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Printed by Dollicco Integrated Print Solutions, Ottawa. Appears in February, April, June, August, October and December.

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La revue est imprimée par Dollicco Integrated Print Solutions, Ottawa. Elle paraît en février, avril, juin, août, octobre et décembre.

Retournez toutes copies canadiennes non livrées au Centre des services aux membres, Association médicale canadienne, 1870, prom. Alta Vista, Ottawa (Ontario) K1G 6R7 (courriel : cmamsc@cma.ca).

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An article discussing a proposed curriculum to provide surgical training to family physicians is included in this issue of the journal. We decided to publish it with accompanying commentaries for and against the proposal in order to facilitate an informed debate. The argument for enhancing the surgical skills of family physicians is that they could provide surgical care for patients in remote locations, where surgeons may not be based. Those against the proposal question its premise; patients in remote areas have remarkably good access to surgical care and they expect the same standard of care as patients elsewhere.

The proposal comes at a time when specialty training is undergoing change. Rather than designing a training program as a time-based process for the sequential acquisition of knowledge and skill, it is suggested that progression of surgical training should depend on the acquisition of defined competencies. The Royal College of Physicians and Surgeons of Canada has given this transformation the name “competence by design” (CBD). While CBD implementation currently deals with postgraduate medical education (residency), the intention is to include the postcertification career training currently referred to as “continuing professional development” (CPD). One promised aspect of CBD is that it will permit surgeons to tailor their education to fit the practice required in their particular situations. Some surgeons will restrict their practices to areas of special interest (e.g., arthroplasty, hepatobiliary surgery); others will undertake cross-specialty training to expand their competencies (e.g., cesarian section performed by general surgeons). Where then does this proposal to train family physicians to undertake major surgery fit in the era of CBD?

Competence by design removes the element of time but does not alter the other fundamentals of training. All course modules have 4 elements: prerequisites, a learning phase, testing and maintenance of competence. Currently, the prerequisites for a trainee to undertake advanced surgical training is successful completion of the Principles of Surgery (POS) course and examination. While some credit should be given to certified family physicians, the proposal would need to include additional training and testing in the fundamentals of surgery to meet the validated prerequisite standard. Competence by design will accommodate a practising surgeon learning a new procedure where established surgical skills facilitate the acquisition of new skills. On the other hand, there is no reason to believe that non-surgeons, even if they have completed POS, would become competent more quickly than residents in training. If this is true, the curriculum for enhanced surgical skills cannot be completed within a year. More likely it would take the same effort and time as a conventional surgical training program — without the determined checks and balances of a certified training program. Patients and regulatory authorities expect physicians with surgical privileges to have passed standard tests of competence. Testing of cross-specialty competencies should remain within the responsibility of the subspecialty. Testing the wide range of competencies proposed in this curriculum will be logistically difficult. Training and testing within the time frame proposed is impossible. Finally, maintenance of competence has 3 elements: practice of the specific skill, practice of related skills and CPD. The premise of the proposal is that insufficient volumes of work are available in remote areas to maintain conventionally trained surgeons. In this situation, the family physician will be unable to maintain competence by practice of the specific or related skills and will have to spend an inordinate amount of time undertaking course-based CPD.

Provision of surgical services in a country as large as Canada requires collaboration between several levels of government, hospital authorities and several medical specialties. While the lack of a surgeon is often cited as the reason why a patient has to be transferred, the true logistical evaluation is always more complex. Surgeons who undertake care have to be prepared to deal with unexpected, difficult intraoperative findings and complex postoperative courses. Adages such as “preparing for the worst is better than hoping for the best” and “the last thing a surgeon learns is when not to operate” have stood the test of time. Good care of residents of remote areas must include close collaboration and
shared care with their family physician. This requires enhancement of skills over those practised by the urban family physician. It is unlikely that such enhancement would usefully include the addition of major surgery. The curriculum proposed for enhanced surgical skills of a family physician actually describes that of a generalist general surgeon. The authors of the curriculum proposal have identified a perceived need for surgery in underserviced areas of Canada. Simple dismissal of the proposal will not resolve the concern. The solution will require multilevel discussions about the roles of generalist general surgeons and family physicians with enhanced skills (general practitioners) in an era where super-specialization is threatening care in less populated districts.

Edward J. Harvey, MD; Vivian C. McAlister, MD
Coeditors, Canadian Journal of Surgery
Competing interests: E.J. Harvey is the Chief Medical Officer of Greybox Healthcare (Montréal) and Chairman of the Board of NXT-Sens Inc. (Montréal). None declared for V.C. McAlister.
DOI: 10.1503/cjs.015515

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pourra s’appliquer à un chirurgien en exercice qui apprend une nouvelle intervention : les compétences chirurgicales établies faciliteront l’acquisition des nouvelles compétences. D’autre part, il n’y a aucune raison de croire que les médecins non-chirurgiens — même s’ils ont terminé leur formation sur les principes fondamentaux de la chirurgie — deviendront compétents plus rapidement que les résidents en formation, auquel cas le programme d’acquisition de compétences chirurgicales avancée ne peut être terminé en 1 an. Il est plus probable qu’il nécessitera autant d’efforts et de temps qu’un programme classique de formation en chirurgie — sans les mécanismes de contrôle déterminés d’un programme de formation agréé. Les patients et les organismes de réglementation s’attendront à ce que les médecins qui ont des privilèges chirurgicaux aient réussi les examens normalisés de compétences. La responsabilité des examens sur les compétences interspécialités devrait continuer d’incomber à la surspécialité. Il sera difficile sur le plan logistique de tester la large gamme de compétences que ce programme propose. Il sera presque certainement impossible de dispenser la formation et de faire passer les examens selon le calendrier proposé. Enfin, le maintien des compétences comporte 3 éléments : la pratique de la compétence particulière, la pratique des compétences connexes et le développement professionnel continu. La proposition se fonde sur une prémisse, soit que les régions éloignées offrent un volume insuffisant de travail pour garder sur place des chirurgiens ayant reçu une formation classique. Or, dans une telle situation, le médecin de famille sera incapable de maintenir sa compétence par la pratique de la compétence particulière ou des compétences connexes. Il devra par ailleurs consacrer une quantité excessive de temps à suivre des cours pour son développement professionnel continu.

La prestation de services de chirurgie dans un pays aussi vaste que le Canada exige une collaboration entre plusieurs ordres de gouvernement, les administrations hospitalières et plusieurs spécialités médicales. Bien que l’absence d’un chirurgien soit souvent citée pour justifier le transfert d’un patient, la véritable évaluation logistique est toujours plus complexe. Les chirurgiens qui fournissent des soins doivent être prêts à faire face à des constatations intraopératoires inattendues et difficiles et à des développements postopératoires complexes. Des adages tels que « se préparer au pire est mieux qu’espérer le meilleur » et « la dernière chose qu’un chirurgien apprend est quand ne pas opérer » ont résisté à l’épreuve du temps. La prestation de bons soins aux habitants des régions éloignées doit reposer sur une étroite collaboration et le partage des soins avec les médecins de famille des patients. À cette fin, les médecins de ces régions doivent acquérir des compétences supplémentaires par rapport à celles dont ont besoin les médecins de famille en milieu urbain. Or, il est peu probable qu’il leur soit utile d’acquérir les compétences nécessaires pour la pratique de chirurgies lourdes. Le programme proposé pour l’acquisition par un médecin de famille de compétences chirurgicales avancée correspond en fait à la formation d’un chirurgien généraliste. Les auteurs du programme de formation proposé ont déterminé qu’il y avait un besoin perçu de compétences chirurgicales dans les régions mal desservies du Canada. Le simple rejet de la proposition ne résoudra pas le problème. Pour trouver une solution, il faudra tenir des discussions à plusieurs niveaux sur les rôles des chirurgiens généraux et des médecins de famille ayant des compétences avancées ( omnipraticiens), à une époque où la « super-spécialisation » menace les soins dans les régions les moins peuplées.

Edward J. Harvey, MD; Vivian C. McAlister, MD
Corédacteurs, Journal canadien de chirurgie

Intérêts concurrents: E.J. Harvey est médecin hygiéniste en chef de Greybox Healthcare (Montréal) et président du Conseil d’administration de NXTSens Inc. (Montréal). Aucun déclaré pour V.C. McAlister.

DOI: 10.1503/cjs.016015

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Why Canada needs networks to provide rural surgical care, including family doctors with essential surgical skills

Garth Warnock, MD, MSc
Peter Miles, MEd, MB

Accepted for publication
Oct. 26, 2015

See also the editorial on p. 364, the commentary by Vinden and Ott on p. 369, and the discussion paper by Caron and colleagues on p. 419

Correspondence to:
G. Warnock
University of British Columbia
Department of Surgery
3100 – 950 West 10th Avenue
Vancouver BC V5Z 1M9
garth.warnock@vch.ca

DOI: 10.1503/cjs.014715

SUMMARY
Time is long overdue for action to improve rural surgical services in Canada. In this issue of CJS, a proposed curriculum for the provision of enhanced surgical skills (ESS) to rural family physicians offers an opportunity to fortify a seamless network of high-quality surgical care for rural Canada. It is supported and enhanced by the best available evidence and measured advice from specialists and generalists alike. Publication of this curriculum proposal provides for essential dialogue with general surgeons. We discuss why we must play an active role in the development, teaching and evaluation of ESS, or we will have minimal influence and limited grounds on which to criticize its outcome or celebrate the opportunity of success it promises.

Two decades ago, a crisis was identified in recruiting and retaining specialist surgeons in rural communities throughout Canada.1 Since then, many communities with more than 5000 but less than 15 000 people have closed their local maternity and surgical service, leaving residents with hours of travel to larger centres.2 This shortfall has displaced risks and socioeconomic burdens of travel onto rural communities, shrunk capacity for local operative maternity care, degraded emergency care of bleeding and injured patients, and withered surgical infrastructure. These scenarios have prompted a rethink of ways to help remote communities sustain expertise in surgical care. A Taskforce on the Future of General Surgery in Canada validated concerns of the Canadian Association of General Surgeons (CAGS) about shortfalls in the preparation of rural general surgical specialists.3 A new curriculum is proposed, but it will take a decade to prepare new specialists, and it is unclear if these graduates can be enticed to work in isolated communities where they are susceptible to burnout.

A model of care that has kept lights on in some rural surgical programs is a collaboration of surgical specialists working together with family practitioners who have enhanced surgical skills (FPESS). Their patients have continued to receive high-quality care drawing upon an evidence-base confirming safety and efficacy of rural surgical and maternity care close to patients’ homes.2

A novel multistakeholder joint position paper developed with the collaboration of the Rural Committee of CAGS and endorsed by its executive presents an enlightened framework for high-quality rural surgical care.4 Built on the principle of a collaborative network, it transcends a static description of geographic positioning of physical and human resources by introducing a dynamic collaborating community of providers of surgical practice, including rural FPESS, surgical specialists, anesthesiologists, nurses, laboratory personnel and transport staff. The network carries a covenant that providers in all disciplines collectively share the responsibility of high-quality surgical care seamlessly provided by the right surgical specialist or generalist team at the right time with the right equipment and
COMMENTAIRE

in the right place for the right patient. The model welcomes leadership from general and obstetrical surgeons to attract graduating general surgical residents and locum surgeons to remote communities while promoting mentorship between specialists and family physicians. It pushes care beyond scheduled surgery to accommodate realities of providing surgery for trauma, emergency operative delivery and surgical emergencies that occur 24/7.

This issue of *CJS* presents a proposed curriculum and evaluation framework to prepare family practitioners who acquire ESS within the network model. It defines thoughtful care for essential and emergent surgical problems in the nonpregnant and pregnant abdomen as well as nonabdominal emergencies. It is directed toward rural physicians — not those who work downtown. Several aspects of this proposal merit scrutiny. First, can family practitioners acquire the skills identified within a more abbreviated period of training compared with surgical specialists? A compelling argument in support is that ESS trainees are exposed to the realities of rural medicine for 3 or more years, acquiring astute judgment of when and when not to offer surgical management remotely. The curriculum tailors their experience to manage diverse causes of right lower quadrant pain, including respect for the hostile peritoneal cavity. The capable family physician with laparoscopy skills can apply careful assessment and treatment without compromising care. Generalists who obtain cross-skills in body cavities, such as the pelvis (cesarean section), oropharynx (surgical airways) and the gastrointestinal tract (endoscopy), may deal confidently with categories of emergency identified in the curriculum. This preserves a collective experience of rural specialist surgeons who have long worked shoulder to shoulder with rural family physicians trained in similar programs in anesthesiology and operative delivery within a culture of patient safety. This proposal offers potential for measured, reported and examined outcomes going forward. Differences of opinion we might hold represent testable hypotheses to be evaluated within a networked, continuous quality improvement process.

An overarching concern is whether the proposed curriculum might degrade quality surgical care in rural Canada. Abundant evidence presented in the curriculum publication supports the contrary, as demonstrated by the research literature on high-quality maternity anesthesia and surgical care, including operative delivery, by family practitioners in rural centres. But we can do better. Building upon the network concept, there is already evidence that multiple surgical communities in Canada, large and small alike, such as the Surgical Quality Assurance Network of British Columbia, have examined their outcomes by peer review with the American College of Surgeons’ National Surgical Quality Improvement Program. Obstetrical outcomes are being tracked through the Managing Obstetrical Risk Efficiently in Obstetrics Program in Alberta, a comprehensive performance improvement initiative that creates a culture of patient safety in obstetrical units. Networked urban and rural surgical programs should likewise aspire to measure, report and examine the quality of surgical care regardless of whether patients receive care close to home or whether they are transferred to urban centres.

Might the proposed curriculum educate practitioners who become undisciplined, unaccountable “cowboys”? This is a risk for all disciplines, enabled by the silos in which we often work. We recommend that networks replace our present system of silos. Within the network, formal continuous quality improvement programs would hold all surgical staff accountable through common medical staff bylaws that follow due process. We can then adopt a unified patient-centred approach that sheds attitudes of professional condescension and tribal xenophobia.

Affiliations: From the Faculty of Medicine, University of British Columbia, Vancouver, BC (Warnock); and the Department of Surgery, Queen Elizabeth II Hospital, Grande Prairie, Alta. (Miles).

Competing interests: None declared.

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

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GPs with enhanced surgical skills: a questionable solution for remote surgical services

Christopher Vinden, MD
Michael C. Ott, MD, MSc

The Canadian College of Family Physicians recently decided to recognize family physicians with enhanced surgical skills (ESS) as a “Community of Practice” section analogous to Family Practice Anesthesia and Family Practice Emergency Medicine. In response, the National ESS Working Group has proposed a generic 1-year curriculum for the training and evaluation of the ESS skill set.1 This proposal is problematic on many fronts: the scope of practice is incredibly wide, the educational model is completely out of sync with current trends, and the underlying premise that patients should receive surgical care from family practitioners in order to avoid travel is a questionable solution to the issue of rural health care access.

This initiative lays out an ambitious curriculum through which family practitioners will be expected to gain competency for procedural skills in almost every surgical domain during a single additional year of training. From general surgery, the proposed curriculum covers laparoscopy and laparotomy; hernia repair; appendectomy; and perianal presentations, including hemorrhoids. Endoscopic skills would include management of both upper and lower gastrointestinal bleeding, as well as screening and surveillance. From obstetrics and gynecology, the skill set is proposed to include operative vaginal delivery, cesarean sections, dilation and curettage, ectopic pregnancy and tubal ligation, as well as ovarian and adnexal disease and hysteroscopy. The curriculum would also cover tonsillectomy and adenoidectomy from the field of otolaryngology; vasectomy, circumcision and management of acute testicular issues from the domain of urology; and small flaps, skin grafting, carpal tunnel release and extensor tendon repair from plastic surgery. In addition, it is proposed that the program will include training in procedural sedation and competency in ultrasonography.

Concerns with the proposed curriculum

Surgeons facile in all the proposed domains have rarely been seen since the 19th century. When one considers that many residents in focused general surgery programs still struggle with difficult appendices and hernias in their...
fifth year of residency, it seems naive to suggest that competency in the proposed curricula can be achieved during such a short training program. Moreover, one of the major challenges currently facing general surgical training is to ensure that residents develop competency in both open and laparoscopic domains within the 5-year training program. These issues are likely reflected by the recent 44% increase in American board examination failures as well as the increasing proportion of surgical trainees who complete fellowships after residency to gain additional experience. To suggest that general practitioners can master these same skills in a fraction of the time is not realistic. Some evidence of this can be drawn from the fact that the “GPs with enhanced surgical skills” currently practising in Western Canada, two-thirds also completed foreign fellowships unrecognized by the Royal College of Physicians and Surgeons of Canada (RCPSC). While these fellowships may not be recognized, many of these GPs likely acquired some surgical training before enrollment in the ESS program. The ability of this program to provide an alternate pathway that circumvents the rigours of the RCPSC certification process is concerning.

Another concern is that the educational model of the proposed curriculum diverges substantially from current trends in medical education. The RCPSC established the CanMEDS roles with the vision of training clinicians who encompass all of the competencies required to fulfill their obligations to patients. These competencies cannot be stripped from one another or developed in isolation. The CanMEDS roles, including the recent revision, continue to ensure that Canadian surgeons represent a broad set of competencies, not just a subset of technical skills. To distill what a surgeon represents to a community to a list of basic technical elective procedures downplays the importance of the competencies beyond the role of medical expert.

Furthermore, the RCPSC is embarking on an ambitious redesign of Canadian medical education with the introduction of the Competence by Design program, which aims to promote skills beyond competency and toward eventual expertise. Competency-based education is founded on the principle that competencies are learned and integrated in a longitudinal manner throughout undergraduate and postgraduate training. As surgical residents progress through the stages of this program (including transition to discipline, foundations of discipline, core of discipline, transition to practice and enhanced expertise), they mature in broad aspects of surgical care that are well beyond the simple technical tasks that they would learn from completion of a procedural module. The concept of “enhanced surgical skills” training, as described in the ESS proposal, is the antithesis of what competency-based training represents, wherein the fundamental principle is not just to master simple, straightforward cases but rather to be able to safely and competently manage complex, unexpected situations. To accept minimal competency in very select procedures is unacceptable to surgeons and the general public who expect and demand more of their physicians.

Separate from the educational issue is the fact that surgery differs drastically from general practice; surgery is almost always delivered as part of a complex team that includes anesthesiologists, operating room nurses as well as inpatient nursing and ancillary services. Surgical suites have complex infrastructure and equipment and teams that look after them. Hospital laboratory facilities and blood banks play a vital role, especially when surgeons encounter unexpected findings or complications. Radiology, particularly cross-sectional imaging and percutaneous approaches, also plays an ever increasing role in the delivery of modern, high-quality surgical care. All parts of the surgical team have to be functioning well to achieve consistent, high-quality outcomes. Moreover, whereas surgical teams gain skill through completion of a large volume of procedures, this is not likely to be true within general practice. Volume-outcome associations have been studied since the 1970s, and their effect at both the surgeon level and at the hospital level are well established. These effects are not confined to high-risk or complex surgery, but have also been shown to impact outcomes of simple procedures, such as endoscopy and inguinal hernia repair. Even within obstetrics, it has been demonstrated that complications are significantly greater in hospitals with low delivery volumes and that rural mothers in Canada have a 40% higher chance of major morbidity than urban mothers.

Although studies comparing outcomes between different specialties performing the same procedure are rare, a large Canadian study reported that rates of complications and missed colon cancers are significantly higher when colonoscopy is performed by family doctors than by gastroenterologists or general surgeons.

The background information in the ESS curriculum describes the obligation to travel for care as a significant barrier to equitable access for rural Canadians. The Canada Health Act mandates that Canadians should have “reasonable access” to insured services, a phrase that provides some latitude in interpretation. Perhaps more importantly, the Act also mandates that health care be delivered on uniform terms and conditions, a phrase that has much less latitude. For surgical care, equity in outcomes and quality should clearly take precedence over equity in travel times. Surgical outcomes last a lifetime, whereas travel times are measured in hours or minutes. Patient ideologies that place more importance on the location of the procedure than on the outcome are exceedingly rare outside of obstetrics and, even within obstetrical care, only a minority of patients willingly choose to have deliveries without backup services.

The threshold population size required to allow a viable and sustainable surgical service within a rural area is a debatable number and likely a moving target. If the population is too small, either the call becomes onerous or the practice volume becomes low enough that maintenance of competence and acquisition of experience become an
issue.3 Previous generations of surgeons were willing to tackle solo practice and onerous burdens of call, which facilitated surgical services in smaller centres, but such positions are unattractive to current surgical graduates. Australia, a country with similar population density to Canada, has detailed recommendations of population requirements to maintain viable specialist practices.15 For example, for Australian orthopedic surgeons, it is recommended that resident rural surgical services not be provided unless the service includes at least 3 surgeons and the population catchment is approximately 30,000. It is recommended that smaller communities be served by outreach programs rather than by a resident program. Canadian communities would be well served if similar recommendations were developed, as this would provide community members and politicians with realistic expectations regarding viable rural surgical services.

Addressing Access to Surgery in Remote Areas

While we object to the ESS proposal, it does highlight the fact that issues regarding access to surgery in remote areas have not been adequately addressed within this country. Reasons for this are multifactorial, with the dominant historical explanations being a lack of available manpower and supporting infrastructure, in addition to unattractive remuneration models.3 While Canadian-trained surgeons have historically been able to find “more appealing positions,” this situation is likely to change drastically within the next few years. Given that the number of trainees has been substantially above replacement levels for several surgical specialties, an oversupply of new graduates will ultimately result in shifts in the job market. The ESS policy will only worsen this issue, as small communities trying to attract surgeons will find increasing difficulty if valuable resources are consumed by family practitioners doing easy elective procedures or endoscopy.

The other historical impediment has been a training model that did not prepare general surgeons for isolated remote practice. The RCPSC’s new competency-based training program may offer a solution to this issue by providing trainees with the opportunity to acquire skills within the community setting. During the transition to practice phase of the program, surgical residents will be able to train in communities similar to those they intend to serve rather than continuing training in tertiary care teaching centres. Under-serviced communities will be better served by competent surgeons who can deal with the simple and complex, the elective and emergent, and who have the nonprocedural-based expertise of a dedicated surgeon rather than a family practitioner with limited surgical skills.

While we cannot support ESS as an appropriate solution for rural Canadians, we do feel that the impending manpower surplus creates considerable opportunities to address these issues. The national strategy should frame the debate with a detailed analysis of what a rural community can realistically expect for both resident and outreach surgical services and then focus on mechanisms that make community practice in underserviced areas attractive to new graduates in surgical disciplines. Strategies such as changes in remuneration practices, a nationally coordinated long-term locum system and enhanced training in community practice during surgical training will provide rural Canadians with truly competent surgeons.

Affiliations: From the Schulich School of Medicine and Dentistry, Western University, London, Ont. (Vinden, Ott).

Competing interests: None declared.

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

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Providing mentorship support to general surgery residents: a model for structured group facilitation

Mentorship has been a cornerstone of surgical education since its inception and over the course of the past century has evolved beyond surgical role-modelling to a mutual relationship in which an individual draws on past experiences to promote the personal or professional growth of another. Although mentorship is often thought of as occurring in a vertical, dyadic pairing between a senior staff physician and junior trainee, mentorship can also occur horizontally in a peer or group format. Mentorship within medicine has many recognized benefits, including increased career satisfaction, perceived academic success, networking, stress management, academic productivity and work–family balance for mentees. Mentors report increased personal satisfaction, positive relationships with residents and faculty members and increased opportunities for career advancement.

While informal vertical mentorship relationships are common within surgical training and have high levels of trainee satisfaction, they may not provide the same degree of structured outcomes and accessibility as formal mentorship programs. Informal mentorship relationships may self-select for outgoing and socially dominant trainees and exclude those who may be more introverted or part of a marginalized group, often visible minorities and women. Residents without mentors often identify the lack of a formal program as a major barrier to finding one. Once established, mentorship relationships in surgery are often subject to scheduling and time pressures, which may limit their impact.

The University of Ottawa General Surgery Mentorship Program was developed in recognition of the benefits of mentorship in surgical training with an understanding of the barriers to providing inclusive and meaningful mentorship opportunities, particularly among junior trainees. The themes explored in the 8-module program were identified as priority areas for junior surgical trainee development through a literature review and feedback from residents and staff surgeons within the general surgery program. The program was well-received by staff and resident participants and may provide a time-efficient and inclusive mentorship structure with the additional benefit of peer support. We review the development and implementation of the program to date and share our mentorship experience to encourage the growth of formal mentorship opportunities within general surgery training programs.
training program (Appendix 1, available at canjsurg.ca). Modules were completed throughout the first 2 years of residency training and were facilitated in an informal environment by a staff physician mentor following the same cohort of residents throughout the program. The module themes included a program introduction, health and wellness, study skills, leadership styles, conflict resolution, team management, career development and a wrap-up session. Each module was structured around a theme and included supplemental resources for discussion, including a TED talk and reading from the surgical literature. The program provided structured guidance for mentors and mentees with regards to module topics, but the way in which each topic was explored and the use of supplemental resources was determined by the mentor and mentee group. The creation of a longitudinal structured mentorship relationship within an informal environment was intended to promote the benefits of mentorship, while also promoting the development of a peer support network.

Participation in the program was voluntary for both mentors and mentees, with all residents choosing to participate. At the conclusion of its first year, the impact of the mentorship program was evaluated with anonymous participant program evaluations rating perceived benefits identified from the mentorship literature as well as participants’ module-specific experiences and perceptions of the overall program structure on a 5-point Likert scale. At the time of evaluation all 8 program modules had been completed across the first- and second-year resident cohorts.

Residents across both groups rated the utility of the sessions, improvements in their understanding of the issues raised in the module and the supportive environment of their mentors and fellow mentees very highly. Residents rated all perceived mentorship benefits as neutral or higher as a result of the program, with the most benefit seen in the areas of positive impact on residency life, increased collegiality and the opportunity for reflection. Residents also identified the program as helping them to become stronger residents through improved motivation, improved work-life balance, increased confidence, improved creativity and goal setting. Residents felt encouraged to pursue independent one-on-one mentorship relationships at the conclusion of the program. Staff surgeon mentors also rated their perceived benefits highly, including increased collegiality with the residents, increased personal satisfaction and an opportunity to reflect on their own practices. They felt they had made a positive impact on their mentees and that the program had positively impacted their lives, and they would consider participating again.

