didactic undergraduate medical student teaching per year, in addition to supervision of 10 to 20 on-service medical students per year. The successful candidate will lead the inter-professional critical care team during clinical weeks on call in the role of attending physician at UHN – TGH MSICU or TWH MSNICU. The Toronto Western Hospital Medical-Surgical and Neuro-Intensive Care Unit provides specialized care to patients with brain, spine, neuromuscular and neurovascular disease, and also provides care to a general population of critically ill patients. The Medical Surgical ICU at Toronto General Hospital specialises in care of critically ill transplant patients and is the regional centre for extra-corporeal life support.

In addition, he/she will develop an academic profile and body of work in the field of surgical and critical care quality improvement and patient safety. The candidate will have demonstrated a strong academic commitment. Evidence of productivity, excellence, and the potential to become an international leader is essential. Start-up research support and mentoring will be provided.

Please submit a letter of intent, CV and the name of three referees by May 30, 2017 to:

Allan Okrainec, MD, MHPE, FRCS(C), FACS
Head, Division of General Surgery, UHN
Peter A. Crossgrove Chair in General Surgery
Toronto General Hospital
10 Eaton Room 220, 200 Elizabeth St.
Toronto, Ontario, Canada M5G 2C4

Questions and correspondence should be directed to: Deborah Wilson, email deborah.wilson@uhn.ca, tel 416 340-3573.

The University of Toronto is strongly committed to diversity within its community and especially welcomes applications from visible minority group members, women, Aboriginal persons, and persons with disabilities, members of sexual minority groups, and others who may contribute to the further diversification of ideas. All qualified candidates are encouraged to apply; however, Canadians and permanent residents will be given priority.

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ENDOCRINE SURGEON
Division of General Surgery
University Health Network, University of Toronto

The Division of General Surgery at the University Health Network and the University of Toronto are inviting applications for a full-time faculty position as an academic Endocrine Surgeon at the level of Clinical Lecturer or Assistant Professor. The effective date of this position is July 1, 2017.

The successful candidate will support the clinical programs and academic mission of University Health Network, which is an academic institution affiliated with the University of Toronto. The University Health Network is comprised of the Toronto General Hospital, Toronto Western Hospital, Princess Margaret Cancer Centre and the Toronto Rehabilitation Institute. UHN is recognized internationally for excellence in patient care, innovation, research and education. The Division of General Surgery currently has 25 surgeons, 2 of whom specialize in Endocrine Surgery.

The successful candidate will have completed a residency program in general surgery as well as an American Association of Endocrine Surgeons accredited fellowship in endocrine surgery (or equivalent), with an emphasis on thyroid and parathyroid oncology. She/He will have demonstrated outstanding technical skills, the ability to work within a multidisciplinary team and to teach trainees at all levels. She/He will hold, or be eligible for, licensure with the College of Physicians and Surgeons of Ontario.

The successful candidate will hold, or plan to obtain, a graduate degree (Masters or PhD). She/He will lead clinical and research academic initiatives focused on the management and outcomes of thyroid and parathyroid neoplasms. The candidate will have demonstrated a strong academic commitment. Evidence of productivity, excellence, and the potential to become an international leader is essential. Start-up research support and mentoring will be provided.

Responsibilities will include general surgery call at the attending staff level, practical and didactic teaching of general surgery junior and senior residents, as well as general surgery oncology fellows. This position entails 20 to 30 hours of didactic undergraduate medical student teaching per year, in addition to supervision of 10 to 20 on-service medical students per year.

Please submit a letter of intent, CV and the name of three referees by May 30, 2017 to:

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The University of Toronto is strongly committed to diversity within its community and especially welcomes applications from visible minority group members, women, Aboriginal persons, persons with disabilities, members of sexual minority groups, and others who may contribute to the further diversification of ideas. All qualified candidates are encouraged to apply; however, Canadians and permanent residents will be given priority.

For more information about the Faculty of Medicine/Department of Surgery, please visit our home page at http://surgery.utoronto.ca