Use of the supplemental resources varied between and among the first- and second-year mentorship groups, with some participants rating them very highly and others rating them neutrally. Beyond the variable response to the supplemental resources, all participants felt the program should continue to be offered in its current form to incoming resident cohorts over their first 2 years of training. With regards to mentorship in senior training years, the majority of participants recommended a transition to self-selected, one-on-one mentorship relationships, but some expressed interest in an ongoing group program.

Overall, our initial program evaluation indicates that the recognized benefits of mentorship may be achieved in a facilitated, structured group format with high mentor and mentee satisfaction. The program is perceived to be of benefit to general surgery trainees during their first 2 years of residency, promotes inclusive mentorship opportunities for residents and may support the formation of self-selected independent mentorship relationships at the completion of the structured program. The group format may also help alleviate time pressures on participants by providing an opportunity for longitudinal mentorship relationships among a cohort of residents developed across multiple brief sessions. Lack of mentorship opportunities and social supports within Canadian general surgery training programs have been identified as potential contributors to resident burnout and attrition. The access to mentorship combined with increased collegiality and peer support provided by a facilitated group program may improve the training experience of general surgery residents and support their overall career development.

Affiliations: From the Division of General Surgery, Department of Surgery, The Ottawa Hospital, Faculty of Medicine, University of Ottawa (Champion, Bennett, Carver, El Tawil, Fabbro, Howatt, Noet, Rae); the Department of Surgery, The Ottawa Hospital Research Institute, University of Ottawa (Haggar); and the Division of General Surgery, Department of Surgery, Faculty of Medicine, University of Ottawa (Arnaout), Ottawa, Ont.

Competing interests: None declared.

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

References

Current perioperative practice in Canadian vascular surgery

Mark Rockley, BSc
Kathleen Chu, BSc
Jason Bayne, MD


Accepted for publication April 7, 2015

Correspondence to:
M. Rockley
The Ottawa Hospital – Civic Campus
Rm A-280, 1053 Carling Ave
Ottawa ON K1Y 4E9
mrockley@ualberta.ca

DOI: 10.1503/cjs.013614

Background: The Enhanced Recovery After Surgery (ERAS) Society has set out to improve patient recovery by developing evidence-based perioperative practices. Many institutions and other specialties have begun to apply their principles with great success; however, ERAS principles focus mostly on general surgery, and their applicability to other specialties, such as vascular surgery, is less clear. We sought to investigate the current standard of perioperative care in Canadian vascular surgery by assessing surgeons’ perceptions of evidence supporting ERAS practices, identifying barriers to aligning them and identifying aspects of perioperative care that require research specific to vascular surgery before they could be broadly applied.

Methods: We administered an online survey with 26 questions to all Canadian Society for Vascular Surgery members.

Results: Respondents varied largely in perioperative practice, most notably in the use of nasogastric tubes, Foley catheters and neck drains. Familiarity with supporting evidence was poor. Approximately half (44%) of respondents were not familiar with contrary evidence, while those who were often perceived institutional barriers to change. Finally, one-third (30%) of respondents felt that relevant evidence did not exist to support changing their practice.

Conclusion: The variability of perioperative practice in Canadian vascular surgery is likely due to multiple factors, including a lack of specific evidence. Further research in areas of perioperative vascular care where the current standard of practice varies most greatly may help improve recovery after vascular surgery in Canada over simply adopting existing ERAS principles.


Méthodes : Nous avons mené un sondage en ligne de 26 questions auprès de tous les membres de la Société canadienne de chirurgie vasculaire.

Résultats : La pratique périopératoire des répondants variait considérablement, surtout en ce qui concerne l’usage des sondes naso-gastriques, des cathéters de Foley et des drains de cou. La connaissance des données probantes à l’appui était faible. Environ la moitié (44%) des répondants ne connaissaient pas bien les données probantes allant à l’encontre de ces pratiques, et ceux qui le connaissaient percevaient souvent des obstacles institutionnels au changement. Enfin, le tiers (30%) des répondants étaient d’avis qu’aucune donnée probante pertinente ne justifiait un changement de pratique.

Conclusion : La variabilité de la pratique périopératoire en chirurgie vasculaire au Canada est probablement attribuable à de multiples facteurs, y compris le manque de données probantes précises. Des recherches plus poussées dans les domaines des soins vasculaires périopératoires où la norme actuelle de pratique varie le plus pourraient aider à améliorer la convalescence après une chirurgie vasculaire au Canada par rapport à la simple application des principes de l’ERAS.
A growing body of evidence in multiple surgical specialties suggests that the traditional perioperative care of surgical patients needs to be updated. As the evidence supporting updated perioperative management builds, a gap has developed between actual practice and the established best practice from the literature. This gap is evident in a variety of common perioperative management principles.

Attempts in specialties such as general surgery have been made to create a perioperative practice that reflects current evidence. For example, the Enhanced Recovery After Surgery (ERAS) Society was formed to aggregate various evidence-practice gaps into a “multimodal perioperative care pathway designed to achieve early recovery for patients undergoing major surgery.” The ERAS Society has published 3 specific guidelines for perioperative practice specific to the practice of general surgery.

Unfortunately, evidence specific to the perioperative management of vascular surgery patients is not as well established as it is for their general surgery counterparts. While randomized trials have generally supported the implementation of ERAS concepts in major vascular surgery, these trials were relatively small and did not specifically support the individual components of ERAS protocols. Some areas of perioperative practice have been specifically investigated in vascular surgery patients, while many other areas have yet to be individually investigated with robust studies in the vascular surgery literature. As such, these minimally examined areas of perioperative care in vascular surgery present an opportunity to establish directed investigations to guide practice.

To direct future focused investigation in vascular perioperative management we must first understand the current state of practice and surgeons’ impressions of the current evidence. The primary objective of this study was to review the current standard of perioperative care in Canadian vascular surgery. We also assessed the perceptions of evidence in perioperative care and identified barriers to changing perioperative practice.

**Methods**

We sent an online survey (Appendix 1, available at canjsurg.ca) to all Canadian Society for Vascular Surgery (CSVS) members, inquiring about specific components of perioperative practices. Four subsequent reminders to participate in the survey were distributed until an insignificant increase in response rate was achieved. Surgeons were asked to describe their perceptions of current evidence in perioperative care and the barriers that limit potential change in their practices. The survey was developed using validated research techniques of surveying physicians, and was reviewed by University of Alberta statisticians for scientific consistency.

The questions in this survey were constructed using the ERAS guidelines as a framework to delineate components of perioperative practice:

**Preoperative**
- Clear fluids fast before surgery
- Solid food fast before surgery
- Preoperative use of oral bowel preparation
- Use of epidural analgesia

**Intraoperative**
- Use of abdominal drains

**Postoperative**
- Use of postoperative nasogastric tubes
- Foley catheter removal, regardless of epidural analgesia
- Use of chewing gum

**Results**

Of the 135 CSVS members who received the survey, 51 (38%) responded. Figure 1 shows the typical preoperative fasting instructions given to patients. The most common instruction was the traditional guideline of fasting at midnight before surgery. Only 13% of respondents practised in line with the Cochrane Review findings at the time of our survey; however, 21% of respondents commented that there is a lack of relevant evidence in vascular surgery to support this guideline (Table 1).

The reported use of routine postoperative drains is displayed in Figure 2. While 96% of respondents avoid routine abdominal drainage, drains are more commonly placed in the groin and neck. Figure 3 displays the use of Foley catheters. Although 79% of respondents routinely use Foley catheters while there is epidural analgesia, the majority of those users believe that it is safe to remove Foley catheters during epidural analgesia.

**Fig. 1.** Preoperative fasting instructions given by respondents to their patients.
We also sought to characterize the perceived barriers to changing perioperative care (Table 1). For each of the perioperative components, the most common response was that there is “no need to change.” An average of 30% of respondents felt that there is a lack of relevant evidence to justify changing their practices. As well, there were significant institutional barriers to changing preoperative fasting timelines and postoperative Foley catheter removal.

Finally, respondents were asked to relate their practices with their understanding of current evidence (Table 2). The most common answer was that respondents were “unaware of evidence contrary” to their practices. Of those who were aware of contrary evidence, respondents were least convinced by evidence surrounding early nasogastric tube removal and the use of postoperative chewing gum. In addition, respondents were most likely to manage Foley catheters contrary to their belief of opposing evidence.

**DISCUSSION**

In recent years, the awareness of perioperative research and resulting changes in practice have resulted in similar surveys in other surgical specialties. A common theme of both these previous surveys and ours is variability in the management of perioperative care. Interestingly, this variability is not always confined to the components of perioperative care that have minimal supporting evidence, and may be attributable to multiple external factors.
In our survey, the majority of respondents reported routinely avoiding abdominal drainage, which may be a result of convincing evidence over the last 2 decades in general surgery. There is less evidence regarding the routine use of groin and neck drains in any surgical specialty, and the current practice is accordingly variable. In particular, the bimodal distribution of neck drain placement indicates that surgeons are conflicted about their utility. Respondents also identified the management of postoperative nasogastric tubes as being supported by unconvincing evidence, which is reflected in the variability seen in current practice. These results are contrasted by a survey of general surgeons, who use nasogastric tubes less frequently, and are supported by more robust evidence specific to their specialty. The use of both postoperative nasogastric tubes and nonabdominal drains are areas of perioperative management that would therefore benefit from focused research in vascular surgery.

The lack of relevant research, however, was not the only barrier to changing perioperative management. External factors, such as anesthesia, nursing and institutional protocols, were cited as barriers to changing preoperative fasting guidelines and timing of Foley catheter removal. These barriers should not be dismissed, as more than half of the respondents who routinely use Foley catheters during epidural anesthesia believe that it is actually safe to remove the catheters. Establishing focused perioperative evidence in these topics and further dissemination of existing evidence may help with advancing institutional change.

Although we have identified multiple components of perioperative practice for which there are barriers to change, many respondents reported that there is no need to change. In addition, the most prevalent barrier reported was a lack of awareness of evidence contrary to current practice. Thus, there is an opportunity to discuss the current evidence for perioperative management in vascular surgery to potentially improve patient care.

**CONCLUSION**

Perioperative practice in vascular surgery varies nationally, and we have identified multiple trends of practice in vascular surgery that conflict with evidence established in other surgical specialties. Respondents identified the use of postoperative nasogastric tubes and nonabdominal drains as areas of limited relevant evidence in vascular surgery, which would benefit from further investigation. In addition, surgeons perceive multiple external pressures that influence their perioperative management. Components most prominently affected by external pressures include preoperative fasting and postoperative Foley catheter removal timelines. While components of ERAS may promote evidence-based practice and improve patient care in general surgery, broad implementation of a general surgery–based ERAS program in vascular surgery may have negative effects if evidence is not first established and accepted by vascular surgeons.

**Affiliations:** All authors are from the University of Alberta, Edmonton, Alta.

**Competing interests:** None declared.

**Contributors:** M. Rockley and J. Bayne designed the study. M. Rockley acquired the data, which all authors analysed. All authors wrote and reviewed the article and approved the final version for publication.

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Randomized controlled trial to investigate the
effect of metal clips on early migration during
stent implantation for malignant esophageal
stricture

Changxiong Wang, MD
Cui Lou, MD

Accepted for publication
May 12, 2015

Correspondence to:
C. Wang or C. Lui
Digestive Endoscopy Center
Lishui People’s Hospital
Lishui 323000
Zhejiang, China
wangchenbo2006@163.com
lou_cui@126.com

DOI: 10.1503/cjs.002615

Background: The rate of stent migration, especially in the short term after implantation, is high in the treatment process. We sought to explore an effective method for preventing early migration after stent implantation for malignant esophageal stricture and to provide the basis for clinical treatment.

Methods: We conducted a prospective, open-label, parallel-assignment randomized controlled trial with patients undergoing stent implantation for malignant esophageal stricture. The proximal segments of stents in the treatment group were fixed with 2 metal clips during the perioperative period of esophageal stent implantation, while no treatment was used in the control group. All patients underwent radiography at 3 and 7 days and 1 and 3 months after placement to assess the stent migration.

Results: There were 83 patients in our study. Demographic characteristics were similar between the groups. There was no stent migration observed in the treatment group within 2 weeks of the operation, while stent migration was observed in 6 of 41 (14.6%) cases in the control group, occurring at 3 and 7 days after placement. There were no perioperative complications.

Conclusion: Perioperative fixation of the proximal segments of stents with metal clips is effective in preventing early stent migration.
Esophageal cancer is one of the most common malignant tumors in China, ranking second in all digestive malignancies. China ranks first worldwide in incidence of and death from esophageal cancer.\(^1\) When esophageal cancers are associated with progressive dysphagia, 60%–70% of them have already lost surgical indications,\(^2\) and stent implantation remains the primary option.\(^3\)–\(^7\) Esophageal stent implantation can rapidly re-establish the esophageal passage, relieve stricture symptoms, improve the nutritional status and replace esophageal reconstruction surgery, which is risky and traumatic. Therefore, esophageal stent implantation is of high clinical importance.\(^8\) Because of various reasons, stent migration often occurs after implantation, especially in the short term. Between January 2011 and December 2013, we used metal clips to clamp and fix the esophageal stents during the perioperative period to prevent stent migration.

**METHODS**

We studied adult patients who underwent stent implantation for malignant esophageal stricture in our hospital between January 2011 and December 2013. Diagnoses of all patients were confirmed with gastroscopic and histological examinations. The Clinical Trials Committee of Lishui People’s Hospital approved our study protocol, and all participants provided written informed consent before enrolling in the trial.

The patients were randomly assigned to the treatment or control groups using a random number table. We used an allocation concealment method in which the researchers responsible for study grouping did not participate in the inclusion of participants or any other process during the trial. Our study was an open-label clinical trial because the assessors of stent migration could not be blinded. Each assessor’s results were confirmed by a second person in order to reduce bias.

The equipment and materials used in this study were as follows: oral electronic gastroscope (Olympus GIF-H260), nasal gastroscope (Olympus GIF-N260), esophageal dilation bougie in diameter sizes of 5, 7 and 9 mm (Cook, SGD-100–1), Blue Zebra guidewire (Medi-Globe, GGW-03–35–450), silicone-coated esophageal stents with a diameter size of 20 mm and lengths of 80–120 mm (Micro-Tech Co. Ltd., MTN-SE), disposable esophageal stent inserter with a diameter of 8 mm and length of 650 mm (Micro-Tech Co. Ltd., MTN-SR) and cold saline. Uncovered metal stents were used in this study. Stent migration is defined as a deviation or change in the stent position in the human digestive tract, which leads to partial or complete loss of luminal dilation.

Electrocardiograms, blood tests and blood clotting time were examined in all patients, and the results matched the surgical requirements. Water deprivation and fasting were prescribed for 12 hours before the surgery, and lidocaine jelly was administered orally 10 min before the operation. In the control group, an endoscope was inserted at the proximal end of the lesion site, and a Zebra guidewire was extended to the gastric cavity under radiography guidance. After the stricture site and length were confirmed dually by endoscopy and radiography, a bougie was used to dilate the strictured segment to 9 mm. The inserters were placed at the corresponding sites along the guidewire. Sequentially, the stent was slowly released until complete apposition. Finally, the stent status was re-examined with gastroscopy. In the treatment group, the esophageal lumen was divided into 4 quadrants (anterior, posterior, left and right) under the endoscope, and 2 metal clips were symmetrically placed at the proximal end of the stent for fixation (Fig. 1 and Fig. 2). Stent position was observed on radiographs obtained 3 and 7 days and 1 and 3 months after placement.

![Fig. 1. Use of 2 metal clips to fix the upper segment of the stent to prevent stent migration.](image1)

![Fig. 2. Radiograph showing 2 metal clips fixed to the upper segment of the stent.](image2)
Statistical analysis

We used Student $t$ tests and $\chi^2$ tests to compare the baseline characteristics between the 2 groups. The $\chi^2$ test was used to compare the stent migration rates between the groups. We performed our statistical analysis using SPSS software version 18.0, and we considered results to be significant at $p < 0.05$.

RESULTS

We included 83 patients in our study: 61 had squamous cell carcinoma, 21 had adenocarcinoma, and 1 had adenosquamous carcinoma. All patients had stage III or IV disease. The obstruction sites in 21 patients were in the mid-upper segments; in the other 62 patients, they were in the lower segments. Twenty-eight patients received radiotherapy, and the remaining patients either did not have surgical opportunities or refused surgery. Five patients could not drink (level 0 of dysphagia), 59 could eat only liquid food (level I), and 19 could have semiliquid food (level II). Patients were randomized into 2 groups in parity using their hospital numbers, with 42 in the treatment group and 41 in the control group. No significant differences were found between the groups in demographic and clinical characteristics, such as sex, age, pathological type, clinical stage, obstruction site, lesion length and radiotherapy history (Table 1). In this study, all implantations were primarily successful. Radiograph examinations were performed 3 and 7 days and 1 and 3 months postoperatively to observe the status of the stents. No dropout or loss to follow-up occurred. A flow chart of enrolled patients is shown in Figure 3. The results indicated that the stents in all the patients were located appropriately with a dilation degree longer than 1.5 cm. With a total effective rate of 100%, significant improvements could be observed in the dysphagia symptoms of the patients from the treatment group 1 week postoperatively, and they could eat semiliquid food or soft food. Although no stent migrations were found 1 and 3 months postoperatively in the control group, 2 occurred 3 days postoperatively and 4 occurred 7 days postoperatively, resulting in a total effectiveness of 85.4% (Table 2). There were no perioperative complications.

DISCUSSION

As a palliative treatment, esophageal stent implantation is effective in resolving diseases, such as benign and malignant esophageal strictures and esophageal fistula, and has been widely applied in clinical practice. As more cancer patients survive, complications with stents are more frequently observed. The common complications include retrosternal pain, bleeding, reflux, stent migration and loss, and restenosis. Stent migration is the most common complication clinically, with an incidence of 12.27%, accounting for 57.82% of all stent complications. The possible reasons include severe vomiting and improper diet, severe coughing and high tension, and overdilated esophageal lumen. Therefore, treatment for stent migration after esophageal stent implantation is a major problem for doctors. We share our successful experience in treating short-term stent migration after esophageal stent implantation, hoping to provide a basis for clinical treatment.

Long and colleagues reported that the uncoated segment of the esophageal stent would stimulate intralumen-oriented growth of the granulation tissues and that it would be extremely difficult to withdraw the stents 3 weeks later. In our study, the stent migration rate of the control group was 14.6%, and most of them occurred after 3–7 days. No stent migration was observed in the treatment group within 2 weeks of the operation; therefore, the difference between

| Table 1. Demographic and clinical characteristics of study participants (n = 83) |
|-------------------------------|----------------|----------------|
| Characteristic               | Treatment, n = 42 | Control, n = 41 |
| Sex                          |                |                |
| Male                         | 29             | 27             |
| Female                       | 13             | 14             |
| Mean age, yr                 | 67.6           | 69.8           |
| Pathological type            |                |                |
| Squamous cell carcinoma      | 30             | 31             |
| Adenocarcinaoma              | 11             | 10             |
| Adenosquamous carcinoma      | 1              | 0              |
| Dysphagia degree             |                |                |
| Level 0                      | 2              | 3              |
| Level 1                      | 30             | 29             |
| Level II                     | 10             | 9              |
| Obstruction site             |                |                |
| Mid-upper segment            | 11             | 10             |
| Lower segment                | 31             | 31             |
| Lesion length, cm            |                |                |
| 4                            | 10             | 10             |
| 6                            | 21             | 22             |
| 8                            | 11             | 9              |
| Radiotherapy history         |                |                |
| Yes                          | 13             | 15             |
| No                           | 29             | 26             |

*Unless otherwise indicated.
†All $p > 0.05$.

| Table 2. Stent migration rates in the treatment and control groups (n = 83) |
|-------------------|----------------|----------------|
| Migration         | Treatment, n = 42 | Control, n = 41 |
|                   |                |                |
| Timing            |                |                |
| 3 d               | 0              | 2              |
| 7 d               | 0              | 4              |
| 1 mo              | 0              | 0              |
| 3 mo              | 0              | 0              |
| Rate              | 0%             | 14.6%          |

*Unless otherwise indicated.
†$\chi^2 = 4.62, p = 0.032$. 
these 2 groups was significant ($p = 0.032$). No stent migration occurred in either group at 1 month or 3 months, which indicated that the stent was fixed to the esophageal lumen 2–3 weeks postoperatively and that migration was unlikely to happen; therefore, preventive treatment should be performed during the perioperative period. After the endoscopic removal of the metal clips, granulation tissues, which are similar to those induced by surgical sutures, could be observed. These granulation tissues would detach from the stent spontaneously and would then be excreted through the digestive tract 1–4 weeks later, usually without complication. We think application of metal clips within 2 weeks of the operation will prevent stent migration. Two weeks later, when the stent is fully released, the metal clips will detach from the stent spontaneously.

**Limitations**

Measures to reduce bias in our study were the randomized control method, enrolment of inpatients, good patient compliance, trained researchers and appropriate statistical analysis. However, the sample size was small owing to insufficient funds and the time and number of researchers, but we will increase the sample size in future studies. We believe our approach was appropriate and rational.

**CONCLUSION**

Perioperative fixation of the proximal segments of stents with metal clips is effective in preventing stent migration. However, there are still 2 noteworthy points. First, 2 metal clips should be used in the operation because 1 clip is definitely not effective enough and more than 2 clips will increase the economic burden of the patient. Second, the prestenting esophageal lumen expansion should not exceed 9 mm, and the stricture length can be determined once the nasal gastroscope penetrates the stricture. If the esophageal lumen is overdilated, the stent is prone to migration or even loss; as the inserter’s diameter is only 8 mm, the 9 mm dilation is wide enough.
Acknowledgments: The authors thank their colleagues from the Digestive Endoscopy Center, Lishui People’s Hospital, for their comments and support.

Affiliations: From the Digestive Endoscopy Center, Lishui People’s Hospital, Lishui, Zhejiang, China (Wang); the Sixth Affiliated Hospital of Wenzhou Medical University, Wenzhou, Zhejiang, China (Wang); and the Department of Gastroenterology, Jinyun County Hospital of traditional Chinese Medicine, Zhejiang, China (Lou).

Competing interests: None declared.

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

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Effects of adding Braun jejunojejunostomy to standard Whipple procedure on reduction of afferent loop syndrome — a randomized clinical trial

Farzad Kakaei, MD
Samad Beheshtirouy, MD
Seyed Moahammad Reza Nejatollahi, MD
Iqbal Rashidi, MD
Touraj Asvadi, MD
Afshin Habibzadeh, MD
Mohammad Oliaei-Motlagh, MD

Accepted for publication
May 12, 2015

Correspondence to:
F. Kakaei
Department of Surgery
Tabriz University of Medical Sciences
Imam Reza Hospital
Golgahst St.
Tabriz, Iran
fkakaei@yahoo.com

DOI: 10.1503/cjs.005215

Background: Whipple surgery (pancreateoduodenectomy) has a high complication rate. We aimed to evaluate whether adding Braun jejunojejunostomy (side-to-side anastomosis of afferent and efferent loops distal to the gastrojejunostomy site) to a standard Whipple procedure would reduce postoperative complications.

Methods: We conducted a randomized clinical trial comparing patients who underwent standard Whipple surgery (standard group) and patients who underwent standard Whipple surgery with Braun jejunojejunostomy (Braun group). Patients were followed for 1 month after the procedure and postoperative complications were recorded.

Results: Our study included 30 patients: 15 in the Braun and 15 in the standard group. In the Braun group, 4 (26.7%) patients experienced 6 complications, whereas in the standard group, 7 (46.7%) patients experienced 11 complications ($p = 0.14$). Complications in the Braun group were gastrointestinal bleeding and wound infection ($n = 1$ each) and delayed gastric emptying and pulmonary infection ($n = 2$ each). Complications in the standard group were death, pancreatic anastomosis leak and biliary anastomosis leak ($n = 1$ each); gastrointestinal bleeding ($n = 2$); and afferent loop syndrome and delayed gastric emptying ($n = 3$ each). There was no significant difference between groups in the subtypes of complications.

Conclusion: Our results showed that adding Braun jejunojejunostomy to standard Whipple procedure was associated with lower rates of afferent loop syndrome and delayed gastric emptying. However, more studies are needed to define the role of Braun jejunojejunostomy in this regard.

Trial registration: IRCT2014020316473N1 (www.irct.ir)

Contexte: La chirurgie de Whipple (pancréatoduodenectomie) s’accompagne de taux de complications élevés. Nous avons voulu vérifier si l’ajout d’une jejunojejunostomie de Braun (anastomose latéro-latérale des anses afférente et efférente à la partie distale de la gastrojéjunostomie) à une chirurgie de Whipple standard permet de réduire les complications postopératoires.

Méthodes : Nous avons procédé à un essai clinique randomisé pour comparer des patients soumis à une chirurgie de Whipple standard (groupe standard) à des patients soumis à une chirurgie de Whipple standard avec jejunojejunostomie de Braun (groupe Braun). Les patients ont été suivis pendant 1 mois après l’intervention et les complications postopératoires ont été notées.

Résultats : Notre étude a regroupé 30 patients : 15 dans le groupe Braun et 15 dans le groupe standard. Dans le groupe Braun, 4 patients (26,7 %) ont présenté 6 complications, tandis que dans le groupe standard, 7 patients (46,7 %) ont présenté 11 complications ($p = 0.14$). Les complications dans le groupe Braun ont été saignements gastro-intestinaux et infection de plaie ($n = 1$ chacun) et retard de la vidange gastrique et infection pulmonaire ($n = 2$ chacun). Les complications dans le groupe standard ont été décès, fuite de l’anastomose pancréatique et fuite de l’anastomose biliaire ($n = 1$ chacun); saignement gastro-intestinal ($n = 2$); et syndrome de l’anse afférente et retard de la vidange gastrique ($n = 3$ chacun). On n’a noté aucune différence significative entre les groupes pour ce qui est des sous-types de complications.

Conclusion : Nos résultats ont montré que l’ajout de la jejunojejunostomie de Braun à une chirurgie de Whipple standard a été associé à des taux moindres de syndrome de l’anse afférente et de retard de la vidange gastrique. Il faudra toutefois procéder à d’autres études pour définir le rôle de la jejunojejunostomie de Braun à cet égard.

Enregistrement de l’essai: IRCT2014020316473N1 (www.irct.ir)
Pancreaticoduodenectomy, as first described by Allen Whipple in 1935, is a well-established operation and standard treatment for operable pancreatic head and other periampullary tumours.1–3 Although this operation has a great impact on treatment and patient survival, up to 60% of patients experience various complications, including postoperative bleeding, delayed gastric emptying, afferent loop syndrome, and systemic complications, such as sepsis, deep vein thrombosis and infection.4

In order to reduce these complications, particularly delayed gastric emptying and afferent loop syndrome, various methods for anastomosis, including pyloric preservation, Roux-en-Y, or different methods of intestinal loop resection to separate pancreatic anastomosis from other anastomoses, are introduced to use with or replace the standard Whipple procedure. The Roux-en-Y method has been reported to reduce postoperative complications of Whipple surgery, especially pancreatic fistula and delayed gastric emptying.1 Braun jejunoojejunostomy (side-to-side anastomosis of afferent and efferent loops distal to the gastrojejunostomy site) is functionally equal to Roux-en-Y, but is performed in less time and could replace Roux-en-Y in Whipple surgery. However, there are few reports demonstrating the efficacy of Braun jejunoojejunostomy in reducing postoperative delayed gastric emptying or afferent loop syndrome.6 We aimed to evaluate the efficacy of adding Braun jejunoojejunostomy to the standard Whipple surgery in reducing these type of postoperative complications.

METHODS

Study design and participants

Between June and December 2013, patients aged 18–75 years with confirmed operable pancreatic head, duodenal or common bile duct tumours who were scheduled for a Whipple procedure at Tabriz Imam Reza hospital, Tabriz University of Medical Sciences, were recruited for this study. Patients with previous upper abdominal surgery, preoperative signs of inoperability according to imaging studies (e.g., mesenteric or portal vein or superior mesenteric artery involvement, distant metastases, nearby organ involvement) or general conditions not suitable for a Whipple procedure (e.g., heart or renal failure) were excluded from the study. We also excluded patients whose tumours were found to be inoperable according to intraoperative findings and patients who died during the operation.

The study was a prospective, randomized clinical trial designed by the surgery department and approved by the Institutional Review Board and Ethics Committee of Tabriz University of Medical Sciences. The trial was registered in the Iranian Registry of Clinical Trials (IRCT2014020316473N1; www.irct.ir). We obtained written informed consent from all patients.

Sample size

The trial was powered to detect an effect size of $\delta \geq 0.70$ as statistically significant in a 2-tailed test with $\alpha = 0.05$ and a power of 0.90 with 14 participants per condition. As there was a possibility that some patients would not complete the study, we recruited 15 participants per group.

Randomization and blinding

Randomization of patients into 2 equal groups was performed using Randlist software (DatInf). The control group underwent the standard Whipple procedure (standard group). In the intervention group (Braun group), a Braun jejunoojejunostomy was added at the end of the standard Whipple procedure. The attending surgeon received a sealed envelope in the operating room indicating the type of operation to be performed. The envelopes were unsealed only after complete resection of the pancreatic-duodenal complex. All the preoperative and postoperative clinical and paraclinical data were collected, and the follow-up was done by another member of the team who was completely blind to the type of surgery.

Pancreaticoduodenectomy procedure

All patients underwent the standard Whipple procedure, including 20%–40% distal gastrectomy, cholecystectomy, pancreaticoduodenectomy and then pancreaticojejunostomy, choledochojejunostomy and antecolic gastrojejunostomy. All anastomoses were performed using the appropriate size of PDS II polydioxanone sutures (Ethicon, Johnson & Johnson). In the intervention group, Braun jejunoojejunostomy was added to other anastomoses at the end of the operation. In both groups, pancreaticojejunostomy was performed using the duct-to-mucosa method in 2 layers. Jejunoojejunostomy was performed using a standard, manual 2-layer method (side-to-side anastomosis of afferent and efferent loops distal to the gastrojejunostomy site). The jejunoojejunostomy site was performed between the proximal and distal jejunal loops about 30 cm distal to the choledochojejunostomy and 45 cm distal to the gastrojejunostomy sites, respectively. At the end of operation, 2 corrugated drains were inserted bilaterally in the liver and pancreas bed. Drainage fluid was collected by sterile colostomy-type bags every 6 hours until the removal of the drains.

Postoperative management

Postoperative treatment included prophylactic antibiotics (cefazolin and metronidazole), intravenous pantoprazole (as the prophylaxis against stress ulceration) for 1 week and 100 µg of subcutaneous octreotide 3 times per day for 48 hours. Antibiotics were continued for any infectious
complications or changed according to the cultures of body fluids when needed. Patients spent at least 24 hours in the intensive care unit (ICU) and were transferred to the general ward when their hemodynamic and respiratory conditions were stable. Nasogastric tubes were removed after 48 hours if the bowel sounds returned, and patients were started on a soft diet usually on the fifth postoperative day.

Patient characteristics and outcome measures

We collected the following data using a checklist to compare the 2 groups: age, sex, body mass index, time from the first symptoms until the operation, cause of the disease (pancreatic head, duodenal, or common bile duct tumour), duration of the operation, intraoperative bleeding and total volume of intraoperative blood product transfusion. We also collected the following laboratory data: white blood cell count, hemoglobin level, alanine aminotransferase, aspartate aminotransferase, and total and direct bilirubin both preoperatively and postoperatively on days 1, 3, 5, 7 and 14. We recorded the volume of nasogastric tube evacuations for 48 hours after the operation as well as the number of times per day that patients vomited after the nasogastric tubes were extracted. We noted postoperative complications, including death and its cause, pancreatic anastomosis leakage, gastric anastomosis leakage, biliary anastomosis leakage, postoperative bleeding requiring another operation, postoperative gastrointestinal bleeding requiring another operation, afferent loop syndrome, delayed gastric emptying, surgical site infection, pulmonary infection and deep vein thrombosis. Patients were followed for 1 month after the operation or until in-hospital death.

Primary outcome measures were afferent loop syndrome, defined as sudden, bulky bile-stained vomit unrelated to eating; volume of nasogastric tube evacuations in the 48 hours after the operation; frequency of vomiting after extraction of nasogastric tubes; and delayed gastric emptying, defined as gastric stasis requiring nasogastric intubation for 10 days or more or the inability to tolerate a regular diet 14 days after the operation.

Secondary outcome measures were biliary leakage, defined as persistent secretion of bilirubin-rich drainage fluid of more than 50 mL/d from drains; postoperative intra-abdominal bleeding, defined as the need for more than 2 units of red blood cells more than 24 hours after surgery or repeat laparotomy because of bloody discharge from the drains; and gastrointestinal bleeding, defined as the need for more than 2 units of red blood cells more than 24 hours after surgery or need for any surgical or endoscopic intervention because of bloody discharge from the nasogastric tube or lower gastrointestinal bleeding (melena or hematochezia).

Statistical analysis

All data were analyzed using the Statistical Package for Social Sciences, version 17.0 (SPSS). Baseline data are reported as means ± standard deviations for continuous data or as percentages for categorical data. In order to analyze the differences between the groups in the quantitative variables, we used the Student t test for normally distributed data and the Mann–Whitney U test for non-normally distributed data. We studied the association between qualitative variables using the χ² test or Fisher exact test. We considered results to be significant at p < 0.05.

RESULTS

We included 30 patients in our analysis: 15 who underwent a standard Whipple procedure alone and 15 who underwent a standard Whipple procedure combined with Braun jejunojunostomy. No patients were lost to follow-up (Fig. 1). There were no significant differences in baseline demographic and clinical characteristics between the groups (Table 1). The most common cause for surgery in both groups was pancreatic head tumour (n = 19), followed by obstructive jaundice with probable periampullary tumour (n = 5), duodenal tumour (n = 3), bile duct cancer (n = 2) and other disease (n = 1).

Perioperative findings

Mean duration of surgery was 6.23 ± 1.83 hours in the Braun group compared with 6.08 ± 1.55 hours in the standard group (p = 0.81). Mean bleeding volume during surgery was 500.00 ± 142.00 mL in the Braun group and 626.66 ± 145.23 mL in the standard group (p = 0.53). There was no significant difference between the Braun and standard groups in mean packed red blood cells (1.60 ± 1.35 v. 1.33 ± 1.17 units, p = 0.56) or fresh frozen plasma (0.40 ± 0.28 v. 1.06 ± 0.54 units, p = 0.29) used during surgery.

Postoperative findings

Mean nasogastric tube drainage was 468.00 ± 414.88 mL in the Braun group and 760.71 ± 503.51 mL in the standard group (p = 0.09). The standard group had significantly more periods of vomiting after nasogastric tube removal than the Braun group (1.54 ± 1.50 v. 0.53 ± 0.51 times/d, p = 0.032). We observed 6 complications in 4 (26.70%) patients in the Braun group compared with 11 complications in 7 (46.7%) patients in the standard group. Although the rate of complications in the Braun group was lower than in the standard group, the difference was not significant (p = 0.14). There was no significant difference between groups in the subtypes of postoperative complications (Table 1). There was 1 death in the standard group, which occurred due to pulmonary embolism. One patient in the Braun group had pancreatitis,
which was managed conservatively, and 1 patient experienced biliary leak, which was managed conservatively. Three patients in the standard group had recurrent nausea and vomiting as well as afferent loop syndrome and underwent Braun jejunojejunostomy. One case of afferent loop syndrome occurred with postoperative bleeding. All cases of postoperative bleeding occurred at the gastrojejunostomy site and were controlled and managed conservatively. Table 2 summarizes the complications in our patients.

### DISCUSSION

Braun jejunojejunostomy has been recommended as an adjacent method to a standard Whipple procedure to reduce postoperative delayed gastric emptying and afferent loop syndrome, and it is shorter than other methods such as Roux-en-Y diversion. Vogel and colleagues reported that postoperative complications, including enterogastric reflux and biliary reflux, were significantly less frequent in patients undergoing Braun jejunojejunostomy than in those undergoing any types of gastrojejunostomy without adding Braun jejunojejunostomy. Another study reported that adding Braun jejunojejunostomy after gastroenterostomy in patients with biliary reflux significantly reduced the reflux. Wang and colleagues documented a lower complication rate after adding Braun anastomosis to a standard Whipple procedure. In the present clinical trial, we evaluated the postoperative complications after standard Whipple surgery with or without Braun jejunojejunostomy. There was no significant difference between groups before or during the operation. Six complications were seen in 4 patients in the Braun group, and 11 complications were seen in 7 patients in the standard group, but the difference was not significant. We also observed no difference between groups in nasogastric tube volume; however, vomiting after the tube removal occurred significantly more frequently in the standard group. Hochwald

### Table 1. Baseline demographic and clinical characteristics of participants

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Group; no. (%) or mean ± SD</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>57.26 ± 13.80</td>
<td>55.26 ± 13.15</td>
<td>0.82</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>10 (66.7%)</td>
<td>10 (66.7%)</td>
<td>—</td>
</tr>
<tr>
<td>Female</td>
<td>5 (33.3%)</td>
<td>5 (33.3%)</td>
<td>—</td>
</tr>
<tr>
<td>Body mass index</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 20</td>
<td>5 (33.3%)</td>
<td>3 (20%)</td>
<td>—</td>
</tr>
<tr>
<td>20–25</td>
<td>8 (53.3%)</td>
<td>10 (66.7%)</td>
<td>—</td>
</tr>
<tr>
<td>26–30</td>
<td>1 (6.7%)</td>
<td>1 (6.7%)</td>
<td>—</td>
</tr>
<tr>
<td>&gt; 30</td>
<td>1 (6.7%)</td>
<td>1 (6.7%)</td>
<td>—</td>
</tr>
<tr>
<td>Symptom duration, d</td>
<td>159.33 ± 34.34</td>
<td>173.20 ± 52.28</td>
<td>0.68</td>
</tr>
<tr>
<td>Reason for surgery</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pancreatic head tumour</td>
<td>8 (53.3%)</td>
<td>11 (73.3%)</td>
<td>—</td>
</tr>
<tr>
<td>Duodenum tumour</td>
<td>3 (20%)</td>
<td>0</td>
<td>—</td>
</tr>
<tr>
<td>Tumour of distal coledoc</td>
<td>1 (6.7%)</td>
<td>1 (6.7%)</td>
<td>—</td>
</tr>
<tr>
<td>Obstructive jaundice with</td>
<td>2 (13.3%)</td>
<td>3 (20%)</td>
<td>—</td>
</tr>
<tr>
<td>possible tumour of ampul water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>1 (6.7%)</td>
<td>0</td>
<td>—</td>
</tr>
</tbody>
</table>

SD = standard deviation.
and colleagues\textsuperscript{10} documented earlier nasogastric tube removal in patients undergoing Braun anastomosis than in those undergoing a standard Whipple procedure; however, they reported no significant difference in vomiting rate or reinsertion of the nasogastric tube between groups.

Various complications have been reported following standard Whipple surgery. In one study, anastomosis leak, delayed gastric emptying and bleeding were the prevalent complications of Whipple surgery.\textsuperscript{11} In another study, postoperative bleeding was the most common complication after surgery.\textsuperscript{12} In yet another study,\textsuperscript{13} fever, pancreatic fistula and increase in bilirubin levels were the prevalent complications.\textsuperscript{13} In our study, complications in the standard group were death, pancreatic and biliary anastomosis leakage, gastrointestinal bleeding, afferent loop syndrome and delayed gastric emptying. Complications in the Braun group were gastrointestinal bleeding, wound infection, delayed gastric emptying and pulmonary infection. There was no significant difference between the groups in the rate of complications observed. We observed pancreatic anastomosis and biliary anastomosis leak only in the standard group, whereas Hochwald and colleagues\textsuperscript{10} reported similar failure of pancreatic anastomosis between the groups.

In our study, delayed gastric emptying was observed in 13.3\% cases in the Braun group and 20\% of cases of the standard group. Similarly, Hochwald and colleagues\textsuperscript{10} and Nikfarjam and colleagues\textsuperscript{14} observed that delayed gastric emptying was significantly reduced after Braun anastomosis. Conversely, Jurgens and colleagues\textsuperscript{8} reported a gastric emptying complication rate of 81\% after Braun anastomosis. However, 57\% of these patients had gastroparesis before the operation; 42\% of those with delayed gastric emptying responded to medical therapy and the symptom improved.

Afferent loop syndrome is an unusual complication with a reported incidence of 0.2\%–20\%. It usually occurs after gastrojejunostomy with Billroth II reconstruction and partial gastrectomy. However, this complication could occur even after surgical resection and anastomosis between gastric and other parts of the foregut, such as in a pancreaticoduodenectomy procedure.\textsuperscript{15,16} In our study study, afferent loop syndrome was observed in 3 (20\%) patients in the standard group, whereas no patients in the Braun group experienced this complication. Considering our findings, it is possible that Braun jejunoojejunostomy was associated with the decrease in this complication rate.

Braun anastomosis has some potential advantages. It tends to stabilize the afferent and efferent limbs of the gastrojejunostomy, so the gastrojejunostomy has a low tendency to twist and angulate. Braun anastomosis prevents any increase in pressure in the biliopancreatic limb if an obstruction occurs at the level of the gastroenterostomy. The Braun anastomosis also allows gastric content to pass distally unimpeded into either the efferent or afferent limb of the gastroenterostomy. Kinking at either of these limbs alone theoretically would not alter gastric emptying in these circumstances.\textsuperscript{14,17} These advantages could prevent the occurrence of afferent loop syndrome.

\textbf{Limitations}

Although the occurrence of afferent loop syndrome did not differ significantly between the standard group and the Braun jejunoojejunostomy group, the difference was clinically important, Braun jejunoojejunostomy was associated with a reduced rate of complications. However, observing significant findings in previous studies and no significant differences in our study could be related to the smaller number of patients included in our study. Overall findings indicate the efficacy of adding Braun jejunoojejunostomy to a standard Whipple procedure to reduce postoperative complications, especially the incidence of afferent loop syndrome and delayed gastric emptying.

\textbf{CONCLUSION}

Adding Braun jejunoojejunostomy to a standard Whipple procedure may be associated with lower rates of afferent loop syndrome and delayed gastric emptying. More studies are necessary to define the role of Braun jejunoojejunostomy in this regard.

\textbf{Acknowledgments:} This research was financially supported by the Vice Chancellor for Research, Tabriz University of Medical Sciences, Iran.

\textbf{Affiliations:} From the Department of Surgery, Tabriz University of medical sciences, Imam Reza Hospital, Tabriz, Iran (Kakaei, Beheshtirouy, Rashidi, Asvadi, Habibzadeh, Oliaei-Motlagh); and the Department of Surgery, Shahid Beheshti University of Medical Sciences, Ayatollah Taleghani Hospital, Evin, Tehran, Iran (Nejatollahi).

\textbf{Competing interests:} None declared.

\textbf{Contributors:} F. Kakaei, S. Beheshtirouy, S.M.R. Nejatollahi and A. Habibzadeh designed the study. F. Kakaei, I. Rashidi, T. Asvadi and A. Habibzadeh acquired the data, which I. Rashidi, A. Habibzadeh and M. Oliaei-Motlagh analyzed. F. Kakaei, I. Rashidi, T. Asvadi and A. Habibzadeh wrote the article, which all authors reviewed and approved for publication.
References


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Early clinical experience with the POEM procedure for achalasia

Dennis Hong, MD, MSc
Radu Pescarus, MD
Rana Khan, MD
Luciano Ambrosini, MD
Mehran Anvari, MB, PhD
Margherita Cadeddu, MD

This paper was presented at the Canadian Surgery Forum, Vancouver, BC, Sept. 17–21, 2014.

Accepted for publication
May 19, 2015

Correspondence to:
D. Hong
50 Charlton Ave E
Rm G814
St. Joseph’s Healthcare
Hamilton ON L8N 4A6
dennishong70@gmail.com

DOI: 10.1503/cjs.017214

Background: Peroral endoscopic myotomy (POEM) is a viable alternative to standard Heller myotomy for surgical treatment of achalasia. Outcomes from the United States, Europe and Asia have been reported. We sought to report data after the initiation of POEM in a Canadian centre.

Methods: We enrolled patients with achalasia in a research ethics board–approved pilot study. Surgeons learned the POEM procedure in a systematic manner that included visiting experts in POEM, practice in an animal laboratory and mentoring from POEM experts. Preoperative evaluation included manometry, 24-hour pH, barium swallow, endoscopy and Eckhardt Symptom Score. All patients underwent gastrografin swallow on postoperative day 1. Patients were re-evaluated using the Eckhardt score on postoperative day 14.

Results: Ten patients underwent POEM. Seven patients had previous endoscopic treatments: 6 had balloon dilatation and 1 had botulinum toxin injection. Mean preoperative Eckhardt score was 8.1 ± 2.4. Mean preoperative lower esophageal sphincter resting and residual pressure was 32.3 ± 9.2 and 20.8 ± 5.3, respectively. Mean duration of surgery was 141.3 ± 43.7 minutes. Mean length of hospital stay was 1 day. No major perioperative complications occurred. On postoperative day 14, the mean Eckhardt score was 1 ± 1.2.

Conclusion: Our approach to POEM introduction was systematic and deliberate. The procedure is safe, feasible and has good perioperative outcomes. Our early results are consistent with current literature.

ConteXte : La myotomie perorale endoscopique (POEM) est une solution de rechange viable à la myotomie de Heller standard pour le traitement chirurgical de l’achalasie. Des rapports ont fait état de résultats enregistrés aux États-Unis, en Europe et en Asie. Nous avons voulu faire le point après l’instauration de la méthode POEM dans un centre canadien.

Méthodes : Nous avons inscrit des patients atteints d’achalasie à une étude de recherche pilote, approuvée par le comité d’éthique. Les chirurgiens se sont initiés à la technique POEM de façon systématique auprès d’experts de cette technique, en s’exerçant sur des animaux de laboratoire et ensuite auprès d’experts-mentors. L’examen préopératoire incluait : manométrie, pH des 24 heures, repas baryté, endoscopie et score d’Eckhardt (pour les symptômes). Tous les patients ont subi un transit du grêle avec Gastrografin au jour 1 postopératoire. Le score d’Eckhardt des patients a été réévalué au jour 14 postopératoire.

Résultats : Dix patients ont subi la technique POEM. Sept avaient déjà reçu des traitements endoscopiques : 6 avaient subi une dilatation par ballonnet et 1 avait reçu une injection de toxine botulique. Le score d’Eckhardt préopératoire moyen était de 8,1 ± 2,4. La pression préopératoire moyenne du sphincter œsophagien inférieur au repos et résiduelle était de 32,3 ± 9,2 et de 20,8 ± 5,3, respectivement. La durée moyenne de la chirurgie a été de 141,3 ± 43,7 minutes. La durée moyenne du séjour hospitalier a été d’un jour. Aucune complication périopératoire majeure n’est survenue. Au jour 14 postopératoire, le score d’Eckhardt moyen était de 1 ± 1,2.

Conclusion : Notre approche à l’instauration de la technique POEM a été systématique et délibérée. L’intervention s’est révélée sécuritaire, réalisable et a procuré des résultats périopératoires positifs. Nos résultats préliminaires concordent avec ceux de la littérature actuelle.
Achalasia is a rare disease characterized by nonperistaltic esophagus and incomplete relaxation of the lower esophageal sphincter (LES). These 2 characteristics are the basis of the symptoms of achalasia that include dysphagia, regurgitation, reflux, vomiting and weight loss.

Treatments for achalasia include medical, endoscopic and surgical therapy. Medications, such as calcium channel blockers and nitrates, are generally ineffective and poorly tolerated. Endoscopic botox injections are usually recommended for elderly patients and poor operative candidates. Endoscopic balloon dilatation is an effective treatment for achalasia; however, it is associated with a relatively high perforation rate and may require repeated treatments. The main surgical therapy is a Heller myotomy with a partial fundoplication. Several studies have shown this to be an effective treatment for achalasia. The newest surgical treatment for achalasia is per oral endoscopic myotomy (POEM), an endoscopic treatment that divides the circular esophageal muscle fibres through a submucosal tunnel in the esophagus. The muscle fibre division includes the LES and at least 2 cm into the stomach. Small case series from various institutions have shown POEM to be safe and viable. To our knowledge, there have been no studies from a Canadian institution.

The objective of this study was to assess the safety, feasibility and observed perioperative outcomes of POEM as a treatment for achalasia in a Canadian institution.

Methods

Our research ethics board (REB) approved a pilot study to offer POEM for the treatment of achalasia to patients who met the inclusion criteria. Exclusion criteria were previous esophageal or mediastinal surgery, pregnancy, age younger than 18 years, inability to tolerate general anesthesia, a body mass index (BMI) greater than 40, presence of a hiatal hernia (> 3 cm) or a need for an associated intra-abdominal procedure. Previous endoscopic dilation or botulinum toxin injection was not an exclusion criterion.

Preoperative assessment included the Eckhardt questionnaire, upper endoscopy, barium swallow, esophageal manometry and 24-hour pH when feasible. Patients were instructed to consume only clear liquids for 48 hours before their surgery date. A 5-day course of nystatin (500 000 units 3 times/d, swish and swallow) was given before their surgery. Only a mechanical compressive device was used for deep vein thrombosis prophylaxis. A second-generation cephalosporin was given preoperatively.

Surgical technique

Patients were under general anesthesia and placed in the supine position with the left arm tucked. A single-channel high-definition flexible gastroscope (GIF-H180, Olympus Canada) with carbon dioxide insufflation was used. An oblique dissecting cap was fitted onto the gastroscope. Gastroscopy was performed and the esophagus suctioned clear. A submucosal lift (10–15 mL of a mixture of 0.2 mg/mL indigo carmine, 5 µg/mL epinephrine and 0.9% saline) was performed 10 cm above the gastroesophageal junction on the anterior surface of the esophagus (Fig. 1A). A triangle-tip endoscopic knife (Olympus Canada) was used to make a 2 cm longitudinal mucosotomy (Fig. 1B). The endoscope was manoeuvred into the submucosal space. The submucosal tunnel was created using the triangle-tip knife (Fig. 1C). The submucosal tunnel extended 2 cm distal to the gastroesophageal junction onto the lesser curvature of the stomach (Fig. 1D). After completion of the submucosal tunnel, the gastroscope was removed and inserted into the gastric lumen to confirm adequate extent of the submucosal tunnel. Presence of gastric mucosal blanching identified on a retroflexed endoscopic view in the stomach indicated adequate submucosal tunnel. After confirmation, the gastroscope was reinserted into the submucosal tunnel, and a selective myotomy of only the inner, circular muscle fibres was performed using the triangle-tip knife (Olympus Canada; Fig. 1E). The myotomy was started 2– 3 cm distal to the mucosotomy site. After successful completion of the myotomy the mucosotomy was closed using endoscopic clips (QuickClip, Olympus, Canada; Fig. 1F).

Postoperative routine

We performed a water-soluble contrast study on postoperative day 1. A clear liquid diet was started after the contrast study was read. Narcotic usage was recorded. Patients were scheduled for a follow-up appointment 2 weeks postsurgery. A dietician instructed the patients on diet advancement before discharge from hospital.

Results

We included 10 patients in our pilot study. All patients underwent successful POEM. Preoperative patient and manometric characteristics are shown in Table 1. Seven (70%) patients had prior endoscopic treatments for achalasia. We found that performing POEM in the patient who had a previous botulinum toxin injection was more technically challenging owing to scarring in the submucosal layer at the level of the LES. The duration of surgery for this patient was 182 minutes compared with a mean duration of 141 minutes for the...
group. Patients who underwent previous balloon dilatation were technically equivalent to patients who did not have previous treatments. Seven (70%) patients had an American Society of Anaesthesiologists (ASA) physical status score of 3, and 3 (30%) patients had an ASA score of 2.

There were no deaths or mobidities among our patients. One patient had clinically important intraoperative capnoperitoneum that required decompression via a Veress needle placed in the left upper quadrant. Another patient experienced a transient, intraoperative episode of hypotension that resolved with endoscopic decompression of the stomach. A third patient had a fever (38°C) on postoperative day 1 that resolved spontaneously.

All patients had a normal water-soluble gastrografin swallows on postoperative day 1. Perioperative outcomes are shown in Table 2. Six (60%) patients took no narcotics postoperatively. Three (30%) patients took 1 dose of narcotic and 1 (10%) patient took 3 doses of narcotics. Nine (90%) patients were discharged on postoperative day 1, and 1 patient stayed in hospital 2 days. No complications were reported by patients during their 2-week follow-up visit. All patients reported substantial symptomatic improvement.

**DISCUSSION**

The first endoscopic division of the lower esophageal sphincter was described by Ortega and colleagues in 1980. However, it wasn’t until Pasricha and colleagues described an endoscopic submucosal myotomy in a pig model and, subsequently, Inoue and colleagues...
described the first human study of endoscopic submucosal myotomy for achalasia that interest in this technique gained attention. Since the first human report, investigators from the United States, Europe and Asia have reported their results using the POEM technique.

Most published outcomes using POEM have been positive. Several recent reviews have shown excellent operative and short-term outcomes. No deaths from POEM have been reported in the more than 1000 cases performed. We had no clinically important complications in our pilot study. We did have 1 patient with intraoperative capnoperitoneum that required decompression, and several patients showed a small capnoperitoneum on postoperative day 1 water-soluble contrast. This highlights the need to use carbon dioxide insufflation, as air does not extend beyond the thin longitudinal muscle fibres of the esophagus and stomach. If regular air is used for insufflation, a clinically important pneumothorax, pneumomediastinum or pneumoperitoneum may occur. These excellent outcomes are likely a result of careful patient selection, surgeons and gastroenterologists who are expert endoscopists and physicians undergoing a rigorous systematic approach to learn POEM.

POEM is an advanced therapeutic endoscopic procedure requiring advanced endoscopic skills. Our group had previous advanced endoscopic skills, including stent placement, advanced clipping and endoscopic mucosal resection. In preparation for undertaking the POEM study, we were deliberate, conservative and systematic in our approach. One of us (D.H.) travelled to the institution of a high-volume POEM surgeon (Dr. Lee Swanstrom, Portland, Oregon, USA) to observe how the team was set up and to learn technical skills. He then completed a formal course in POEM (American Society for Gastrointestinal Endoscopy, 2013). We then performed 2 animal models to familiarize ourselves with the submucosal anatomy and master instrumentation. We obtained REB approval for our pilot study, and an expert (Dr. Lee Swanstrom) who had performed more than 100 POEM procedures assisted us in our first 2 cases. Other investigators have followed similar, systematic approaches to introducing POEM at their institution. We feel participation in animal laboratories and expert mentoring are necessary when introducing new, technically demanding procedures, such as POEM.

A criticism of POEM has been the potential risk of reflux. Unlike Heller myotomy, the angle of His and esophageal attachments are not disrupted in POEM, obviating the need for an antireflux procedure. Data suggest that a limited hiatal dissection with preservation of hiatal anatomy may result in lower reflux. Bhayani and colleagues recently described their comparative study on laparoscopic Heller myotomy plus fundoplication versus POEM. At 6 months, they found no statistical difference in abnormal acid exposure between the 2 procedures. Some have criticized the high percentage of POEM patients with abnormal acid exposure on 24-hour testing (39%) in their study. A second comparative study between POEM and laparoscopic Heller myotomy plus fundoplication found similar rates of reflux postoperatively. Advocates of POEM have suggested that the rates of reflux following a Heller myotomy plus fundoplication are just as high as the rates found following POEM. This would suggest that, in the short-term, POEM produces the same rates of reflux as a Heller myotomy with fundoplication.

Another concern has been that division of only the circular muscle fibres in the POEM procedure may limit its effectiveness in alleviating the symptoms of achalasia as compared with division of all muscle fibres in a standard Heller myotomy. Yet a recent comparative study on endoscopic full-thickness myotomy versus circular muscle myotomy found no clinical or manometric differences. This suggests that circular muscle myotomy alone is sufficient for excellent outcomes.

**Limitations**

Our study has some limitations. The first is our small sample of 10 patients. Low prevalence of achalasia will require several institutions specializing in esophageal motility disorders to collaborate to achieve adequate numbers. Another limitation is the lack of longer-term data regarding the rate of reflux. We will continue to

---

**Table 1. Patient and manometry characteristics**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Mean ± SD or no. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, yr</td>
<td>53.8 ± 10.8</td>
</tr>
<tr>
<td>Male sex</td>
<td>7 (70%)</td>
</tr>
<tr>
<td>Previous treatment</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>3 (30%)</td>
</tr>
<tr>
<td>Balloon dilation</td>
<td>6 (60%)</td>
</tr>
<tr>
<td>Botulinum toxin</td>
<td>1 (10%)</td>
</tr>
<tr>
<td>Preoperative Eckhardt scores (&lt; 3 is normal)</td>
<td>8.1 ± 2.4</td>
</tr>
<tr>
<td>LES resting pressure</td>
<td>32.3 ± 9.2</td>
</tr>
<tr>
<td>LES residual pressure</td>
<td>20.8 ± 5.3</td>
</tr>
</tbody>
</table>

LES = lower esophageal sphincter; SD = standard deviation.

**Table 2. Perioperative outcomes of POEM**

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration of surgery, min</td>
<td>141.3 ± 43.7</td>
</tr>
<tr>
<td>Submucosal tunnel length, cm</td>
<td>12 ± 1.1</td>
</tr>
<tr>
<td>Myotomy length, cm</td>
<td>8.9 ± 1.1</td>
</tr>
<tr>
<td>No. of clips to close mucosotomy</td>
<td>7.5 ± 2.1</td>
</tr>
<tr>
<td>LOS, d</td>
<td>1.1 ± 0.3</td>
</tr>
<tr>
<td>Postoperative (2 wk) Eckhardt score (&lt; 3 is normal)</td>
<td>0.9 ± 1.2</td>
</tr>
</tbody>
</table>

LOS = length of stay in hospital; POEM = per oral endoscopic myotomy; SD = standard deviation.
accruing patients prospectively and are currently obtaining esophageal manometry, 24-hour pH, barium swallow and upper endoscopy at 6 months for all patients.

CONCLUSION

To our knowledge, this is the first published series of POEM in Canada. Even in the early learning curve, POEM is safe and feasible to treat esophageal achalasia. Multi-institutional, collaborative studies are required to assess the long-term results of POEM.

Affiliations: All authors are from the Department of Surgery, McMaster University, Hamilton, Ont.

Competing interests: None declared.

Contributors: D. Hong, R. Pescarus and M. Anvari designed the study. D. Hong, R. Khan, L. Ambrosini and M. Cadeddu acquired the data, which D. Hong and M. Anvari analyzed. D. Hong and L. Ambrosini wrote the article, which all authors reviewed and approved for publication.

References

Early experience with robotic pancreatic surgery in a Canadian institution

Sabrina Piedimonte, MDCM, MSc
Yifan Wang, MDCM
Simon Bergman, MD, MSc
Tsafrir Vanounou, MD, MBA

This paper was presented as a poster presentation at the SAGES Annual Meeting, Baltimore MD, Apr. 17–20, 2013, and as a poster presentation at the Canadian Surgery Forum, Ottawa, ON, Sept. 19–21, 2013.

Accepted for publication
June 9, 2015

Correspondence to:
T. Vanounou
Jewish General Hospital, Rm A5-15
3755 Cote Ste Catherine Rd
Montreal QC H3T 1E2
tvanounou@hotmail.com

DOI: 10.1503/cjs.003815

Background: Pancreatic resections have traditionally been associated with substantial morbidity and mortality. The robotic platform is believed to improve technical aspects of the procedure while offering minimally invasive benefits. We sought to determine the safety and feasibility of the first robotic pancreaticoduodenectomies performed at our institution.

Methods: We retrospectively reviewed data on all patients who underwent robotic-assisted pancreaticoduodenectomy (RAPD) between July 2010 and June 2014 and compared them to outcomes of patients undergoing hybrid laparoscopic pancreaticoduodenectomies (HLAPD) during the same time period.

Results: Fifteen patients were scheduled for RAPD; 2 were converted to an open approach and 1 to a mini-laparotomy during the laparoscopic portion of the procedure. Patients who had RAPD (n = 12) had a median duration of surgery of 596.6 (range 509–799) minutes, estimated blood loss of 275 (range 50–1000) mL and median length of stay of 7.5 (range 5–57) days. Mean total opioid use up to postoperative day 7 was 142.599 ± 68.2 versus 176.9 ± 112.7 mg equivalents of intravenous morphine for RAPD and HLAPD, respectively. There was no significant difference between RAPD and HLAPD in any parameters, highlighting the safety and feasibility of a step-wise minimally invasive learning platform. Most patients in the RAPD group had malignant pathology (88.2%). Oncologic outcomes were maintained with no significant difference in ability to resect lymph nodes or achieve negative margins. There were 4 (28.5%) Clavien I-II complications and 3 (29.4%) Clavien III–IV complications, 2 of which required readmission. There were no reported deaths at 90 days. Complication, pancreatic leak and mortality rates did not differ significantly from our laparoscopic experience.

Conclusion: Outcomes of RAPD and HLAPD were comparable at our centre, even during the early stages of our learning curve. These results also highlight the safety, feasibility and patient benefits of a step-wise transition from open to hybrid to fully robotic pancreaticoduodenectomies in a high-volume academic centre.

Contexte : L’ablation du pancréas a de tout temps été associée à une morbidité et une mortalité importantes. Le recours à une plateforme assistée par robot devrait vraisemblablement améliorer les aspects techniques de l’intervention et offrir en même temps les avantages d’une intervention minimalement invasive. Nous avons voulu déterminer l’innocuité et la faisabilité des premières pancréatoduodénectomies assistées par robot effectuées dans notre établissement.

Méthodes : Nous avons passé en revue de manière rétrospective les données concernant tous les patients ayant subi une pancréatoduodénectomie assistée par robot (PDAR) entre juillet 2010 et juin 2014 et nous les avons comparées aux résultats enregistrés chez les patients ayant subi une pancréatoduodénectomie laparoscopique hybride (PDLH) au cours de la même période.

Résultats : Quinze patients ont été pressentis pour une PDAR; 2 ont plutôt subi une intervention ouverte et 1 a subi une mini-laparotomie durant la portion laparoscopique de l’intervention. Chez les patients soumis à la PDAR (n = 12), la durée médiane de la chirurgie a été de 596,6 (plage de 509 à 799) minutes, les pertes sanguines estimées ont été de 275 (plage de 50 à 1000) mL et la durée médiane du séjour hospitalier a été de 7,5 (plage de 5 à 57) jours. L’utilisation totale moyenne d’opioïdes jusqu’au septième jour postopératoire a été de 142,599 ± 68,2 mg équivalents de morphine intraveineuse contre 176,9 ± 112,7 pour la PDAR et la PDLH, respectivement. On n’a noté aucune différence significative entre la PDAR et la
Preliminary results of the current study compared to those previously reported outcomes for hybrid laparoscopic pancreaticoduodenectomies (HLAPD), which showed significantly lower intraoperative blood loss and shorter LOS compared with open surgery while maintaining comparable results for oncologic outcomes and complications. This experience has provided us with the tools needed to adopt an MIS approach for nearly all pancreatic surgery at our centre within well-established inclusion criteria. Furthermore, the experience with the hybrid approach, where the pancreaticoduodenectomy resection is completed laparoscopically and the reconstruction completed through a mini-laparotomy, provided our group with the necessary preparation to transition from an open reconstruction to a robotic reconstruction, as previously described by Zureikat and colleagues. The purpose of the present study was to determine the safety and feasibility of robotic pancreatic surgeries during the initial phase of our institutional learning curve and to compare these results to our previously validated outcomes for HLAPD.

METHODS

This is a retrospective study of patients who underwent RAPD between July 2010 and June 2014. We compared the results with the outcomes for patients undergoing HLAPD. All procedures were performed by the same 2 attending staff surgeons (T.V. and S.B.).

Patient selection

All patients underwent preoperative high-resolution imaging (either computed tomography [CT], magnetic resonance imaging [MRI], or both). Patients were selected for a minimally invasive approach (RAPD or HLAPD) based primarily on tumour characteristics: localized tumours with no vascular invasion. A clear, fat plane had to be present around all arterial and venous structures, including the superior mesenteric artery (SMA), superior mesenteric vein (SMV) and common hepatic artery on preoperative high-resolution CT imaging. Any patient with suspected vascular

Surgical procedures of the pancreas have traditionally been associated with substantial morbidity and mortality. Minimizing morbidity has been one of the major factors initiating a shift toward minimally invasive (MIS) approaches in pancreatic resections. While still accounting for a minority of all pancreatic resections, MIS techniques now account for 1 of every 13 pancreatic resections. Three recent meta-analyses, including 1 using data from the Nationwide Inpatient Sample database, report that minimally invasive hepatobiliary surgery has consistently been associated with decreased blood loss and intraoperative complications as well as decreased length of stay in hospital (LOS) and increased lymph node harvest. These benefits have been achieved while maintaining comparable complication and leak rates to open resections despite increased duration of surgery. Beyond the traditional laparoscopic techniques, robotics offer additional advantages with increased magnification, depth, range of motion and dexterity. Giulianotti and colleagues first reported the outcomes of 8 robotic-assisted pancreaticoduodenectomies (RAPD) in 2003, demonstrating safety and feasibility, with morbidity and mortality comparable to open surgery. Because of the robotic platform’s versatility and relatively rapid learning curve, several groups worldwide have gained ease in the procedure and have unanimously reported decreased conversion rates, decreased blood loss and ability to maintain oncologic outcomes. In 2011, a meta-analysis reported that more than 1 in 5 of all MIS cases were performed using a robotic approach, with the majority of robotic hepatopancreatobiliary (HPB) cases (75%) being performed on the pancreas, with increasing pancreaticoduodenectomies performed over time. Despite this progress, robotic pancreatic surgery continues to account for a very small proportion of overall cases performed worldwide.

In Canada, the experience with the robotic platform in pancreatic resections is forthcoming, and to our knowledge no cases have yet been reported in the literature. Certain high-volume Canadian institutions have begun to transition into laparoscopic techniques with encouraging results. We
invasion underwent an open pancreaticoduodenectomy (OPD). In cases of equivocal vascular invasion, our group erred on the side of attempting a laparoscopic resection and then converting to an open resection rather than opting for an upfront open approach. This was not an intention to treat protocol, therefore all patients who were converted to open or mini-laparotomy before the docking of the robot for the reconstruction were not included in the RAPD group, as no robotic reconstruction was undertaken to justify inclusion into this group. We previously reported that patients in the HLAPD group who were converted to the OPD group did not contribute to worse outcomes for this group or favour outcomes of the minimally invasive group. Thus, any patient in whom a conversion to an open operation was required was included in the open group. All patients for whom a mini-laparotomy was used for reconstruction following a totally laparoscopic resection were included in the HLAPD group. Of note the choice of HLAPD versus RAPD during the study period was purely dictated by robot availability.

**Data collection**

Data were abstracted from the medical records and the surgical clinic notes and limited by the patient chart reporting. A blood loss reported as “nil” in the patient chart was estimated to be 50 mL.

We recorded the following demographic and clinical characteristics: age, sex and American Society of Anaesthesiologists (ASA) class. We also collected the following operative factors: duration of surgery, estimated blood loss, positive margin rate, positive lymph node rate, number of lymph nodes harvested, intraoperative transfusion rate and tumour size. We reported complications up to postoperative day 90 based on the Clavien Classification System; pancreatic fistula rates as per the postoperative pancreatic fistula international study group (ISGPF) criteria outlined in Appendix 1, available at canjsurg.ca; and delayed gastric emptying, as defined by the grading scheme outlined in Appendix 1.

Readmission, reoperation and mortality at 90 days were also reported.

**Operative technique**

The following outlines the operative steps for the laparoscopic portion of the RAPD.

1. The patient is prepared and draped in a sterile fashion and positioned in a dorsal lithotomy position. Placement of the trocars are illustrated in Figure 1.
2. Diagnostic laparoscopy is performed.
3. The gastrocolic ligament is divided from the midportion of the greater curvature to the right side, identifying the plane between the gastroepiploic omentum and the transverse mesocolon. The gastroepiploic vein is identified and traced back to the level of the infrapancreatic SMV and then divided.
4. The right colon is mobilized and the duodenum kocherized until the ligament of Treitz is released.

![Fig. 1. Patient and trocar position for (A) laparoscopic resection and (B) robotic reconstruction. *Liver retractor; A1 and A2 = assistant laparoscopic port; C = camera port (10 mm); R1, R2 and R3 = robotic port (8 mm); S1 and S2 = surgeon laparoscopic port (5 mm).](image-url)
5. The jejunum is brought back toward the right side of the abdomen and divided using a linear stapler. The mesentery of the proximal jejunum and duodenum is divided.
6. The distal stomach is divided using a linear stapler.
7. The common hepatic node is identified and sampled.
8. The gastroduodenal artery is divided using a vascular linear stapler.
9. The retropancreatic tunnel is developed above the SMV/portal vein (PV), and a Penrose drain is used to encircle the pancreas.
10. A complete hepatic hilar lymphadenectomy is performed, including all retropancreatic and periportal nodes.
11. A retrograde cholecystectomy is performed.
12. The common bile duct is transected above the junction with the cystic duct using a linear stapler.
13. The pancreas is then divided using bipolar energy.
14. The uncinate process dissection is performed by dividing the venous branches coming off the SMV as well as the first jejunal branches with clips or bipolar energy. The SMA is identified inferiorly, a subadventitial plane is developed, and the uncinate process is divided along this plane in a cephalad direction.
15. The specimen is extracted through a Pfannenstiel incision. This incision is closed and pneumoperitoneum is reobtained.
16. The proximal jejunum, onto which all reconstructions are performed, is brought up in the right upper quadrant. A side-to-side antecolic retrogastric loop gastrojejunostomy is created.

The robotic portion is performed as outlined below.

Patient and trocar positioning are outlined in Figure 1B.

1. The robotic trocars are placed and the robot is then docked.
2. A duct-to-mucosa pancreaticojejunostomy is performed in a Blumgart fashion. Using a 3–0 silk, several stitches are placed through the pancreas and back through the jejunum. Three duct-to-mucosa stitches using 4–0 suture are placed along the 9, 6 and 3 o’clock positions.
3. A pediatric feeding tube is placed in the pancreatic duct as a stent. The posterior duct-to-mucosa stitches and Blumgart stitches are tied. The anterior ductal mucosa stitches are completed using 4–0 suture. The needles left on the Blumgart stitches are then used to dunk the pancreaticojejunostomy.
4. The hepaticojejunostomy is performed in an interrupted fashion using 4–0 suture.
5. Two drains are left deep and superficial to the pancreatic and biliary anastomoses.

Statistical analysis

We used SPSS software version 22.0 to perform all data analyses. We chose to report medians over means for all parameters except for postoperative opioid use, given normally distributed numbers in a population with outliers. For reported medians, we used a Mann–Whitney U test to determine significance between RAPD and HLAPD. We performed a χ² test to determine significance of categorical values. We used Microsoft Excel to generate a graph of postoperative opioid use.

RESULTS

Between July 2010 and June 2014, 19 patients were scheduled to undergo robotic pancreaticoduodenectomies; 4 were found to have metastatic disease upon diagnostic laparoscopy and thus were excluded from the present analysis. Among the 15 remaining patients, 2 were converted to an open approach before the docking of the robot: 1 owing to adherence between the tumour and the common bile duct and right hepatic artery and 1 owing to a puckered mesocolon and tumour invasion into the SMV. A third patient, who had familial polyposis, was converted to a mini-laparotomy owing to adhesions precluding mobilization at the level of the ligament of Treitz. These 3 patients were not included in the present analysis, as their conversions were not related to any aspect of the robotic reconstruction but rather to intraoperative findings that could not be predicted preoperatively and for which a minimally invasive approach was deemed unsafe.

Twelve patients successfully underwent RAPD and were included in the present analysis. The median age of patients was 71 (range 26–80) years, and the median duration of surgery was 596.6 (509–799) min. There was a net improvement in the learning curve; patients in the second half of the study period had a median duration of surgery of 567 (range 509–650) min compared with 668.5 (range 555–799) min for those in the first half of the study period. The median estimated blood loss was 275 (300–1000) mL. There was 1 intraoperative complication with injury to the SMV during the laparoscopic portion of the procedure, which was immediately repaired laparoscopically. Demographic and operative findings are summarized in Table 1. Fourteen patients underwent HLAPD during the same timeframe. The choice of HLAPD versus RAPD was mostly dictated by robot availability. There was no significant difference between the RAPD and the HLAPD groups.

There was no significant difference in oncologic outcomes between the RAPD and HLAPD groups (Table 2). The majority of patients (88.5%) had malignant pathology. The most common pathology for RAPD was pancreatic ductal adenocarcinoma, accounting for 58.3% of cases, followed by pancreatic neuroendocrine tumours (16.7%), cholangiocarcinoma (8.3%), duodenal gastrointestinal stromal tumour (GIST; 8.3%) and intraepithelial neoplasia (8.3%). The R0 resection rate was 91.7%, and the median number of harvested lymph nodes was 22.5 (range 4–44),
58.3% of which were positive. The median tumour size was 2.85 cm. There was no recurrence at 90 days.

The median LOS was 7.5 (range 5–57) days in the RAPD group, as compared to 8 (range 6–14) days in the HLAPD group \( (p = 0.78) \), and mean total 7-day opioid use was 142.599 ± 68.2 mg of intravenous morphine equivalents in the RAPD group versus 176.9 ± 112.7 mg of intravenous morphine equivalents in the HLAPD group (Fig. 2). There was no significant difference between 90-day complication and pancreatic leak rates. Four patients had Clavien I–II complications that were conservatively managed (Table 3). Three patients had Clavien III–IV complications, 2 of which required admission to the intensive care unit; there was 1 reoperation for transverse colon perforation and peritonitis and 1 case of sepsis from pancreatic leak requiring intubation and CT-guided drainage. The third patient was readmitted with delirium secondary to a biliary leak and intra-abdominal abscess and required percutaneous drainage. There were no deaths within 90 days.

**DISCUSSION**

The versatility of the robotic platform to successfully perform well-selected pancreatic procedures with a low

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**Table 1. Patient demographic and perioperative characteristics**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Group; mean (range)*</th>
<th>p value†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient, no.</td>
<td>RAPD</td>
<td>HLAPD</td>
</tr>
<tr>
<td>Age, yr</td>
<td>71 (26–80)</td>
<td>69 (49–88)</td>
</tr>
<tr>
<td>Sex, male:female, %</td>
<td>50.50</td>
<td>78.6:21.4</td>
</tr>
<tr>
<td>ASA score</td>
<td>2 (2–3)</td>
<td>2 (2–3)</td>
</tr>
<tr>
<td>Duration of surgery, min</td>
<td>596.5 (509–799)</td>
<td>592.5 (407–779)</td>
</tr>
<tr>
<td>Estimated blood loss, mL</td>
<td>275 (50–1000)</td>
<td>400 (100–4000)</td>
</tr>
<tr>
<td>Intraoperative blood transfusion, no. (%)</td>
<td>1 (8.3)</td>
<td>5 (35.7)</td>
</tr>
<tr>
<td>Total 7-day analgesic use, mg IV, mean ± SD</td>
<td>142.599 ± 68.2</td>
<td>176.9 ± 112.7</td>
</tr>
<tr>
<td>LOS, d</td>
<td>7.5 (5–57)</td>
<td>8 (6–14)</td>
</tr>
<tr>
<td>90-day mortality, %</td>
<td>0%</td>
<td>7.1%</td>
</tr>
</tbody>
</table>

ASA = American Society of Anaesthesiologists; HLAPD = hybrid laparoscopy-assisted pancreaticoduodenectomy; IV = intravenous; LOS = length of stay; RAPD = robotic-assisted pancreaticoduodenectomy; SD = standard deviation.

*Unless indicated otherwise.
†Mann–Whitney U test.

**Table 2. Pathologic and oncologic outcomes**

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Group; mean (range) or no. (%)</th>
<th>p value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tumour size, cm</td>
<td>RAPD (n = 12)</td>
<td>HLAPD (n = 16)</td>
</tr>
<tr>
<td>Positive resection margin</td>
<td>1 (8.3)</td>
<td>3 (18.8)</td>
</tr>
<tr>
<td>Lymph node harvest</td>
<td>22.5 (4–44)</td>
<td>22 (13–56)</td>
</tr>
<tr>
<td>Positive lymph nodes</td>
<td>7 (56.3)</td>
<td>9 (56.3)</td>
</tr>
<tr>
<td>Malignant</td>
<td>11 (91.7)</td>
<td>12 (75.0)</td>
</tr>
<tr>
<td>Pancreatic adenocarcinoma</td>
<td>6 (50.0)</td>
<td>10 (62.5)</td>
</tr>
<tr>
<td>Ampullary adenocarcinoma</td>
<td>1 (8.3)</td>
<td>1 (6.3)</td>
</tr>
<tr>
<td>Neuroendocrine tumour</td>
<td>2 (16.7)</td>
<td>1 (6.3)</td>
</tr>
<tr>
<td>Cholangiocarcinoma</td>
<td>1 (8.3)</td>
<td>0</td>
</tr>
<tr>
<td>Duodenal GIST</td>
<td>1 (8.3)</td>
<td>0</td>
</tr>
<tr>
<td>Benign</td>
<td>1 (8.3)</td>
<td>2 (12.5)</td>
</tr>
<tr>
<td>IPMN</td>
<td>0</td>
<td>1 (6.3)</td>
</tr>
<tr>
<td>Pan-IN</td>
<td>1 (8.3)</td>
<td>0</td>
</tr>
<tr>
<td>Duodenal polyp</td>
<td>0</td>
<td>1 (6.3)</td>
</tr>
<tr>
<td>Perforated gastric ulcer</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Familial polyposis related tubular adenomas</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

GIST = gastrointestinal stromal tumour; HLAPD = hybrid laparoscopy-assisted pancreaticoduodenectomy; IPMN = intraductal papillary mucinous neoplasm; Pan-IN = pancreatic intraepithelial neoplasia; RAPD = robotic-assisted pancreaticoduodenectomy.

*Mann–Whitney U test.
conversion rate is a major advantage when transitioning from an open to a minimally invasive approach. In doing so, fundamental surgical principles must be maintained: safe dissection, ability to control hemorrhage, achieving negative margins and focusing on meticulous reconstruction. To date, Zureikat and colleagues have provided the largest body of evidence for robotic pancreatic resections performed in a single centre ($n=250$), including 132 pancreaticoduodenectomies, 83 distal pancreatectomies, 13 central pancreatectomies, 10 enucleations, 5 total pancreatectomies, 4 Appleby procedures, and 3 Frey procedures. In regards to RAPD, their findings support low complication rates (14% and 6% for Clavien III and Clavien IV complications, respectively) and mortality (2% at 90 days), with minimal conversion (6%). Their findings emphasize the ability to successfully complete complex pancreatic resections and reconstructions in a minimally invasive fashion, provided a minimal learning curve of 60–80 cases. They demonstrated that with increasing experience robotics has replaced open as the most common approach to pancreatic resections at their institution since the transition in 2008.

Similarly, our centre began performing robotic-assisted pancreatic resections in July 2010. We have adopted a more diversified robotic-assisted laparoscopic approach, in contrast to a purely robotic approach as described by Zureikat and colleagues. We complete the entire resection laparoscopically and also undertake the gastrojejunostomy laparoscopically. We use the robotic platform only for the pancreaticojunostomy and hepatojunostomy — steps for which we believe the robot adds the most value relative to a purely laparoscopic or hybrid approach. Our experience previously gained performing HLAPD has facilitated a step-wise introduction of minimally invasive techniques and eased our transition from laparoscopic to robotic techniques. In our previous study comparing 13 HLAPD and 20 open cases, with similar demographic parameters, we found significantly decreased blood loss (450 mL v. 1000 mL, $p=0.023$) and postoperative LOS (8 v. 12 d, $p=0.025$), with no difference in complication rates, pancreatic leak rates or mortality. This initial experience with a hybrid approach allowed us not only to master the laparoscopic resection, which is identical to the resection performed in RAPD, but also to focus on the reconstruction phase and maximize the robotic platform’s advantages for magnification, stability and increased ability for challenging suturing of small-calibre ducts. As such, the present study compares outcomes of RAPD with HLAPD to truly determine if there is any difference in the robotic reconstruction as compared with a hybrid approach and if it is safe and feasible to incorporate it in a centre with previous laparoscopic experience.

Though we initially expected to see an impact of robotics when performing enteric anastomosis, there was no significant difference in the pancreatic leak rate as compared with HLAPD; 25% of the RAPD patients experienced a high-grade (B or C) leak as compared with 12.5% in the HLAPD group. This is consistent with the range for RAPD reported in the literature (4%–38%; Table 4). Our operative approach to the pancreatic remnant involved a duct-to-mucosa pancreaticojunostomy in a Blumgart fashion with placement of a pediatric feeding tube as a stent in an attempt to reduce pancreatic leaks. Zureikat and colleagues used the same approach and reported a 21% leak rate among all patients undergoing robotic duct-to-mucosa pancreaticojunostomies, which is less than other groups that opted for

![Fig. 2. Postoperative analgesic requirements. Data points from hybrid laparoscopy-assisted pancreaticoduodenectomy (HLAPD) and open pancreaticoduodenectomy (OPD) patients extracted from the study by Wang and colleagues. POD = postoperative day; RAPD = robotic-assisted pancreaticoduodenectomy.](image)

<table>
<thead>
<tr>
<th>Table 3. Ninety-day complication rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complication</td>
</tr>
<tr>
<td>Clavien I–II</td>
</tr>
<tr>
<td>Intra-abdominal abscess</td>
</tr>
<tr>
<td>Wound infection</td>
</tr>
<tr>
<td>Delayed gastric emptying</td>
</tr>
<tr>
<td>Pneumonia</td>
</tr>
<tr>
<td>Hypotension</td>
</tr>
<tr>
<td>Wound dehiscence</td>
</tr>
<tr>
<td>Clavien III–IV</td>
</tr>
<tr>
<td>Intra-abdominal abscess</td>
</tr>
<tr>
<td>Anastomotic breakdown</td>
</tr>
<tr>
<td>Portal vein thrombosis</td>
</tr>
<tr>
<td>Postoperative hemorrhage</td>
</tr>
<tr>
<td>Peritonitis/colon perforation</td>
</tr>
<tr>
<td>Acute myocardial infarction</td>
</tr>
<tr>
<td>Bowel ischemia</td>
</tr>
<tr>
<td>Pancreatic fistula</td>
</tr>
<tr>
<td>Grade A</td>
</tr>
<tr>
<td>Grade B</td>
</tr>
</tbody>
</table>

*RLAPD = hybrid laparoscopy-assisted pancreaticoduodenectomy; RAPD = robotic-assisted pancreaticoduodenectomy.
†Not necessitating radiological, endoscopic or operative intervention and not causing organ failure.
‡Necessitating radiological, endoscopic or operative intervention and/or causing organ failure.

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Giulianotti and colleagues\(^6\) reported a 36.5% pancreatic fistula rate in the RAPD patients who underwent sclerosis compared with those who underwent anastomosis (21%). Given multiple failed attempts to decrease pancreatic leak rates reported in the literature and in light of the present findings, there may be an inherent pancreatic leak rate that must be accepted and managed early, despite minimally invasive approaches. That being said, our leak rate is well within the norms reported in the literature and is in fact below that reported by the largest centre performing RAPD despite the early phase of our learning curve.\(^6\)

Early management of these leaks, including drain removal, would contribute to decreasing progression to intra-abdominal abscesses which accounted for 2 of the 3 major (Clavien III–IV) complications encountered in our study. One patient, who had ileus in the immediate postoperative course, was readmitted 2 days postdischarge with an intra-abdominal abscess requiring admission to the intensive care unit. The patient was subsequently stabilized but remained admitted for a pre-existing comorbidity unrelated to the surgical procedure. Similarly, the second patient was readmitted 2 days postdischarge with delirium secondary to intra-abdominal collection, which resolved with ultrasound-guided drainage. The third severe complication was in a patient with cholangiocarcinoma who required admission to the intensive care unit for sepsis and peritonitis secondary to the surgical procedure. Similarly, the second patient was readmitted 2 days postdischarge with delirium secondary to intra-abdominal collection, which resolved with ultrasound-guided drainage. The third severe complication was in a patient with cholangiocarcinoma who required admission to the intensive care unit for sepsis and peritonitis secondary to transverse colon perforation. This patient underwent reoperation on postoperative day 7 and subsequently experienced recurrent bowel obstructions, potentially due to recurrent cholangiocarcinoma, and was eventually discharged on postoperative day 37 with no further complications. Zureikat and colleagues\(^6\) reported a drop in severe (grade III–IV) complications encountered in our study. One patient, who had ileus in the immediate postoperative course, was readmitted 2 days postdischarge with an intra-abdominal abscess requiring admission to the intensive care unit.

Furthermore, there was no significant difference in estimated blood loss, duration of surgery, postoperative opioid use or postoperative LOS between the RAPD and HLAPD groups in the present study. The benefit of the robotic arms to gain access into the retroperitoneal space and provide adequate hemostasis is demonstrated by our median estimated blood loss of 275 mL, which is less than the rate reported in our laparoscopic cases (400 mL) and consistent with the significant difference reported in the literature.\(^4\) This also reflects our ability to control bleeding during both phases of the procedure and highlights the benefits of experience with both laparoscopy and robotics, so as to avoid severe complications related to hypovolemia.\(^1\) Because of less damage to surrounding vasculature, we achieved a low rate of severe complications (25% Clavien III–IV), and none was related to hypovolemia or disseminated intravascular coagulation.

In addition, owing to the precision and care needed to perform these intricate resections and reconstructions with minimal complications, duration of surgery in the RAPD group (596 min) was longer than that reported for open resections\(^3,19\) but virtually identical to that in the HLAPD group (592 min) and is in the range reported in the literature for RAPD (431–718 min).\(^6,7,17\) These long operations, despite our centre’s experience with the hybrid laparoscopic approach, may be in part attributed to the added complexity of malignant pathology in most of our patients (91.7%) and to the increased care in executing an adequate resection to preserve oncologic outcomes comparable to the open experience. Similar lymphadenectomy rates (22.5 nodes, range 4–44) were achieved as with HLAPD and in the range described by Zureikat and colleagues\(^18\) using a completely robotic approach (17 nodes, range 5–37). In addition, both attending surgeons are still within their learning curve, which is 60–80 procedures.\(^6\) In the second half of our study, we observed a median improvement of 101.5 minutes, and we predict future improvement in operative duration with increasing experience, as was reported by Zureikat and colleagues,\(^6\) who experienced a significant decrease in operative duration in their last 60 cases.\(^6\)

**Table 4. Early comparative experience with robotic pancreaticoduodenectomy, June 2010–July 2014**

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>n</th>
<th>Procedure</th>
<th>LOS</th>
<th>Duration, mean (range) min</th>
<th>Pancreatic leak</th>
<th>Complications</th>
<th>Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Giulianotti et al.(^5)</td>
<td>Italy</td>
<td>8</td>
<td>PD</td>
<td>20</td>
<td>490</td>
<td>NA</td>
<td>37.5%</td>
<td>12.5%</td>
</tr>
<tr>
<td>Narula(^2)</td>
<td>USA</td>
<td>5</td>
<td>PD</td>
<td>9.6</td>
<td>420</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Horiguchi(^13)</td>
<td>Japan</td>
<td>3</td>
<td>PD</td>
<td>26</td>
<td>703</td>
<td>33%</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Zeh(^14)</td>
<td>USA</td>
<td>50</td>
<td>PD</td>
<td>10</td>
<td>568</td>
<td>22%</td>
<td>Clavien I–II (26%)</td>
<td>2%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Clavien III–IV (30%)</td>
<td></td>
</tr>
<tr>
<td>Zureikat et al.(^15)</td>
<td>USA</td>
<td>24</td>
<td>PD</td>
<td>9</td>
<td>512 (327–848)</td>
<td>21%</td>
<td>Clavien III–IV (25%)</td>
<td>3.3%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Clavien I–II (27%)</td>
<td></td>
</tr>
<tr>
<td>Chalikonda(^16)</td>
<td>USA</td>
<td>30</td>
<td>PD</td>
<td>9.8</td>
<td>476</td>
<td>6.7%</td>
<td>30%</td>
<td>4%</td>
</tr>
<tr>
<td>Zhou(^17)</td>
<td>China</td>
<td>8</td>
<td>PD</td>
<td>16.4</td>
<td>718</td>
<td>50%</td>
<td>25%</td>
<td>0</td>
</tr>
<tr>
<td>Zureikat et al.(^8)</td>
<td>USA</td>
<td>132</td>
<td>PD</td>
<td>10</td>
<td>527</td>
<td>17%</td>
<td>Clavien III: 14% Clavien IV: 6%</td>
<td>1.5</td>
</tr>
</tbody>
</table>

LOS = length of stay; NA = not available; PD = pancreaticoduodenectomy.
Although long-term and quality of life data are not available in the present study, we quantified the level of immediate postoperative pain based on daily analgesic requirements up to postoperative day 7. We noted minimal use of opioids with a mean of 142.599 ± 68.2 mg of intravenous morphine equivalents in the week following RAPD compared with 176.9 ± 112.7 mg of intravenous morphine equivalents in the HLAPD group, tapering to close to zero by postoperative day 7 in both groups; 41% of RAPD patients were weaned off by postoperative day 5. To our knowledge, we are the first to report postoperative analgesic use as an indicator of postoperative pain, but conclude decreased need for opioids in patients undergoing minimally invasive than in those undergoing open pancreaticoduodenectomy as previously reported.7 Comparative trends up to postoperative day 7 are illustrated in Figure 2. We believe that the decreased need for opioids may have directly contributed to a decreased LOS in the RAPD group (7.5 d) compared with historic open data, but there was no significant difference between the RAPD and HLAPD groups.

In light of our findings, patients at our institution continue to be selected for a minimally invasive approach based solely on tumour characteristics on preoperative imaging. These criteria have not changed over time, even with increasing experience. Including a patient in the RAPD or HLAPD group is not based on superiority or preference of one procedure over another but rather on robot availability on the scheduled procedure date, as this resource limitation is a reality we must face in a Canadian institution. This resource limitation also restricts our ability to overcome our learning curve in a more timely fashion. Despite this constraint, our centre nonetheless completed 28 minimally invasive pancreaticoduodenectomies (12 RAPD and 16 HLAPD) during the study period. What has evolved over time, however, is our willingness and confidence to begin a procedure by laparoscopy and then convert to hybrid or open if needed, so that the patient may benefit from as much of a minimally invasive procedure as possible. We have noted no deaths or significant differences in major complications and thus plan to pursue RAPD at our institution in all patients amenable to a minimally invasive approach according to our aforementioned inclusion criteria.

**Conclusion**

In our early experience, RAPD is safe and feasible and can ensure adequate oncologic resections and lymphadenectomies with acceptable complication rates compared with HLAPD. The importance of minimal blood loss, lower levels of postoperative opioids and shorter LOS emphasize the ability to perform robotic reconstructions safely in a highly specialized centre with previous experience in laparoscopic pancreatic resections. Our initial results with RAPD are positive and encouraging compared with both HLAPD and an open procedure, further providing evidence that the robotic platform provides meaningful patient benefit and should be considered in centres with access to a robot and trained surgeons.

**Affiliations:** From the Department of Surgery, Sir Mortimer B. Davis Jewish General Hospital, McGill University, Montreal, Que. (Piedimonte, Wang, Bergman, Vanounou); and the Lady Davis Institute for Medical Research, Montreal, Que. (Bergman).

**Competing interests:** None declared.

**Contributors:** S. Piedimonte, S. Bergman and T. Vanounou designed the study. S. Piedimonte and Y. Wang acquired and analyzed the data, which T. Vanounou also analyzed. S. Piedimonte and T. Vanounou wrote the article, which all authors reviewed and approved for publication.

**References**

Functional outcomes of acutely infected knee arthroplasty: a comparison of different surgical treatment options

Ivan Dzaja, MD  
James Howard, MD, MSc  
Lyndsay Somerville, PhD  
Brent Lanting, MD

Accepted for publication  
Jul. 2, 2015

Correspondence to:  
I. Dzaja  
Department of Surgery  
London Health Sciences Centre  
London ON N6A 5W9  
ivandzaja@yahoo.ca

DOI: 10.1503/cjs.017614

Background: An infected total knee arthroplasty (TKA) can be treated with irrigation and débridement with polyethylene exchange (IDPE) or a 2-staged revision (2SR). Although research has examined infection eradication rates of both treatments, patient outcomes have not been reported. We examined patient-reported outcomes following treatment compared with matched, noninfected controls.

Methods: We retrospectively identified patients with infected TKAs who had undergone the index procedure between May 1991 and November 2011. Patient-reported outcomes included the 12-item Short Form Health Survey, Western Ontario and McMaster Universities Arthritis Index, and Knee Society Scores as well as range of motion. Patients with noninfected primary TKAs matched by age and age-adjusted Charlson Comorbidity Index score were used as controls. Intention-to-treat groups of 2SR and IDPE were used, with the IDPE group subdivided into successful and unsuccessful groups.

Results: We included 145 patients with infected TKAs with mean follow-up of 64.2 months and 145 controls with a mean follow-up of 35.4 months in our analysis. Outcomes of the controls and the successful IDPE groups were equivalent. The 2SR cohort had lower scores in all categories than controls. There was a 39% success rate in eradicating infection with IDPE. Patients in whom IDPE failed had lower scores in all categories than controls. There was no difference between the failed IDPE group and the 2SR group.

Conclusion: Controversy regarding treatment options for acutely infected TKA has been focused on infection eradication. However, functional outcomes following treatment need to be taken into consideration. Patients whose infections were successfully treated with IDPE had equivalent outcomes to controls.

Contexte : Il est possible de traiter une arthroplastie totale du genou (ATG) infectée par irrigation et débridement avec changement du polyéthylène (IDCP) ou par une révision en 2 étapes. Même si la recherche a examiné les taux d’éradication de l’infection au moyen des 2 traitements, les résultats chez les patients n’ont pas fait l’objet de rapports. Nous avons comparé les résultats enregistrés chez les patients traités à ceux de témoins assortis non infectés.

Méthodes : Nous avons recensé de manière rétrospective les patients qui ont présenté une infection de leur ATG et qui avaient initialement subi leur intervention entre mai 1991 et novembre 2011. Les résultats rapportés par les patients incluaient le questionnaire SF (Short Form) sur la santé en 12 points, l’indice WOMAC (établi par les universités Western Ontario et McMaster), le score de la Knee Society, de même que l’amplitude de mouvement. Des patients soumis à une ATG primaire non infectée assortis selon l’âge et le score de comorbidités de Charlson ajusté selon l’âge ont servi de participants témoins. On a réparti les groupes selon l’intention de traiter par révision en 2 étapes ou par IDCP, le groupe IDCP a été subdivisé selon que l’intervention avait réussi ou non.

Résultats : Notre analyse a regroupé 145 patients dont l’ATG s’était infectée et qui ont été suivis en moyenne pendant 64,2 mois, et 145 témoins suivis en moyenne pendant 35,4 mois. Les résultats ont été équivalents chez les témoins et les groupes dont l’IDCP avait réussi. La cohorte soumise à la révision en 2 étapes a obtenu des scores moindres dans toutes les catégories, comparativement aux témoins. On a noté un taux de succès de 39 % pour l’éradication de l’infection avec l’IDCP. Les patients chez qui l’IDCP a échoué présentaient des scores moindres dans toutes les catégories comparativement aux témoins. On n’a noté aucune différence entre le groupe chez qui l’IDCP avait échoué et le groupe soumis à la révision en 2 étapes.

Conclusion : La controverse quant aux options thérapeutiques pour les infections aigües d’ATG portait sur l’éradication de l’infection. Or, les résultats fonctionnels après le traitement devraient aussi entrer en ligne de compte. Chez les patients dont les infections ont été traitées avec succès par IDCP, les résultats ont été équivalents à ceux des témoins.
Periprosthetic joint infection is a devastating complication after total knee arthroplasty (TKA). Between 2005 and 2006, 25% of revisions were to manage infection. Demand for primary TKA in the United States is projected to grow by 673% to 3.48 million procedures by 2030. This would translate into a huge number of patients experiencing periprosthetic joint infections, with the care of these patients representing a substantial financial burden to society. The surgical options for treatment of periprosthetic infection include irrigation and débridement with polyethylene exchange (IDPE), single-stage revision, or 2-stage revision (2SR).

Irrigation and débridement with polyethylene exchange is an attractive alternative for both patient and surgeon. Compared with a 2SR, benefits of an IDPE include retention of implants, preservation of bone stock, shorter procedure duration, less chance of intraoperative fracture from removal of components and implantation of cement spacers, and faster postoperative rehabilitation. However, the reported success rate of IDPE is variable, with reports ranging from 29% to 83%. By comparison, 2SR is considered the gold standard, with success rates reported in the range of 75%–100%. In addition, it has been reported that failure rates of 2SR for TKA infections are higher in patients treated with previous IDPE than in patients who did not receive IDPE. Therefore, surgeons considering IDPE need to balance potential benefits of the procedure with the lower eradication rate and potentially decreased chance of eradication should the patient ultimately receive 2SR.

There may be a role for IDPE in certain situations, such as the treatment of acute postoperative and acute hematogenous infections. An acute postoperative infection has been defined as one that occurs within the first 4 weeks after index TKA. Other studies are more reserved in their recommendations and state that IDPE should be considered only in immunologically optimized patients with acute non-Staphylococcal infections. Although there is an abundance of literature studying the successful eradication rates with IDPE and 2SR, there is a paucity of data reporting on the patient experience or patient satisfaction associated with these revision procedures. Understanding patient-reported satisfaction is important to the treatment decision process.

Therefore, the purpose of this study was to examine patient-reported outcomes in patients with infected TKAs based on whether the patients were treated with initial 2SR, successful IDPE, or failed IDPE with subsequent 2SR; to compare each of the above cohorts to a matched control group of patients with noninfected TKAs; and to determine the success rates of 2SR and IDPE in our study population.

**METHODS**

After obtaining institutional review board approval, we performed a database query to identify patients whose index TKAs, performed between May 1991 and November 2011, were acutely infected. Inclusion criteria for our retrospective review were a minimum 1-year follow-up after surgical treatment of infection.

All procedures were performed by 1 of 7 surgeons at our institution. All 7 are high-volume, arthroplasty fellowship-trained surgeons. Implant type for the index procedures included varying levels of constraint, including posterior stabilized, varus-valgus constrained non-hinged, and hinged knees.

In 2011, The Musculoskeletal Infection Society created guidelines for the diagnosis of periprosthetic joint infection (PJI). A definite diagnosis of PJI can be made when the following conditions are met:

- Sinus tract communicating with the prosthesis.
- Pathogen isolated by culture from 2 separate tissue or fluid samples obtained from the affected prosthetic joint.
- Presence of at least 4 of the following: elevated serum erythrocyte sedimentation rate (ESR) or serum C-reactive protein (CRP) concentration, elevated synovial white blood cell count, elevated synovial neutrophil percentage, presence of purulence in the affected joint, isolation of a microorganism in 1 culture of periprosthetic tissue or fluid, and more than 5 neutrophils per high-power field in 5 high-power fields observed from histologic analysis of periprosthetic tissue at ×400 magnification.

At our institution, diagnosis of infection follows these criteria, with the whole clinical picture used to guide treatment. Threshold values for ESR and CRP in the present study were are 30 mm/hr and 10 mg/L, respectively. We excluded patients with less than 1 year of complete follow-up.

Identified patients were matched to a control cohort of patients with noninfected primary TKAs based on age and the age-adjusted Charlson Comorbidity Index (CCI) score. The CCI score is a validated method of estimating risk of death from comorbid disease and has also been found to correlate well with major complications in revision surgery. Patients with a surgically managed infected TKA were then divided into either the 2SR or IDPE group based on intention to treat. The type of treatment performed was at the discretion of the treating surgeon. The IDPE group was then further subdivided based on whether the IDPE was successful or unsuccessful at eradicating infection; patients in whom IDPE was not successful required subsequent 2SR. Both acute hematogenous and acute postoperative infections were defined as those presenting within 4 weeks of onset of symptoms. We considered the infection to be eradicated when the inflammatory markers had normalized, the clinical symptoms had improved and the surgical wound had healed.
Functional outcomes and reoperations associated with unsuccessful eradication of infection were reviewed. We used the most recent patient-reported scores and range of motion (ROM) for analysis. For patients who had unsuccessful IDPE and required subsequent 2SR, clinical outcomes were measured at their most recent follow-up (i.e., after their 2SR). We calculated CCI scores based on a review of patient charts. At each clinic visit, ROM was recorded using a goniometer; ROM at the initial visit and at latest review was used in this study. Western Ontario and McMaster Universities Arthritis Index (WOMAC), Knee Society Clinical Rating System (KSS) and the 12-item Short-Form Health Survey (SF12) scores were recorded from standardized forms that are routinely used for all arthroplasty patients at our institution. All 3 scores have been validated for use in quantifying knee pain and function.25–27

**Statistical analysis**

We used the Statistical Package for the Social Sciences (SPSS Inc.) for the statistical analysis. We used the Student t test for parametric comparisons and the Mann–Whitney U test for nonparametric comparisons between the groups. The Mann–Whitney U test was used when data for a particular variable did not meet the distribution assumptions required by their parametric counterpart.

**RESULTS**

During our study period, 1857 knee revisions were performed at our institution. Review of our database identified 145 infected TKAs in 145 patients. Of the 145 patients with infected TKAs, 91 were treated initially with 2SR and 54 were treated with IDPE. Of the 91 patients treated with 2SR, 79 had successful eradication of infection and 12 had reoperations for infection. Of the 54 patients treated with IDPE, 21 had successful infection eradication and 33 had a persistent infection and required 2SR (Fig. 1). All of the patients in our cohort in whom IDPE failed received a subsequent 2SR. Of the 21 patients in whom IDPE was successful, 9 had their infections diagnosed during the acute postoperative period and 12 had diagnoses of acute hematogenous infection. Of the 33 patients in whom IDPE was unsuccessful, 4 had their infections diagnosed during the acute postoperative period and 29 patients had diagnoses of acute hematogenous infection (Fig. 1). In other words, acute postoperative infection in our patient cohort represented 43% of successful IDPE and 12% of failed IDPE.

There was no difference in age, CCI scores or body mass index between controls and patients with infected TKAs (Table 1). Mean clinical follow-up for patients with infected TKAs was 64.2 (range 12–237) months compared with 35.4 (range 24–120) months in the control group ($p < 0.001$; Table 1).

For the successful IDPE cohort, 6.7% of patients had a hinged prosthesis and 93.3% had posterior stabilized prostheses. All patients in the failed IDPE group had posterior stabilized prostheses. In the 2SR group, 6.1% had a hinged prosthesis, 57.3% had varus-valgus constrained prostheses, and 36.6% had posterior stabilized prostheses. The mean duration from initial arthroplasty surgery to the 2SR was 31.7 (range 2–180) months. The mean duration from initial

![Fig. 1. Distribution of patients based on treatment algorithm. 2SR = 2-staged revision; IDPE = irrigation and débridement with polyethylene exchange.](image-url)
arthroplasty to successful IDPE was 15.3 (range 1–89) months. Finally, the mean duration from initial arthroplasty to failed IDPE was 23.8 (range 1–120) months.

Compared with the 2SR group, the control group performed better on all measures, with better SF12 mental composite score ($p = 0.005$), SF12 physical composite scale ($p = 0.002$), WOMAC ($p < 0.001$) and KSS ($p < 0.001$) scores and improved ROM ($p < 0.001$) at latest review (Table 2). When the 2SR group was divided into successful and failed 2SR, the control group performed better than both on all measured outcomes (all $p < 0.05$). Similarly, the control group performed better on all measures than the failed IDPE group (all $p < 0.05$; Table 3). Comparing the failed IDPE group with the 2SR group revealed no difference in any outcome (all $p > 0.05$; Table 4). Comparing the control group with the successful IDPE group demonstrated no difference in any measured outcome (all $p > 0.05$; Table 5). The success rate with IDPE was 39% and the success rate with 2SR was 87% in our cohorts.

### Table 1. Patient demographic and clinical characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Control</th>
<th>Infection</th>
<th>$p$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, yr</td>
<td>67.7</td>
<td>68.9</td>
<td>0.21</td>
</tr>
<tr>
<td>CCI score</td>
<td>1.51</td>
<td>1.65</td>
<td>0.49</td>
</tr>
<tr>
<td>BMI</td>
<td>32.8</td>
<td>33.1</td>
<td>0.84</td>
</tr>
<tr>
<td>Follow-up, mo</td>
<td>35.4</td>
<td>44.2</td>
<td>$&lt; 0.001$</td>
</tr>
</tbody>
</table>

BMI = body mass index; CCI = Charlson Comorbidity Index.

### Table 2. Outcome scores comparing controls with patients with infected TKAs who received a 2SR

<table>
<thead>
<tr>
<th>Outcome measure</th>
<th>Group; mean</th>
<th>2SR</th>
<th>$p$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SF12 mental component score</td>
<td>53.4</td>
<td>49.7</td>
<td>0.045</td>
</tr>
<tr>
<td>SF12 physical component score</td>
<td>38.9</td>
<td>33.8</td>
<td>0.002</td>
</tr>
<tr>
<td>KSS</td>
<td>169.3</td>
<td>153.3</td>
<td>$&lt; 0.001$</td>
</tr>
<tr>
<td>WOMAC</td>
<td>78.1</td>
<td>62.8</td>
<td>$&lt; 0.001$</td>
</tr>
<tr>
<td>ROM, arc</td>
<td>116.9</td>
<td>91.1</td>
<td>$&lt; 0.001$</td>
</tr>
</tbody>
</table>

2SR = 2-staged revision; KSS = Knee Society score; ROM = range of motion; SF12 = 12-item Short Form Health Survey; TKA = total knee arthroplasty; WOMAC = Western Ontario and McMaster Universities Arthritis Index.

### Table 3. Outcome scores comparing controls with patients with infected TKAs in whom IDPE failed

<table>
<thead>
<tr>
<th>Outcome measure</th>
<th>Group; mean</th>
<th>Failed IDPE</th>
<th>$p$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SF12 mental component score</td>
<td>53</td>
<td>46.1</td>
<td>0.026</td>
</tr>
<tr>
<td>SF12 physical component score</td>
<td>42.5</td>
<td>37.3</td>
<td>0.045</td>
</tr>
<tr>
<td>KSS</td>
<td>170.4</td>
<td>142.1</td>
<td>0.004</td>
</tr>
<tr>
<td>WOMAC</td>
<td>76.2</td>
<td>63.9</td>
<td>0.036</td>
</tr>
<tr>
<td>ROM, arc</td>
<td>116.6</td>
<td>93.6</td>
<td>0.003</td>
</tr>
</tbody>
</table>

IDPE = irrigation and débridement with polyethylene exchange; KSS = Knee Society score; ROM = range of motion; SF12 = 12-item Short Form Health Survey; TKA = total knee arthroplasty; WOMAC = Western Ontario and McMaster Universities Arthritis Index.

### Table 4. Outcome scores comparing failed IDPE with 2SR

<table>
<thead>
<tr>
<th>Outcome measure</th>
<th>Failed IDPE</th>
<th>2SR</th>
<th>$p$ value</th>
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</thead>
<tbody>
<tr>
<td>SF12 mental component score</td>
<td>45.2</td>
<td>49.7</td>
<td>0.08</td>
</tr>
<tr>
<td>SF12 physical component score</td>
<td>37.2</td>
<td>33.8</td>
<td>0.12</td>
</tr>
<tr>
<td>KSS</td>
<td>141.8</td>
<td>135.3</td>
<td>0.54</td>
</tr>
<tr>
<td>WOMAC</td>
<td>63.9</td>
<td>62.8</td>
<td>0.93</td>
</tr>
<tr>
<td>ROM, arc</td>
<td>93.4</td>
<td>91.1</td>
<td>0.47</td>
</tr>
</tbody>
</table>

2SR = 2-staged revision; IDPE = irrigation and débridement with polyethylene exchange; KSS = Knee Society score; ROM = range of motion; SF12 = 12-item Short Form Health Survey; TKA = total knee arthroplasty; WOMAC = Western Ontario and McMaster Universities Arthritis Index.

### Table 5. Outcomes comparing controls with patients with infected TKAs in whom IDPE was successful

<table>
<thead>
<tr>
<th>Outcome measure</th>
<th>Control</th>
<th>Successful IDPE</th>
<th>$p$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SF12 mental component score</td>
<td>49.4</td>
<td>50.1</td>
<td>0.96</td>
</tr>
<tr>
<td>SF12 physical component score</td>
<td>37.2</td>
<td>37.7</td>
<td>0.93</td>
</tr>
<tr>
<td>KSS</td>
<td>160.8</td>
<td>150.1</td>
<td>0.48</td>
</tr>
<tr>
<td>WOMAC</td>
<td>75.6</td>
<td>72.1</td>
<td>0.67</td>
</tr>
<tr>
<td>ROM, arc</td>
<td>109</td>
<td>110.9</td>
<td>0.56</td>
</tr>
</tbody>
</table>

2SR = 2-staged revision; IDPE = irrigation and débridement with polyethylene exchange; KSS = Knee Society score; ROM = range of motion; SF12 = 12-item Short Form Health Survey; TKA = total knee arthroplasty; WOMAC = Western Ontario and McMaster Universities Arthritis Index.

### Discussion

Periprosthetic joint infection continues to be a challenge in TKA for both patients and surgeons. Twenty-five percent of revisions are done as a result of infection, with an incidence rate of 1% for TKA. The optimal treatment for patients with infected TKAs is controversial. While 2SR remains the gold standard in treatment with an eradication rate ranging from 75% to 100%, there is no clear consensus on the role of IDPE in the treatment of periprosthetic infection. Compared with 2SR, the benefits of IDPE include retention of implants with preservation of bone stock, shorter procedure durations, decreased chance of intraoperative fracture from removal of components with implantation of cement spacers, and faster postoperative rehabilitation. The main arguments against the use of IDPE as a treatment option have centered on its low success rate at eradicating infection and on the possibility that IDPE may reduce the success rate of a subsequent 2SR.

There is an abundance of literature on the treatment of an infected TKA with success rates of IDPE reported to range from 29% to 83%. Therefore, we elected not to focus on success or failure rates of eradication. Instead, the aim of the present study was to add to the body of literature by being, to our knowledge, the first study to focus on patient-reported outcomes based on treatment provided.

Our results demonstrate that there is no difference in patient-reported clinical outcomes when comparing...
unsuccessful IDPE and 2SR. Most interestingly, we found no difference in any outcome when comparing the control group with the successful IDPE group. These findings are important when counselling a patient on the treatment options available for an infected TKA. The improved satisfaction of a successful IDPE must be weighed against the lower rates of successful eradication, and these issues need to be discussed with the patient.

In our cohort, IDPE resulted in an eradication rate of 39%, which is consistent with rates reported in the literature.6–10 Similarly, the eradication rate after 2SR in our cohort was 87%, which is also consistent with published rates.11–17 Treatment with IDPE is more likely to be successful in cases of acute postoperative and acute hematogenous infections.19 The failed IDPE group in our study had a greater proportion of acute hematogenous infection than the successful IDPE group. It is possible that some of our patients in whom IPDE failed actually had misdiagnosed chronic infections. However, the 39% eradication rate in our study is consistent with that reported in previous studies evaluating IDPE for infected TKAs.6–10 Furthermore, the main purpose of the present study was to report on outcomes based on the treatment patients received rather than the success or failure of eradication.

**Limitations**

The study limitations were as follows. First, this study involved a retrospective review and was therefore subject to all the biases associated with this type of study design. Second, some patients in whom IDPE failed had been referred from other hospitals. As the referring surgeons followed IDPE treatment protocols similar to those at our tertiary care centre, these patients were included in the current study to maximize cohort size. Third, it should be noted that there is a difference between the infected and control cohorts with regards to mean duration of follow-up (64.2 mo in the infected cohorts v. 35.4 mo in the control cohort). The control cohort was selected by matching patients with noninfected primary TKAs with patients in the infected cohort based on age and age-adjusted CCI scores. This process resulted in a comparable control cohort in terms of patient number, age, age-adjusted CCI and body mass index. As a result of the matching process, there was a difference in mean duration of follow-up between the cohorts. However, since previous literature has demonstrated that clinical outcome scores do not change significantly beyond 18 months after surgery,29,30 the comparison of clinical outcomes in the cohorts is still relevant despite the differential follow-up. Finally, the data included in the current study depend on the quality of the data recorded in the medical records and are therefore subject to the limitations faced by many retrospective cohort designs. In some cases the onset of symptoms were not well recorded in terms of hours and/or days. Therefore, although we could definitively identify that patients fit our definition of acute symptoms (< 4 wk), in some cases we were unable to reliably calculate an hour or day value for onset of symptoms. As a result we have not presented these data in our study.

The main strength of this study is that it offers a unique look at a large patient cohort experiencing a difficult complication after TKA. It also examines how different treatment algorithms affect patient-reported outcomes and ROM after treatment of infection. To our knowledge, patient-reported outcomes have previously not been published in the literature or been considered as part of the controversy regarding the appropriate management of the infected TKA.

**CONCLUSION**

There may be a role for IDPE in the treatment of periprosthetic infections owing to the potential for greater patient satisfaction with IDPE than with 2SR. The improved satisfaction associated with a successful IDPE must be weighed against its lower rate of successful eradication of infection. By attempting to identify the patients in whom IDPE is most likely to succeed, a surgeon can maximize patient outcomes when dealing with periprosthetic infection.
RESEARCH


Working toward benchmarks in orthopedic OR efficiency for joint replacement surgery in an academic centre

Paule E. Beaulé, MD
Aaron A. Frombach, MD
Jae-Jin Ryu, PhD

Accepted for publication
Jul. 14, 2015

Correspondence to:
P. Beaulé
Division of Orthopaedic Surgery
University of Ottawa
The Ottawa Hospital
501 Smyth Rd, CCW 1640
Ottawa ON K1H 8L6
pbeaule@toh.on.ca

DOI: 10.1503/cjs.001215

Background: The introduction of 4-joint operating rooms (ORs) to meet provincial wait time targets represented a major change in practice, providing an opportunity to optimize patient care within an OR time allotment of 8 hours. We reviewed our success rate completing 4 joint replacements within 8 hours and defined benchmarks for successful completion.

Methods: We reviewed the surgeries performed in the 4-joint ORs between May and October 2012. Using prospectively collected data from the Surgical Information Management System, each surgery time was divided into the following components: anesthesia preparation time (APT), surgical preparation time (SPT), procedure duration, anesthesia finishing time (AFT) and turnover time. We defined success as 4 joint replacements being completed within the allotted time.

Results: We reviewed 49 4-joint OR days for a total of 196 joint surgeries. Of the 49 days, 24 (49%) were successful. Only 2 surgeons had a success rate greater than 50%. Significant predictors of success were APT (odds ratio 1.09, 95% confidence interval [CI] 1.02–1.16), procedure duration (odds ratio 1.02, 95% CI 1.00–1.05) and AFT (odds ratio 1.19, 95% CI 1.06–1.34). We calculated probabilities for each component and derived benchmark times corresponding to the probability of 0.60. These benchmarks were APT of 9 min, SPT of 14 min, procedure duration of 68 min, AFT of 4 min and turnover of 15 min.

Conclusion: We established benchmark times for the successful completion of 4 primary joint replacements within an 8-hour shift. Targeted interventions could maximize OR efficiency and enhance multidisciplinary care delivery.

Contexte : Afin d’atteindre les cibles provinciales en matière de temps d’attente, on a mis en service des blocs opératoires (BO) dédiés à la réalisation de 4 arthroplasties consécutives. Cette mesure a représenté un changement de pratique majeur et a offert une occasion d’optimiser les soins aux patients à l’intérieur du temps opératoire alloué, soit 8 heures. Nous avons examiné notre taux de succès à effectuer 4 arthroplasties en 8 heures et défini les critères de réussite.

Méthodes : Nous avons passé en revue les chirurgies effectuées dans les BO dédiés entre mai et octobre 2012. À l’aide des données prospectives fournies par le système de gestion des données chirurgicales, la durée de chaque intervention a été divisée en 5 temps : temps de préparation de l’anesthésie (TPA), temps de préparation chirurgicale (TPC), durée de l’intervention, temps de finalisation de l’anesthésie (TFA) et temps de roulement. La réussite était définie comme la réalisation complète de 4 arthroplasties à l’intérieur des temps alloués.

Résultats : Nous avons analysé 49 jours de BO dédiés, totalisant 196 chirurgies articulaires. Sur les 49 jours, 24 (49 %) ont été couronnés de succès. Seulement 2 chirurgiens ont obtenu un taux de réussite supérieur à 50 %. Les principaux prédicteurs de succès étaient le TPA (rapport des cotes 1,09, intervalle de confiance [IC] de 95 % 1,02–1,16), la durée de l’intervention (rapport des cotes 1,02, IC de 95 % 1,00–1,05) et le TFA (rapport des cotes 1,19, IC de 95 % 1,06–1,34). Nous avons calculé les probabilités pour chaque composante et inféré les critères de durée correspondant à la probabilité de 0,60. Les critères ont été définis comme suit : TPA 9 minutes, TPC 14 minutes, durée de l’intervention 68 minutes, TFA 4 minutes et roulement 15 minutes.

Conclusion : Nous avons établi des durées cibles pour chacune des étapes menant à la réalisation complète de 4 arthroplasties auxiliaires à l’intérieur d’un quart de travail de 8 heures. L’application des cibles aux interventions pourraient maximiser l’efficience des BO et améliorer la prestation des soins multidisciplinaires.
There is no doubt that joint replacement surgery improves the quality of life of patients with arthritis. In recent years, research has focused on registry data to determine trends in patient profiles and to form a quality control process for assessing the success rate of various implant designs. In addition, institution and government agencies are paying closer attention to readmission rates, rates of superficial wound infection and overall quality of care delivery within that context. Overall efficiency is also being examined by these multiple stakeholders. This is particularly relevant in a single payer system like Canada’s, in which public funds are the sole source of financing and increasing demand is coupled with increasing government deficits. Capacity to increase delivery of joint replacements must be accomplished without increasing costs. In 2005, based on the National Health Services initiative, the Canadian government mandated through the National Wait Times Initiative (NWTI) that patients receive their hip or knee replacement within 6 months of the decision for surgery. The most recent data from the Canadian Institute of Health Information (CIHI) show there is still considerable room for improvement, with most provinces being under the 90% goal despite funding directed specifically to decrease wait lists (Fig. 1).

Various models with set benchmarks (e.g., centralized intake clinics that separate wait times into multiple components: time to consult, time to surgical decision and finally time to surgery) have been introduced to improve access to joint replacement care. In addition, how to best improve operating room (OR) efficiency has been a subject of much interest in order to meet the increasing demand for joint replacement putting a substantial burden on the hospital system owing to limited resources. Although several groups have looked at OR inefficiencies, such as turnaround time and dedicated teams, there is still a lack of established benchmarks to successfully maximize OR efficiency without increasing resources.

In 2004, a 4-joint OR initiative was instituted within our hospital to minimize wait times for joint replacements by improving overall throughput while minimizing the need to increase the number of OR days to perform joint replacement surgery. As part of this initiative, team leaders, customized joint instrument trays and patient selection parameters (i.e., body mass index [BMI] < 35, American Society of Anaesthesiologists [ASA] score of 2 or less, no prior joint surgery) were established. The purpose of the present study was to look at the overall success of our high-volume ORs for performing primary joint replacements and to define the factors that are associated with successful completion of 4-joint OR cases within a standard 8-hour shift.

**METHODS**

Four-joint OR data from May 1 to Oct. 31, 2012, were analyzed retrospectively for surgical times. We obtained approval from our institutional ethics committee before the study began.
The goal of the 4-joint room initiative was to complete the cases within a standard 8-hour shift (i.e., 7:30 am to 3:30 pm). All joint replacements were completed by 5 arthroplasty surgeons and 27 different anesthesiologists. Spinal and general anesthetics are both commonly used for lower extremity reconstruction, and the anesthesiologist decided on the method of anesthesia in consultation with the patient. Our institution does not have a block room and, as such, all spinal anesthetics were administered after the patient entered the operating theatre. All surgical time data were prospectively entered using the Surgical Information Management Systems (SIMS). The surgical time intervals were defined using the following events as outlined by the American Association of Clinical Directors, with modifications noted by asterix: anesthesia preparation time (APT; patient in room* to anesthesia ready), surgical preparation time (SPT; anesthesia ready to procedure start), procedure duration (procedure start time to procedure finish), anesthesia finish time (AFT; procedure finish to patient out of room*), and turnover time (room cleanup start to patient in room)*. The APT immediately follows turnover time during the day, as a smooth transition into the room is expected once the room is ready.

Statistical analysis

We report basic descriptive statistics (mean, median, standard deviation and range) as appropriate. For the analysis of surgical time components, we used t tests to compare surgical intervals on successful and unsuccessful days. Success was defined as the last patient (fourth case) of the day leaving the operating theatre within the allotted 8-hour shift. We performed logistic regression analysis to determine significant predictors for success of 4-joint ORs. Furthermore, we used the following equation to calculate predicted probabilities (p) for each time component, averaged per day: \( p = e^{(a + b \text{Time})}/(1 + e^{(a + b \text{Time})}) \).

RESULTS

During the study period, 196 joint replacements were completed in 49 4-joint OR days: 80 (40.8%) total hip arthroplasties (THA), 55 (28%) total knee arthroplasties (TKA), 38 (19.4%) hip resurfacing (HR) and 23 (11.7%) unicompartmental knee arthroplasties (UKA). The mean age of patients was 62 (range 25–87) years; 85 patients were men and 111 were women. The mean BMI was 29.6 (range 20.5–48.3), and the median ASA score was 2 (range 1–3). Twenty-four patients received a general anesthetic, and 164 had a spinal anesthetic. There were 8 cases of converted spinal to general anesthetics.

Each surgical time interval is reported in Table 3, with mean, maximum and minimum values. The mean procedure duration for days that were successful versus unsuccessful were 68.6 ± 13.2 and 72.2 ± 12.4 min, respectively (95% confidence interval [CI] –7.2 to –0.01, \( p = 0.05 \)). Procedures were slightly shorter on successful days for 3 of the 4 surgeons (surgeons A, C and D) who had more than 1 successful day, although this difference for each surgeon was not significant (Table 4).

Each temporal component was averaged per day, and we used logistic regression to calculate predicted probabilities (p) for each time component, averaged per day: \( p = e^{(a + b \text{Time})}/(1 + e^{(a + b \text{Time})}) \).

### Table 1. Patient demographic and clinical characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>No. (%) or mean (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>85 (43%)</td>
</tr>
<tr>
<td>Female</td>
<td>111 (57%)</td>
</tr>
<tr>
<td>BMI</td>
<td>29.6 (20.5–48.3)</td>
</tr>
<tr>
<td>Age, yr</td>
<td>62 (25–87)</td>
</tr>
<tr>
<td>ASA score</td>
<td>2.4 (1–3)</td>
</tr>
<tr>
<td>ASA = American Society of Anaesthesiologists; BMI = body mass index.</td>
<td></td>
</tr>
</tbody>
</table>

### Table 2. Procedure duration, by procedure and surgeon

<table>
<thead>
<tr>
<th>Procedure/surgeon</th>
<th>Mean (range), min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knee hemiarthroplasty</td>
<td>68 (44–88)</td>
</tr>
<tr>
<td>Hip resurfacing</td>
<td>69 (52–87)</td>
</tr>
<tr>
<td>Total hip arthroplasty</td>
<td>73 (53–107)</td>
</tr>
<tr>
<td>Total knee arthroplasty</td>
<td>68 (46–113)</td>
</tr>
<tr>
<td>Surgeon A</td>
<td>71.3 (51–104)</td>
</tr>
<tr>
<td>Surgeon B</td>
<td>73.3 (57–90)</td>
</tr>
<tr>
<td>Surgeon C</td>
<td>71.7 (53–107)</td>
</tr>
<tr>
<td>Surgeon D</td>
<td>66.5 (33–83)</td>
</tr>
<tr>
<td>Surgeon E</td>
<td>69.9 (44–113)</td>
</tr>
</tbody>
</table>

### Table 3. Interval durations

<table>
<thead>
<tr>
<th>Interval</th>
<th>Mean (range), min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anesthesia preparation time</td>
<td>12 (5–32)</td>
</tr>
<tr>
<td>Anesthesia finishing time</td>
<td>5 (0–19)</td>
</tr>
<tr>
<td>Surgical preparation time</td>
<td>16 (4–26)</td>
</tr>
<tr>
<td>Procedure duration</td>
<td>70 (33–113)</td>
</tr>
<tr>
<td>Turnover time</td>
<td>19 (8–48)</td>
</tr>
</tbody>
</table>

### Table 4. Procedure durations for successful and unsuccessful days by surgeons

<table>
<thead>
<tr>
<th>Surgeon</th>
<th>Group</th>
<th>mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Successful</td>
<td>68.6 (13.2)</td>
</tr>
<tr>
<td>A</td>
<td>54</td>
<td>68.9 (12.1)</td>
</tr>
<tr>
<td>B</td>
<td>0</td>
<td>NA</td>
</tr>
<tr>
<td>C</td>
<td>50</td>
<td>70.8 (12.6)</td>
</tr>
<tr>
<td>D</td>
<td>80</td>
<td>66.6 (10.2)</td>
</tr>
<tr>
<td>E</td>
<td>38</td>
<td>66.9 (22.1)</td>
</tr>
</tbody>
</table>

NG = not applicable; SD = standard deviation.
probability of success (Table 5 and Table 6). The maximum probabilities of success for the temporal components ranged from 0.6 to 0.902. Owing to this variability, approximate times that corresponded to the predicted probability of 0.60 were arbitrarily chosen as benchmark estimates. Five anesthesiologists met the average AFT benchmark of 9 min, with the range for daily averages spanning 7–20 min. Reaching the benchmark was common, with 32% of cases having an APT of less than 9 min; however, daily averages were much more difficult for the various physicians to achieve. Five of 27 anesthesiologists were able to meet the AFT target of 4 min, with the range of daily averages spanning 2.5–7.8 min. Individual results are shown in Figure 2.

In order to determine factors that contribute to success, we performed a logistic regression analysis with various surgical (procedure type, surgeon, anesthesiologists) and temporal components. Only the following temporal components emerged as significant predictors of success: APT (odds ratio 0.92, 95% CI 0.86–0.98), procedure duration (odds ratio 0.98, 95% CI 0.95–1.00) and AFT (odds ratio 0.84, 95% CI 0.74–0.94).

**DISCUSSION**

The demands on the Canadian health care system to do more and better with less are growing, and although some may say that there is no more capacity within our system, there are health care organizations that are succeeding. One model that has been applied with success is that of Lean, which originates from the automotive industry. In addition, not only did we find that variability in both surgeon and anesthesiologist had a significant impact on successful completion, we were also able to delineate other steps (i.e., SPT and AFT) affecting OR efficiency.

Efﬁciency in the OR is not only increasing case volume, but also using the same or fewer resources. Given the fixed nature of resources and the inability to expand owing to budget and physical plant restrictions, increasing efﬁciency is paramount to survival in the modern health care environment. Our study provides a guide for efﬁcient utilization of resources within a standard OR shift to increase throughput of primary arthroplasty cases without increasing the budgetary demands by using overtime, extra personnel or added resources, such as block rooms. While other strategies, such as block rooms, have been shown to increase the volume of operations, their role in increasing efﬁciency is less clear. More importantly, the increased efﬁciency requires buy-in from all team members, including the anesthesia team (e.g., the anesthesiologist will often meet the patient outside the OR during turnover time, allowing a smooth transition into AFT from turnover time).

In addition, the benchmarks we developed and the methods we used to determine them can be spread to other specialties, such as bariatric and thoracic surgery, where a step-wise procedure is carried out with high-volume and predictable pre-, intra- and postoperative processes in a given setting. More importantly, the predictors of success were examined as individual markers, so if all 4 successful benchmarks (APT of 9 min × 4, SPT of 11 min × 4; procedure duration of 66 min × 4; AFT of 4 min × 4; turnaround time of 15 min × 3) were combined, the 4-joint OR day would be completed in 6.75 hours, leaving room for unpredictable delays, such as a difﬁcult induction and/or surgical exposures as well as teaching. By knowing where the workday is against the benchmarks, the surgeon can allocate various responsibilities to residents/fellows and predictably know that the day will finish

---

**Table 5. Maximum surgical interval times that correspond to 60% success rate (benchmark) and their odds for predicting success**

<table>
<thead>
<tr>
<th>Interval</th>
<th>Benchmark, min</th>
<th>OR (95% CI)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>APT</td>
<td>9</td>
<td>1.09 (1.02–1.16)</td>
<td>0.009</td>
</tr>
<tr>
<td>SPT</td>
<td>14</td>
<td>1.05 (0.97–1.14)</td>
<td>0.23</td>
</tr>
<tr>
<td>Procedure duration</td>
<td>68</td>
<td>1.02 (1.00–1.05)</td>
<td>0.05</td>
</tr>
<tr>
<td>AFT</td>
<td>4</td>
<td>1.19 (1.06–1.34)</td>
<td>0.003</td>
</tr>
<tr>
<td>Turnover time</td>
<td>15</td>
<td>1.12 (1.05–1.18)</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

AFT = anesthesia finishing time; APT = anesthesia preparation time; CI = confidence interval; OR = odds ratio; SPT = surgical preparation time.

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**Table 6. Comparison between successful and unsuccessful days**

<table>
<thead>
<tr>
<th>Factor</th>
<th>Group; mean (range)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of patients</td>
<td>96 (100)</td>
</tr>
<tr>
<td>Anesthetic, no. (%)</td>
<td></td>
</tr>
<tr>
<td>Spinal</td>
<td>83 (86)</td>
</tr>
<tr>
<td>General</td>
<td>13 (14)</td>
</tr>
<tr>
<td>Age, yr</td>
<td>61.3 (25–86)</td>
</tr>
<tr>
<td>APT, min</td>
<td>11.4 (5–28)</td>
</tr>
<tr>
<td>Total procedural time, min</td>
<td>14 (4–113)</td>
</tr>
<tr>
<td>BMI</td>
<td>29.9 (20.6–44.4)</td>
</tr>
<tr>
<td>First PIR time, min</td>
<td>7.53 (7.44–8.04)</td>
</tr>
<tr>
<td>Procedure duration, min</td>
<td>66.9 (56–77)</td>
</tr>
<tr>
<td>HR</td>
<td>71.3 (33–103)</td>
</tr>
<tr>
<td>THA</td>
<td>67.3 (46–113)</td>
</tr>
<tr>
<td>UKA</td>
<td>62.3 (44–83)</td>
</tr>
<tr>
<td>Procedure prevalence, %</td>
<td>23% (16%)</td>
</tr>
<tr>
<td>Sex, no. (%)</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>36 (38)</td>
</tr>
<tr>
<td>Female</td>
<td>60 (62)</td>
</tr>
</tbody>
</table>

APT = anesthesia preparation time; ASA = American Society of Anesthesiologists; BMI = body mass index; HR = hip resurfacing; PIR = patient in room; THA = total hip arthroplasty; TKA = total knee arthroplasty; UKA = unicompartmental knee arthroplasty.

*AFT = anesthesia preparation time; ASA = American Society of Anesthesiologists; BMI = body mass index; HR = hip resurfacing; PIR = patient in room; THA = total hip arthroplasty; TKA = total knee arthroplasty; UKA = unicompartmental knee arthroplasty.

*Unless indicated otherwise.
on time. More importantly, one can better integrate additional resources (e.g., block rooms, possibly a fifth case) to maximize efficiency.

The pool of patients eligible for a joint replacement is not a perfectly homogeneous population, but some trends are present. We initially intended to include only patients with an ASA score of 2 or less and a BMI of 35 or less to allow for successful completion of our 4-joint OR days; however, this was not an attainable booking strategy as too high a percentage of arthroplasty patients were excluded by these restrictions. Whenever possible, these physical parameters were maintained; however, the incidence of increased BMI and ASA score was not significantly different between successful and unsuccessful days in the data analyzed for the present study.

Limitations

One of the limitations of our study is that the recording of the data within the SIMS system was done by different individuals, potentially introducing variability in the accurate assessment of the different time points. Having said that, the data were collected in the same fashion for all cases, consequently minimizing the possible bias in data gathering. More importantly, all members of the OR team were unaware that these data would be later analyzed, making our analysis a real-life assessment and preventing a Hawthorne effect. Another limitation of our study is the lack of specialized teams (i.e., anesthesiologists), making unclear the potential impact of a specialized team on the various benchmarks. However, because of this lack of specialized teams, our findings are likely more applicable to a wider community of surgeons across the country. Hospitals that already have specialized anesthesiology and nursing teams may be able to more efficiently implement our benchmarks to ensure successful completion of their lists, whereas community hospitals in which human resources are more limited may be able to work toward specialized teams to make their resources go further. Within that context, it is unknown whether a minimum number of joint replacements is required or desired to institute high-efficiency joint replacement ORs. Finally, the level of success was set relatively low at 60%; most individuals and institutions would set higher targets for success at 80%–90%. The low level of success in our study is because of the relatively small number of cases with an associated high variability for the different time points. Having said that, with both groups (successful v. unsuccessful 4-joint ORs) being comparable in regards to procedure type, BMI and sex, this certainly permitted us to focus on the surgical workflow, making our findings applicable to most institutions.

Interestingly when looking at the impact of procedure duration, surgeon D’s average duration did not differ between successful and unsuccessful days, highlighting the importance of the team and other time points, such

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Fig. 2. Breakdown of average anesthesia preparation time (APT) and anesthesia finishing time (AFT) by anesthesiologist with number of cases completed in a 4-joint operating room during the study period in brackets beside the identifier.
as AFT, for the completion of the 4 cases within an 8-hour timeframe. All too often, the surgeon scrubs out once the wound is closed and goes on to complete other administrative tasks, which may give the impression that the “case” is finished and everyone can take a break. Because the SIMS software did not capture the time of departure of the surgeon, we cannot analyze the impact of the surgeon leaving the OR before the patient on overall room efficiency, but this is a possible next step for analysis. As our study has shown, completing this task of exiting the room in an efficient and coordinated manner is as critical as other key aspects of surgical workflow. Similarly the importance of specialized teams is highlighted by the large variability in APT with the 27 anesthesiologists, which contrasts relative grouping of the mean procedure durations within our surgeon group (Table 6). Because the number of arthroplasties to be done per year is capped, it is unlikely that a sufficient number of cases would be available for all 27 anesthesiologists to reach the proficiency required. More importantly, the benefits of an integrated team approach as well as the capacity to provide interprofessional feedback and sustaining the gains in efficiency are lost. The benefits of dedicated teams of highly specialized individuals who share a common goal in improving efficiency in ORs, including academic joint replacement rooms, are well known6,7 and, in turn, permit the maximization of other workflow efficiency measures, such as block/induction rooms, which despite requiring increases in physical resources may permit a greater number of cases to be performed and the patient selection criteria to be expanded (e.g., higher BMI).

**CONCLUSION**

Joint replacement programs are the cause of a large part of both a hospital’s expenditures and revenue.9 By breaking down the delivery of this service in a stepwise fashion, we were able to identify predictive measures to allow the successful completion of 4 primary joint replacements in a standard 8-hour OR day. These benchmarks can facilitate targeted group interventions to improve efficiency and provide direct feedback in regards to individual performances. More importantly, the presence of dedicated teams will ensure the sustainability of these efforts.

**Acknowledgements:** The authors thank Dr. Tim Ramsay at the Ottawa Hospital Research Institute Methods Centre for his statistical advice, Ms. Suham Alexander for providing SIMS data and Mrs. Paula Doering for administrative support at The Ottawa Hospital.

**Affiliations:** All authors are from the Orthopedic Department, the Ottawa Hospital, Ottawa, Ont.

**Competing interests:** None declared.

**Contributors:** P. Beaulé designed the study. A. Frombach acquired and analyzed the data, which JJ Ryu also analyzed. A. Frombach wrote the article, which all authors reviewed and approved for publication.

**References**

Is it safe to wait? The effect of surgical wait time on survival in patients with non–small cell lung cancer

Shaun Coughlin, MD  
Madelaine Plourde, MD  
Keegan Guidolin, BSc  
Dalilah Fortin, MD  
Eric Frechette, MD  
Richard Malthaner, MD  
Richard Inculet, MD

Accepted for publication  
Aug. 28, 2015

Correspondence to:  
Shaun Coughlin  
1963 Beaverbrook Ave  
London ON N6H5X4  
Shaun.coughlin@gmail.com

DOI: 10.1503/cjs.007015

Background: The effect of surgical wait times on survival in patients with non–small cell lung cancer (NSCLC) remains largely unknown. Our objective was to determine the effect of surgical wait time on survival and incidence of upstaging in patients with stage I and II NSCLC.

Methods: All patients with clinical stage I and II NSCLC who underwent surgical resection in a single centre between January 2010 and December 2011 were reviewed. Analysis was stratified based on preoperative clinical stage. We assessed the effect of wait time on survival using a Cox proportional hazard model with wait time in months as a categorical variable. Incidence of upstaging at least 1 stage was assessed using logistic regression.

Results: We identified 222 patients: 180 were stage I and 42 were stage II. For stage I, wait times up to 4 months had no significant effect on survival or incidence of upstaging. For stage II, patients waiting between 2 and 3 months had significantly decreased survival (hazard ratio 3.6, \( p = 0.036 \)) and increased incidence of upstaging (odds ratio 2.0, \( p = 0.020 \)) than those waiting 0 to 1 month. For those waiting between 1 and 2 months, there was no significant difference in survival or upstaging.

Conclusion: We did not identify an effect of wait time up to 4 months on survival or upstaging for patients with stage I NSCLC. For patients with stage II disease, wait times greater than 2 months adversely affected survival and upstaging.

Contexte : En chirurgie, l'effet des temps d'attente sur la survie des patients atteints d'un cancer du poumon non à petites cellules (CPNPC) demeure pour une bonne part inconnu. Notre objectif était de déterminer l'effet des temps d'attente sur la survie et sur l'incidence de la restadiﬁcation à un niveau plus élevé chez les patients atteints d'un CPNPC de stade I et II.

Méthodes : Tous les patients présentant un CPNPC clinique de stade I et II ayant subi une résection chirurgicale dans un seul centre entre janvier 2010 et décembre 2011 ont été passés en revue. L'analyse a été stratifiée selon le stade clinique pré-opératoire. Nous avons évalué l'effet des temps d'attente sur la survie à l'aide d'un modèle de risques proportionnels de Cox, les temps d'attente en mois ayant servi de variable catégorielle. L'incidence de la restadiﬁcation à la hausse d'au moins un stade a été évaluée par régression logistique.

Résultats : Nous avons recensé 222 patients : 180 de stade I et 42 de stade II. Pour le stade I, les temps d'attente allant jusqu'à 4 mois n'ont eu aucun effet signiﬁcatif sur la survie ou sur l'incidence de la restadiﬁcation. Pour les stades II, les patients ayant attendu de 2 à trois 3 mois ont présenté une réduction signiﬁcative de la survie (risque relatif 3,6, \( p = 0,036 \)) et une incidence accrue de restadiﬁcation (rapport des cotes 2,0, \( p = 0,02 \)) comparativement à ceux qui avaient attendu 1 mois et moins. Chez les patients ayant attendu 1 ou 2 mois, on n'a noté aucune différence signiﬁcative sur la survie ou la restadiﬁcation.

Conclusion : Nous n'avons observé aucun effet d'une attente allant jusqu'à 4 mois sur la survie ou la restadiﬁcation chez les patients atteints d'un CPNPC de stade I. Pour les patients atteints d'une maladie de stade II, les temps d'attente de plus de 2 mois ont eu un impact négatif sur la survie et la restadiﬁcation.
A new diagnosis of lung cancer can be very distressing for patients. Adding to this distress is the concern that prolonged surgical wait times may result in cancer progression and impact survival. A study by Visser and colleagues identified significantly impaired quality of life in cancer patients awaiting surgical treatment. They concluded that surgical wait times should be minimized to optimize patient well-being.

In the province of Ontario, Canada, a wait time target of 28 days has been set for the interval between the decision to operate and resection. This target was mandated by Cancer Care Ontario and was determined after a literature review that identified 57 studies assessing the effect of increased wait times on outcomes across a number of different malignancies, including non-small cell lung cancer (NSCLC). Of the 57 studies identified, 9 were specific to lung cancer. These studies generally failed to identify an impact of increased wait times on survival. Cancer Care Ontario concluded that there was very little evidence on the association between surgical wait times and outcomes. In the end, the recommendation of a maximum wait time of 28 days between the decision to operate and the surgical resection reflects consensus expert opinion. We performed a retrospective cohort study to better clarify the effect of increased surgical wait times on survival and the incidence of upstaging in patients with resectable NSCLC.

METHODS

We identified all patients who underwent surgical resection for preoperative clinical stage I or II NSCLC at a single centre between January 2010 and December 2011. Patients were staged according to the seventh edition of the American Joint Committee on Cancer (AJCC) lung cancer staging system. We calculated the surgical wait time as the interval between the decision to operate and the date of surgery. Clinical staging was determined using preoperative computed tomography (CT) of the chest and head as well as positron emission tomography (PET) and invasive mediastinal staging (in the form of mediastinoscopy, endobronchial ultrasonography or endoscopic ultrasonography-guided biopsies) when performed. Lymph nodes with a standardized uptake value (SUV) of 2.5 or greater were considered positive unless pathological evaluation from preoperative invasive mediastinal staging showed them to be negative. For patients who did not undergo PET, we considered lymph nodes greater than 1.0 cm in the short axis to be positive unless mediastinal staging proved otherwise.

Statistical analysis

The primary outcome in this study was survival, which we assessed using a Cox proportional hazard model with wait time in months as a categorical variable. Using logistic regression, we also assessed the secondary outcome of incidence of upstaging. We considered patients to have been upstaged if the pathological stage increased by at least 1 stage compared with the clinical stage. Analysis was stratified based on clinical stage based on the hypothesis that wait times may affect stage I and II NSCLC differently. The stage I analysis was adjusted for presence of a complete resection with pathologically negative margins (R0), histology (adenocarcinoma v. nonadenocarcinoma NSCLC) and type of resection (lobar v. sublobar). These potential confounders were selected a priori and were adjusted for in the analysis regardless of statistical significance. A small sample size precluded any adjustments in the analysis for stage II patients. We considered results to be significant at $p < 0.05$.

RESULTS

We identified 222 patients who underwent resection for NSCLC during the study period: 180 patients were stage I based on preoperative clinical staging and 42 were stage II.

Stage I

Patient characteristics

Of the clinical stage I patients, 39 had wait times less than 1 month, 79 waited 1 to less than 2 months, 36 waited 2 to less than 3 months, and 26 waited 3 to less than 4 months. No patients had a wait time longer than 4 months. Age and sex were similar among the patients with various wait times (Table 1). There was a trend of decreased tumour size with increased wait times. Adenocarcinoma was the most frequent histology for tumours in all wait time categories. Most patients underwent lobar resections, with a minority of patients receiving sublobar resections. Most patients received R0 resections (Table 1). All patients underwent CT as part of the staging workup, and 83% of those with clinical stage I NSCLC underwent PET. Only 9% of the stage I patients underwent mediastinal staging. Most prolonged wait times were owing to waits for operating room access. Of the patients waiting longer than 3 months, 5 (19%) were owing to patient request, 1 (4%) was owing to preoperative medical optimization and the remainder (77%) were owing to operating room access.

Survival

At total of 32 patients with clinical stage I NSCLC died within a mean follow up of 30 ± 11 months. There was no difference in survival among patients waiting 1 to less than 2 months, 2 to less than 3 months, or more than 3 months compared with those who waited less than 1 month (Table 2). The adjusted survival curves for all 4 wait time groups are displayed in Figure 1. The
presence of an R0 resection was significantly associated with improved survival (hazard ratio [HR] 4.96, \( p = 0.013 \)). Neither the type of resection nor the histology of the tumour was significantly associated with survival.

**Incidence of upstaging**

Thirty-four (19%) patients with clinical stage I disease were upstaged at least 1 stage. An increase in wait time of up to 4 months was not associated with an increased incidence of upstaging (Table 3). There was a trend toward a decreased incidence of upstaging with longer wait times; however, this finding was not significant. Patients undergoing sublobar resection had a decreased incidence of upstaging (odds ratio [OR] 7.82, 95% confidence interval [CI] 1.00–61.01, \( p = 0.05 \)). Neither the histology of the tumour nor the presence of an R0 resection was associated with the incidence of upstaging. Fifty-nine percent of upstaged patients had positive N2 lymph nodes on final pathology, while 41% had positive N1 nodes. No patients were upstaged based on T stage.

**Stage II**

**Patient characteristics**

Of the 42 patients with clinical stage II NSCLC, 16 waited less than 1 month, 19 waited 1–2 months and 7 waited 2 to less than 3 months. No patients waited more than 3 months for surgery. Age was similarly distributed among the wait time groups. There was a slight increase in the proportion of women in the group waiting 1–2 months compared with the other wait time groups (Table 4). Nonadenocarcinoma was seen more frequently in those waiting up to 1 month and those waiting 2–3 months, whereas adenocarcinoma was more common in those waiting 1–2 months (Table 4). Tumour size was similar among the groups, and most patients received R0 resections. One patient who waited 1–2 months had a sublobar resection, whereas all other patients had lobectomies or pneumonectomies. All patients underwent CT as part of the staging workup, and 98% of those with clinical stage II NSCLC underwent PET. Thirty-eight percent of patients with stage II disease underwent mediastinal staging. Most prolonged wait times in patients with stage II disease were owing to waits for operating room access. For patients waiting 2–3 months, 1 (14%) was owing to patient request, 2 (28%) were owing to preoperative medical optimization and the remainder (57%) were owing to operating room access.

**Survival**

A total of 19 patients with clinical stage II NSCLC died within a mean follow up of 26 ± 13 months. Survival did not differ significantly between patients waiting 1–2 months and those waiting up to 1 month (HR 0.925, 95% CI 0.32–2.64, \( p = 0.89 \)). Those who waited 2–3 months, however, had significantly decreased survival than those waiting up to 1 month (HR 3.6, 95% CI, 1.09–12.09, \( p = 0.036 \)). Survival curves for the 3 wait time groups are shown in Figure 2.

**Incidence of upstaging**

Nine (21%) patients with clinical stage II disease were upstaged at least 1 stage. Patients waiting 1–2 months did not have a significantly increased incidence of

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**Table 1. Stage I patient (n = 180) characteristics**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>0 to &lt; 1 mo</th>
<th>1 to &lt; 2 mo</th>
<th>2 to &lt; 3 mo</th>
<th>3 to &lt; 4 mo</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of patients</td>
<td>39</td>
<td>79</td>
<td>36</td>
<td>26</td>
</tr>
<tr>
<td>Age, yr</td>
<td>69 ± 8.0</td>
<td>68 ± 10</td>
<td>68 ± 10</td>
<td>64 ± 13</td>
</tr>
<tr>
<td>Female sex</td>
<td>21 (53%)</td>
<td>30 (38%)</td>
<td>21 (58%)</td>
<td>16 (62%)</td>
</tr>
<tr>
<td>Tumour size, cm</td>
<td>3.09 ± 1.03</td>
<td>2.74 ± 1.10</td>
<td>2.42 ± 0.94</td>
<td>2.38 ± 0.83</td>
</tr>
<tr>
<td>Adenocarcinoma</td>
<td>24 (62%)</td>
<td>44 (56%)</td>
<td>22 (61%)</td>
<td>17 (65%)</td>
</tr>
<tr>
<td>Sublobar resection</td>
<td>5 (13%)</td>
<td>15 (19%)</td>
<td>5 (14%)</td>
<td>3 (12%)</td>
</tr>
<tr>
<td>R0 resection</td>
<td>36 (92%)</td>
<td>76 (96%)</td>
<td>34 (94%)</td>
<td>26 (100%)</td>
</tr>
</tbody>
</table>

SD = standard deviation.

**Table 2. Stage I survival analysis**

<table>
<thead>
<tr>
<th>Factor</th>
<th>( p ) value</th>
<th>Hazard ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wait 0 to &lt; 1 mo</td>
<td>—</td>
<td>1.0</td>
</tr>
<tr>
<td>Wait 1 to &lt; 2 mo</td>
<td>0.77</td>
<td>0.875</td>
</tr>
<tr>
<td>Wait 2 to &lt; 3 mo</td>
<td>0.99</td>
<td>1.007</td>
</tr>
<tr>
<td>Wait &gt; 3 mo</td>
<td>0.92</td>
<td>1.064</td>
</tr>
<tr>
<td>R0 resection</td>
<td>0.013</td>
<td>4.959 (favours R0 resection)</td>
</tr>
<tr>
<td>Sublobar v. lobectomy</td>
<td>0.28</td>
<td>2.228 (favours sublobar)</td>
</tr>
<tr>
<td>Histology</td>
<td>0.21</td>
<td>1.262 (favours adenocarcinoma)</td>
</tr>
</tbody>
</table>
upstaging compared with those who waited less than 1 month (OR 4.0, 95% CI 0.40–40.08, \( p = 0.24 \)). Those waiting 2–3 months, however, had a significantly increased incidence of upstaging (OR 20.0, 95% CI 1.61–248.3, \( p = 0.020 \)). Fifty percent of upstaged patients had T3 N1 disease on final pathology, while 33% had positive N2 lymph nodes. Eleven percent had T4 disease, and another 11% were found to have metastatic disease at the time of resection.

Sensitivity analysis
In order to determine if the relatively low incidence of mediastinal staging may have altered the results, we performed a sensitivity analysis by eliminating all patients who had positive N2 lymph nodes on postoperative pathology, on the assumption that they may have been positive before resection. For the patients with clinical stage I disease, this had no effect on survival analysis. For those with clinical stage II disease, there was a similar trend, with decreased survival in those waiting more than 2 months; however, the results were no longer clinically significant.

DISCUSSION
This retrospective cohort study examined the effect of surgical wait times in patients with clinical stage I and II NSCLC. For patients with clinical stage I disease, we identified no effect of wait times up to 4 months on survival or incidence of upstaging. For patients with clinical stage II disease, those waiting longer than 2 months had an increased incidence of upstaging as well as decreased survival compared with those waiting less than 1 month.

A number of studies have previously been performed to assess the effect of surgical wait times on survival in patients with NSCLC. However, these studies combined patients across multiple stages, and some included patients treated both operatively and nonoperatively. Myrdal and colleagues\(^3\) investigated the association between treatment delay and prognosis in 466 patients with NSCLC. Paradoxically, they found that shorter delay was associated with poorer prognosis. They speculated that this finding was due to selection bias, as patients with more severe signs and symptoms and perhaps more aggressive disease may have received more prompt treatment. Myrdal and colleagues\(^3\) included patients across all pathological stages, the majority of whom were stage III or IV. In a study by Buccheri and colleagues,\(^4\) delays in time between the presentation of first symptoms and consultation with a specialist were examined in 1277 patients with stage I–IV NSCLC. They found a small but statistically significant decrease in survival in patients with delays greater than 2 months compared with those who waited less than 2 months. This finding is contrary to those of other studies that found no correlation

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Table 3. Stage I incidence of upstaging

<table>
<thead>
<tr>
<th>Factor</th>
<th>( p ) value</th>
<th>Odds ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wait 0 to &lt; 1 mo</td>
<td>—</td>
<td>1.0</td>
</tr>
<tr>
<td>Wait 1 to &lt; 2 mo</td>
<td>0.45</td>
<td>0.704</td>
</tr>
<tr>
<td>Wait 2 to &lt; 3 mo</td>
<td>0.14</td>
<td>0.403</td>
</tr>
<tr>
<td>Wait 3 to &lt; 4 mo</td>
<td>0.07</td>
<td>0.216</td>
</tr>
<tr>
<td>Histology</td>
<td>0.93</td>
<td>1.04</td>
</tr>
<tr>
<td>R0 resection</td>
<td>0.19</td>
<td>0.42</td>
</tr>
<tr>
<td>Sublobar resection</td>
<td>0.05</td>
<td>7.81 (favours sublobar)</td>
</tr>
</tbody>
</table>

Table 4. Stage II patient (\( n = 42 \)) characteristics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>0 to &lt; 1 mo</th>
<th>1 to &lt; 2 mo</th>
<th>2 to &lt; 3 mo</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of patients</td>
<td>16</td>
<td>19</td>
<td>7</td>
</tr>
<tr>
<td>Age, yr</td>
<td>71 ± 7.2</td>
<td>67 ± 12</td>
<td>66 ± 8.0</td>
</tr>
<tr>
<td>Female sex</td>
<td>5 (29)</td>
<td>9 (47)</td>
<td>2 (29)</td>
</tr>
<tr>
<td>Tumour size, cm</td>
<td>5.47 ± 2.16</td>
<td>4.90 ± 1.77</td>
<td>5.39 ± 1.92</td>
</tr>
<tr>
<td>Adenocarcinoma</td>
<td>4 (24)</td>
<td>10 (56)</td>
<td>3 (43)</td>
</tr>
<tr>
<td>R0 resection</td>
<td>14 (88)</td>
<td>17 (94)</td>
<td>6 (85)</td>
</tr>
</tbody>
</table>

SD = standard deviation.
between delays in diagnosis or treatment of lung cancer and clinical outcome.\textsuperscript{1-8} In one of the largest studies, Aragoneses and colleagues\textsuperscript{2} failed to show any impact of therapeutic delay (defined as the interval from diagnosis to surgical resection) on survival in patients with NSCLC. All of these studies combined patients with various stages of NSCLC. To our knowledge, the present study is the only one to assess the effect of wait times on these outcomes with the analysis stratified based on stage.

**Limitations**

There are a number of limitations to our study. The small sample size leaves the possibility of a type I error in the analysis. For patients with clinical stage I disease, it is possible that with a larger sample size, a subtle difference in survival or upstaging with wait times may have been identified. The small sample size with the stage II analysis also precluded any adjustments of possible confounders. The retrospective nature of the study was also a limitation. Patient comorbidities were not captured in this retrospective data set. For the findings in patients with stage II disease, it is conceivable that patients with more severe comorbidities may have had longer delays in order to optimize them for resection. This may have contributed to the findings of decreased survival in patients with stage II disease. If this were the case, however, we would have also expected to see decreased survival with increased wait times in patients with stage I disease. Had the effect of increased wait times on survival been confounded by patient comorbidities, adjustment for this bias would have eliminated the finding of decreased survival with wait times longer than 2 months. This would therefore lend weight to the argument that wait times in this interval have no significant effect on survival.

The patients in our study had a relatively low incidence of invasive mediastinal staging. One could argue that the results of this study could be biased by the potential inappropriate inclusion of patients who may have had positive mediastinal lymph nodes that were not identified on preoperative PET scans. As mentioned, we performed a sensitivity analysis to assess for this, with no significant impact on our findings. Had every patient undergone invasive mediastinal staging, it is unlikely that our conclusions would have been altered. Furthermore, elimination of this potential bias would be more likely to eliminate any effect of wait times on survival.

**Conclusion**

In patients with clinical stage I NSCLC, we failed to identify an effect of surgical wait times of up to 4 months on survival. In those with clinical stage II disease, patients waiting longer than 2 months had significantly worse survival and increased incidence of upstaging than those who waited less than 2 months. Consideration should be given to prioritizing patients with clinical stage II NSCLC for more timely resection, while those with clinical stage I disease may be able to tolerate longer waits to achieve this goal. Broad recommendations for surgical wait times across all stages therefore may not be appropriate.

**Affiliations:** From the London Health Sciences Centre, London, Ont. (Coughlin, Guidolin, Frechette, Malthaner, Inculet); and the Queen Elizabeth II Health Sciences Centre, Dalhousie University, Halifax, NS (Plourde).

**Competing interests:** None declared.

**Contributors:** S. Coughlin, M. Plourde, D. Fortin, E. Frechette and R. Inculet designed the study. S. Coughlin and K. Guidolin acquired the data, which S. Coughlin, M. Plourde, R. Malthaner and R. Inculet analyzed. S. Coughlin wrote the article, which all authors reviewed and approved for publication.

**References**

A proposal for the curriculum and evaluation for training rural family physicians in enhanced surgical skills

Nadine Caron, MD, MPH
Stuart Iglesias, MD
Randall Friesen, MD
Vanessa Berjat, MD
Nancy Humber, MD
Ryan Falk, MD
Mark Prins, MD
Victoria Vogt Haines, MD
Brian Geller, MD
Fred Janke, MD
Robert Woollard, MD
Bret Batchelor, MD
Jared Van Bussel, MD

See also the editorial on p. 364, the commentary by Warnock and Miles on p. 367 and the commentary by Vinden and Ott on p. 369

 Presented to the Rural Surgery Forum at Rural and Remote Medicine, Victoria, BC, April 2013

Accepted for publication Mar. 17, 2015

Correspondence to:
S. Iglesias
Bella Bella
Denny Island BC V0T 1B0
siglesias64@gmail.com

DOI: 10.1503/cjs.002215

Summary

Rural western Canada relies heavily on family physicians with enhanced surgical skills (ESS) for surgical services. The recent decision by the College of Family Physicians of Canada (CFPC) to recognize ESS as a “community of practice” section offers a potential home akin to family practice anesthesia and emergency medicine. To our knowledge, however, a skill set for ESS in Canada has never been described formally. In this paper the Curriculum Committee of the National ESS Working Group proposes a generic curriculum for the training and evaluation of the ESS skill set.

The precipitous attrition of small volume surgical programs in rural Canada over the past 2 decades has led to the need for rural Canadians to travel for even the most basic procedural care.1 The linkages between sustainable rural maternity care and the presence of robust local surgical programs drive the need for a solution to sustain local surgical services beyond the intrinsic value they offer.2–4 The local benefits to these surgical programs include ensuring appropriate equity of access to health care services; increased community capacity to recruit and retain family physicians and other health care providers in rural settings; maintaining a high level of community health care competence, particularly in regards to critical care and emergency services; and providing the context for rural education and research. At a community level this translates into securing the availability of a surgical first responder trained to handle a variety of scenarios, such as trauma, that require immediate intervention. The obligation to travel for care is a substantial barrier to equitable access for rural Canadians. In western Canada, rural family physicians trained in enhanced surgical skills (ESS) working alongside general surgeons and other specialists underpin this essential health care infrastructure.5,6

Presently, there is 1 accredited 12-month postgraduate training program for family physicians to acquire ESS training. The University of Saskatchewan accepts 2 trainees per year at its Prince Albert site. The University of Alberta appears poised to start a similar program at its Grande Prairie site.

The National Working Group on ESS represents a large number of volunteers drawn from the shallow pool of those experienced and active in ESS training programs and practice in British Columbia, Alberta and Saskatchewan, along with interested national partners (http://ess.rcbc.ca/fifth-page/). This article has been crafted by our Curriculum Committee. Our goal has been to describe a generic training and evaluation program for ESS rural family physicians suitable for introduction at any of Canada’s medical schools. To our knowledge, this has never been done. With the recent recognition by the College of Family Physicians of Canada (CFPC) of ESS as a community of practice (CoP) section, there is a potential pathway to a certificate of added competence for ESS. We believe that a curriculum and evaluation framework, such as the one we propose, is an essential platform in this pathway.1
TRAINING: FOR WHOM, WHERE, AND TO DO WHAT?

In the year 2000 there were 150 ESS rural family physicians sustaining local surgical programs in rural communities in western and northern Canada. Although the number of these programs has shrunk substantially (from 80 in 1995 to 55 in 2011), the number of ESS physicians has remained stable (140 in 2011; unpublished data, Society of Rural Physicians of Canada, 2011). There is some evidence that several of these smaller programs grew larger in volume, absorbing a workforce displaced from programs that closed.

The proposed curriculum comprises a set of competencies drawn from

- the historical skill sets in which ESS physicians have provided services,
- the skill sets for which there is good research evidence on the outcomes and safety of appropriately trained ESS physicians performing these procedures on selected patients in facilities with suitable health and human resources,
- the present University of Saskatchewan R3 ESS training program.

Historically, training programs for ESS have recognized that acquired skills should be tailored to the needs and resources of the community where practice is intended. We support this opinion; however, we also appreciate that

- the integrity of ESS requires a core curriculum of defined competencies shared by all ESS graduates, not unlike the competencies acquired in any other medical or surgical discipline;
- the sustainability of rural small volume surgical programs requires a workforce with a generic portable skill set; and
- surgical skills deemed reasonable but outside the routine spectrum of ESS require additional training, evaluation and application for such privileges.

CURRICULUM

The curriculum is based on 23 integrated modules, with each module representing a clinical presentation that might be referred to a rural family physician with ESS training. Each of these modules documents the knowledge and the diagnostic, management and procedural skills required for each clinical presentation. Evaluation includes documenting the minimum volume of clinical exposure (milestones) for that module. The 23 modules fall under 5 broad categories as follows.

Basic operative management

1) Surgery 101: antisepsis, hemostasis, incisions, stabilization, wound healing, suturing and instruments, physiologic reaction to surgery, nutrition

2) Patient selection and preparation: surgical and anesthetic

3) Surgical decision-making: crew resource management/operating room (OR) decision-making, patient transfer decision and management, triage

Management of abdominal presentation in the nonpregnant patient in rural and remote settings

4) Abdominal wall mass or pain: herniorrhaphy

5) Acute right lower quadrant pain: appendicitis/appendectomy, adnexal/ovarian disease

6) Gastrointestinal (GI) bleeding (upper and lower)

7) GI screening and surveillance (upper and lower)

8) Perianal presentations: hemorrhoids, infections, warts

Management of pregnancy in rural and remote settings

9) Complications of labour and delivery: operative vaginal delivery, cesarean section, perineal trauma, uterine inversion, postpartum hemorrhage, retained placenta, advanced labour and risk management (ALARM), neonatal resuscitation program (NRP)

10) First trimester pain and bleeding: dilation and curettage, ectopic pregnancy

Management of nonabdominal presentations in rural and remote settings

11) Integumentary lesions: skin, nails, subcutaneous lesions, ganglia, lipoma, small flaps, skin grafting, digital amputation

12) Fertility: vasectomy, tubal ligation, essure

13) Genitourinary disease: acute testicular/scrotal disease, phimosis, circumcision, urethral dilation

14) Nonpregnant uterine bleeding: dilation and curettage, hysteroscopy

15) Tonsillar disease: tonsillectomy, adenoidectomy

16) Hand: carpal tunnel release, hand trauma/infection, extensor tendon repair, compartment syndrome

17) Other elective procedures

Basic principles

18) Laparoscopy principles and skills

19) Endoscopy principles and skills

20) Laparotomy principles and skills

21) Procedural sedation principles and skills

22) Emergency ultrasound principles and skills: emergency department echo (EDE), emergency department targeted ultrasound (EDTU), focused assessment with ultrasound in trauma (FAST)

23) Hysteroscopy principles and skills
EVALUATION

While it is anticipated that there will be some variation in the evaluative process between different ESS programs, there are substantive core principles that belong in all such programs.

- **Evaluation** is continuous and comprehensive and is embedded in each independent clinical encounter shared by a resident and preceptor, including all consultations and procedures. The evaluation should include the outcomes whether or not the encounter led to a surgical procedure.
- **Evaluation** should be measured as objectively as possible using something similar to an Objective Structured Assessment of Technical Skills (OSATS) form for technical skills and something equivalent that is appropriate for measuring the knowledge, diagnostic and management skills embedded in each ESS consultation.
- **Evaluation should also include assessment that comes from a source external to the local training program.**

**Internal**

The evaluation of an ESS resident’s knowledge and skills as well as their progress within each of the clinical modules has 2 parallel tracks.

- **Volume of clinical exposure:** within each module, there are milestones for the volume of both consultations and procedures. Success in each module requires that these milestones be attained.
- **Verification of competency:** some measurement tool for competency will be completed for each independent clinical encounter shared between a resident and a preceptor. Final success in each module requires sign-off by 2 preceptors on both the consultations and the procedures applicable to that module, verifying the resident’s suitability for independent practice.

**External**

The credibility of the internal evaluation process and the portability of its certificate of completion will be substantially larger with an external examination process. Equally important, the comfort felt by the preceptors who sign off on competence will be supported by the knowledge that the learner will be scrutinized in an external examination process. This external examination process ideally would include both an oral and written component.

- **Oral:** an examination committee that includes an ESS physician, an obstetrician–gynecologist and a general surgeon from outside the program would meet, either in person or remotely by video conference, and examine an ESS resident using clinical scenarios taken from their log book and ESS curriculum. Each examiner would obtain assessment scores using the same measurement tool used for scoring the ESS consultations. A sign-off would be required from 2 of the 3 examiners for success on this exam.
- **Written:** the ESS residents writing the Principles of Surgery examination, which is taken each spring by second-year specialty surgical residents in Canada, would be helpful assessment for topics not covered in clinical evaluations during rotations or oral exams.

CONCLUSION

The availability of safe, high-quality rural surgical services requires educational programs for the training, evaluation, and certification of rural family physicians with ESS. The sustainability of a mobile ESS workforce with a certified portable skill set will be enhanced by a pathway to a Certificate of Added Competence in ESS from the CFPC, which they have now endorsed. We offer this proposal for the curriculum and evaluation of ESS training as a pillar to be considered in that evolution. The next step would be engagement with specialist partners whose expertise and mentorship are required to use this proposed platform to train ESS physicians with fellow ESS physicians.

Affiliations: From the Department of Surgery, University of Northern British Columbia, Prince George, BC (Caron); Bella Bella, Denny Island, British Columbia (Iglesias); the Department of General Surgery, University of Saskatchewan, Prince Albert, Sask. (Friesen); Rocky Mountain House, Alberta (Berjar); the Lillooet Medical Clinic, Lillooet, BC (Humber); the Inuvik Regional Hospital, Inuvik, Northwest Territories (Falk, Prins); the Selkirk Medical Clinic, Revelstoke, BC (Vogt); the University of Saskatchewan, Meadow Lake, Sask. (Geller); Rural and Regional Health, University of Alberta, Sylvan Lake, Alta. (Janke); the Department of Family Medicine, University of British Columbia, Vancouver, BC (Woodlard); the Omnica Medical Clinic, Vanderhoof, BC (Batchelor); and the Associate Clinic, Pincher Creek, Alta. (Van Bussel).

Competing interests: None declared.

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

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The importance of tailoring physicians’ trauma care training needs in rural environments

Payam Tarighi, MD, PhD  
Jill E. Sherman, MPH  
Oxana Mian, MA  
Avery B. Nathens, MD, PhD

This study was presented in part as a poster at the 73rd annual meeting of the American Association for the Surgery of Trauma, Sept. 10–13, 2014, Philadelphia, PA

Accepted for publication  
Apr. 13, 2015

Correspondence to:  
P. Tarighi  
Sunnybrook Health Sciences Centre  
Evaluative Clinical Sciences  
2075 Bayview Ave.  
Rm K3W-27  
Toronto ON M4N 3M5  
payam.tarighi@sunnybrook.ca

DOI: 10.1503/cjs.002315

SUMMARY

Gaps in the provision of care exist in the initial evaluation and management of patients first cared for in the most rural settings. We designed a survey to explore what unmet educational needs might exist so as to improve the care of patients before transfer. Here we discuss opportunities for tailored training that will enhance learning capacity, narrow the trauma education gap and improve trauma care, particularly in rural environments.

For a trauma system to have the maximal survival benefit, severely injured patients must survive long enough to reach trauma centre care. This objective is challenging, particularly in more rural environments where discovery and transport times might be prolonged. In this context, a component of care delivered in either lower-level or nondesignated centres is critical. In rural environments, these are often small community hospitals where the resources for evaluation and management are few and the experience of providers is limited.1 While focused courses to enhance the knowledge and skills of providers have shown benefit, we sought to evaluate the current status and perceived educational needs of physicians working in emergency departments (EDs) across several regional trauma systems in Canada. The principle objective was to identify opportunities to better prepare physicians working in more rural environments.

We designed a cross-sectional survey to evaluate the current status and perceived educational needs of emergency physicians who might be responsible for the initial evaluation and management of major trauma patients. The content of the survey was guided by formative research, consisting of 2 focus groups and a field test. Our population of interest was physicians working in the EDs of non–trauma centres or level III–V trauma centres located at least 30 minutes from the nearest level I or II trauma centre. We identified a total of 382 hospitals across 7 provinces (British Columbia, Alberta, Ontario, New Brunswick, Newfoundland and Labrador, Nova Scotia and Prince Edward Island) meeting our inclusion criteria.

Survey data were collected in 2 waves, October 2011 and December 2012, following identical procedures. Survey packages containing a cover letter, an information and instruction guide, a consent form, a questionnaire and a prepaid return envelope were mailed to selected physicians. For the initial survey 2196 physicians were selected and for the second wave 367 additional physicians were selected, for a total of 2563 physicians. Exploration of regional differences and needs across the rural–suburban continuum are available in Appendix 1 (available at canjsurg.ca).
DISCUSSIONS EN CHIRURGIE

STRUCTURED EDUCATIONAL OPPORTUNITIES

We identified opportunities to enhance training through structured learning opportunities. Physicians indicated difficulty in accessing Advanced Trauma Life Support (ATLS) and Pediatric Advanced Life Support (PALS) courses, and there was lack of awareness about newer trauma educational opportunities, such as the Rural Trauma Team Development Course (RTTDC). Limitations to accessing ATLS might explain why one-third of physicians did not have recent ATLS certification, even though most (80%) respondents felt it would meet their educational needs. The positive impact of courses like ATLS on physicians' knowledge and skills has been documented, and there are strong recommendations that ATLS should be taken by any physician involved in the care of injured patients. Many physicians indicated a preference for training courses in their communities, emphasizing the value of either using telemedicine as a medium for ATLS delivery or having experts provide courses locally. Increasing the cadre of ATLS instructors from more rural centres may also improve the availability of ATLS courses outside of major cities.

Interestingly, there was limited awareness of or experience with the RTTDC; this might be a reflection of either its relative novelty compared with ATLS, lack of awareness among trauma training providers in Canada or the availability of similar alternatives. Other rural-focused training courses reported by participants included the Combined Advanced Life Support Course (CALS) with Trauma Module and the Comprehensive Approach to Rural Emergencies (CARE) Course developed in British Columbia.

Knowledge/expertise gaps among rural providers

There were specific areas that physicians identified as particularly challenging and for which additional educational opportunities would be helpful. Three-quarters of participants expressed interest in content related to pediatric trauma, orthopedic/peripheral vascular trauma, airway management and blunt chest/abdominal trauma. These potential gaps are almost certainly related to the relative infrequency with which they are confronted by these problems. A major challenge for improving the impact of training lies in helping physicians maintain knowledge and skills in environments with limited exposure to major trauma. Many physicians in rural environments might see fewer than 5 patients with severe injuries per year.

Preferences in mode of learning

Having rural physicians travel to major urban areas for didactic lectures is suboptimal, drawing physicians away from where they are most needed. Further, we identified that respondents’ preferred mode of learning was practice-oriented, with a distinct preference for simulation-based training. The integration of simulation into ATLS is a challenge, but one that might serve providers and patients well.

EDUCATION AND SUPPORT IN PRACTICE

This survey identified gaps in training opportunities, knowledge and experience of physicians responsible for the initial care of injured patients in rural environments. Structured learning opportunities like ATLS are difficult to access for rural physicians. The RTTDC is likely more suitable for the most rural environments and provides teams with an understanding of what they can accomplish together using their own resources. Unfortunately, promulgation of RTTDC in Canada has been limited. Leaders in trauma care should take the responsibility of raising awareness of opportunities like these to enhance the care of patients in their regions. Where possible, simulation-based training should be incorporated to provide rural practitioners with hands-on experience with their local teams.

The reality of infrequent exposure and potential delays in transfer related to weather and/or transport need can’t be ignored. Physicians in regional trauma centres need to better support their rural providers in real-time through telemedicine and/or teleresuscitation. Additionally, providing structured feedback to providers based on patients transferred from their institutions brings an educational opportunity to every practice encounter. Taken together, telemedicine with real-time consultation and remote learning opportunities might very well improve trauma care in rural settings.

Our survey had several potential limitations. Recall bias may have been introduced when physicians were asked about their past practices and training courses. Additionally, our low response rate (nearly 20%) leads to the potential of nonresponse bias, where physicians electing not to participate might have had very different perspectives on educational needs and gaps. Moreover, given the expected challenges with response rates, we opted for perceived knowledge gaps over actual ones to try to get a little closer to providing these physicians with something from which they might be able to benefit. However, one of our major strengths was the diversity of physicians participating, with representation of those certified in emergency medicine and those without such credentials, and the broad geographic representation from across Canada. Furthermore, we used a combination of quantitative and qualitative approaches to ensure a full spectrum of responses.

We believe that the delivery and content of trauma education materials should be tailored based on the needs of providers, as the practice setting and physicians’ experiences call for very different requirements. This work focused on providers practising outside of major urban areas who have different interests and needs related to content and mode of delivery than providers in the most urban
areas. The ATLS, PALS and other trauma educational offerings should be more accessible, and greater use of tele-education should be considered. Furthermore, courses focusing on trauma team approaches in the context of scarce resources (e.g., RTTDC) need greater promotion and emphasis. We believe that educational opportunities will be more effective if learning is based on real cases from the local setting, and real-time consultation will provide physicians the training and support they require to in turn provide optimal care in the most rural environments.

**Affiliations:** From the Sunnybrook Health Sciences Centre, Toronto, Ont. (Tarighi, Nathens); the Centre for Rural and Northern Health Research, Laurentian University, Sudbury, Ont. (Sherman, Mian); and the Department of Surgery, University of Toronto, Toronto, Ont. (Nathens).

**Funding:** Funding for this work was received from the Canadian Institutes of Health Research. A. Nathens is supported by the de Souza Chair in Trauma Research.

**Competing interests:** None declared.

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

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The evolution of the Canadian Surgery Forum (CSF) over the past decade has been remarkable. More specifically, it reflects the increasing importance of subspecialty scientific content, relevant continuing medical education and improvements in care within both traditional and new subspecialty societies under the umbrella of the CSF itself. The scientific content within any national surgical congress provides an important commentary on the status and evolution of care within that given country. More specifically, it may act as a barometer of innovation as well as the quality of both clinic care and health care systems (i.e., regionalized care). These conferences and embedded scientific topics also stimulate new directions in clinical care, future research and, not uncommonly, an evaluation of one’s own practice and/or hospital system upon returning home.

While the science behind any individual subspecialty topic tends to follow a “recognition–momentum–plateau” pattern, the more relevant query for the CSF is the evolution of scientific content within the program itself. Changes in the scientific presentations reflect the increasing relevance of certain topics with a concurrent reduction in focus on others. These trends can be driven by technical developments, public health issues, reorganization of health systems and/or changing interests among new generations of surgeons.

Given the importance of understanding past progress and challenges to help define the future, we sought to define the volume, type and methodology of the scientific content within the CSF over the past decade. To this end, all scientific abstracts that were presented at the CSF (oral or poster) from 2004 to 2013 were independently reviewed by our group for topic/subspecialty volume, scientific content, methodology and the geographical region of origin.

A total of 1214 scientific abstracts were presented in oral or poster format during the study interval (2004–2013). The total volume of presented abstracts per year increased significantly over time from a low of 107 in 2004 to a high of 195 in 2012 (Fig. 1). This clearly reflects an enhanced commitment of the CSF to original scientific contributions. It is also interesting to note that this increase in abstract volume correlates with a concurrent increase in overall conference attendance (538 attendees in 2004

SUMMARY
Numerous clinical and basic science–related innovations have been presented at the Canadian Surgery Forum (CSF). We sought to define changes in both the content and methodology of the CSF scientific program over the past decade. While the total volume of CSF abstract presentations has increased dramatically, the methodological quality has remained static, with few randomized trials and minimal prospective work. Although the majority of the scientific content is associated with urban university centres, the program also encourages content from community practices. Surgical education, hepatopancreatobiliary and bariatric content have increased substantially, but remain secondary to colorectal diseases.
and 707 attendees in 2012). Although the geographic distribution of abstracts was consistent across years, it was not directly related to the population within a given province. More specifically, the mean (range) distribution was 49% (43%–60%) from Ontario, 18% (13%–21%) from Quebec, 10% (9%–11%) from Alberta, 8% (6%–12%) from British Columbia and 15% (4%–19%) from other provinces. Interestingly 9% of all abstracts were not directly affiliated with a University centre. Although this was consistent over time, it reflects the continued importance of community surgery perspectives that include advancing clinical care, human resource needs, resource limitations and a wide breadth of practice. This content must be encouraged and fostered moving forward.

The relative proportions among subspecialty topics were also consistent over the decade. Not surprisingly given the commonality of the topic across nearly all surgical subspecialties, colorectal diseases remained the dominant area of focus (mean 26%, range 18%–33%). Additional topics included surgical/medical education (mean 20%, range 8%–27%), thoracics (mean 10%, range 5%–13%), hepatopancreatobiliary (HPB; mean 9%, range 2%–15%), upper gastrointestinal (mean 8%, range 1%–10%), breast (mean 7%, range 4%–9%), bariatrics (mean 6%, range 1%–8%), trauma (mean 6%, range 1%–8%) and other areas (mean 8%). Three of these subspecialties displayed substantial growth in their scientific footprint: surgical/medical education (8% in 2004 v. 27% in 2012), HPB (2% in 2004 v. 15% in 2013) and bariatrics (1% in 2004 v. 10% in 2013) all dramatically increased the volume of their presentations (Fig. 2). This reflects the relatively new and momentum-building evolution of each of these subspecialties; to our knowledge, this is the first report of this finding across a large multisubspecialty meeting within surgery. Interestingly, only trauma-related topics showed a significant decrease in footprint over the decade (11% in 2004 v. 3% in 2013). Also not surprisingly, the majority (91%) of noneducation-based abstracts discussed clinical care.

In addition to the specific content of the abstract, methodological quality/type remains an important factor to both improve the quality of a surgical congress and to parlay these topics into subsequent improvements in actual clinical care. The quality of methodology among the CSF scientific abstracts was consistent across the study interval. The majority were retrospective (mean 76%, range 66%–81%), with an additional 12% each engaging in prospective and survey techniques. This finding reflects the continued need to strive for prospective studies and trials as a surgical community within Canada. It also has a clear and direct link to support from funding agencies and university departments. Despite the retrospective pattern of CSF studies, the median number of study participants across all projects was 895. This represents a relatively large average cohort and therefore greater potential relevance to our field.

The evolution of the scientific content within a national surgical congress is influenced by numerous factors. These include, but are not limited to, revolutionary antidogmatic concepts, persuasive speakers, dominant institutions, program committee viewpoints and general clinical patient issues. In an ideal setting, the peer-reviewed abstract presentations mirror clinical needs for the improvement of patient care and increase in methodological quality as time progresses. Without a regular and objective rearview evaluation of our CSF, however, we will not be able to fine-tune our pathway forward.

In summary, the CSF program has dramatically increased in terms of the volume of scientific abstract presentations, but it has remained static in terms of methodology over the past decade. It has also observed a large
growth in education, HPB and bariatric content footprints. As a national congress, we need to continue to encourage pro-
spective subspecialty and relevant community-driven content.

Affiliations: From the Department of Surgery, University of Calgary, 
Calgary, Alta. (Ball, Eberle, Dixon); and the Canadian Surgery Forum, 
Ottawa, Ont. (Boland).

Competing interests: None declared.

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

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Updated Nov. 10, 2015.
Significance of CD4+ T-cell count in the management of appendicitis in patients with HIV

Kumiko Kitaoka, MD, PhD
Kazuhiro Saito, PhD
Koichi Tokuuye, PhD

Accepted for publication
May 8, 2015

Correspondence to:
K. Kitaoka
Department of Radiology
Tokyo Medical University Hospital
6-7-1 Nishishinjuku, Shinjuku-ku, Tokyo
160-0023, Japan
kumiko_kitaoka@yahoo.co.jp

DOI: 10.1503/cjs.015714

SUMMARY

Identification of complicated appendicitis (CA) is critical to the management of appendicitis. However, previous studies have not investigated indicators of CA among patients with HIV or whether it is safe to use conservative treatment for appendicitis in these patients. Among 322 patients with appendicitis, we identified 14 who had HIV. Six of them were operated and 8 were treated with antibiotics; CA was diagnosed in 4. Patients with HIV and CA had a significantly lower CD4+ T-cell count than those with uncomplicated appendicitis. A white blood cell count lower than $7.4 \times 10^9/L$ was observed exclusively in patients with CA. No patient with HIV whose appendicitis was treated conservatively died or experienced a recurrence. We discuss our findings, which suggest the possibility of conservative treatment of appendicitis in patients with HIV and identification of CA by low CD4+ T-cell count.

Appendicitis has been described in connection with HIV infection, and initially researchers emphasized higher incidence and etiological uniqueness in patients with HIV. In particular, opportunistic infection has been considered to be connected to the pathogenesis of acute appendicitis or an appendicitis-like condition among patients with HIV. In addition, earlier studies of patients with appendicitis who had HIV revealed increased risk of perforation and high perioperative mortality. Some authors suspect that a depressed level of cell-mediated immune response and delay in surgical interventions increase complication in patients with HIV. Other authors reported that lack of elevated white blood cell (WBC) count and delay in presentation to the emergency department were responsible for the higher morbidity and mortality. The general consensus among researchers is that accurate diagnosis is a key to successful management.

Gangrenous appendicitis, appendicitis with perforation and appendicitis with abscess formation are often collectively called complicated appendicitis (CA) because of the higher morbidity and mortality. Some laboratory markers, such as elevation of WBC and C-reactive protein (CRP) levels, have been found to be useful for the diagnosis of CA. Moreover, studies have proven the importance of various computed tomography (CT) findings in the context of diagnosis of appendicitis, including discontinuity of the appendiceal wall, appendiceal diameter, appendicolithiasis and retroperitoneal involvement. Various clinical parameters have been investigated to identify CA. However, to our knowledge, no previous study has been conducted to identify CA in patients with HIV.

We studied 322 patients in whom appendicitis was diagnosed at a single urban university hospital (tertiary referral centre for patients with HIV) between Jan. 1, 2007, and Dec. 31, 2012 (119 female, 203 male). The mean age was 31 (range 4–94) years. Patients were assigned to the CA group if perforation of the appendix, abscess formation, or purulent peritoneal fluid was described in surgical reports; if histology reports indicated
perforation of the appendix, abscess formation, peritonitis, or gangrenous appendicitis; or if abscess was found in proximity to the appendix on CT and appendiceal rupture was the only possible explanation after all diagnostic examinations had been conducted. The remaining patients were included in the uncomplicated appendicitis (UA) group. In all, 121 patients had CA (37.5%). All multidetector noncontrast or contrast CT images were reviewed for signs of appendicitis, abscess, perforation and appendicolithiasis and for maximal appendiceal diameter. Data on baseline characteristics, WBC, CRP, CD4 level and serum RNA detection were retrieved from medical records.

Patients were divided into 2 groups depending on their HIV seropositivity. Fourteen patients (13 men, 1 woman, mean age 37 yr) had HIV (4.3%; Table 1). As to radiographical signs, appendicolith was observed in only 4 patients with HIV despite it being commonly associated with appendicitis and CA in the general population. The mean diameter of the appendix was similar in both groups.

Ten patients with HIV were admitted and treated with antibiotics (71.4%), and 4 were treated as outpatients with antibiotics (28.6%). Surgery was performed in 6 patients, including all 4 patients with appendicolithiasis.

In total, CA was diagnosed in 121 patients, 4 of whom had HIV. Immunosuppression was associated with CA in both groups: CA was found in 3 of 4 (75%) patients in whom HIV had progressed to AIDS, in both patients with chronic kidney disease, in the only patient who had undergone bone marrow transplant, in 1 of 2 patients with liver cirrhosis and in 2 of 3 patients with diabetes.

There were some distinguishing clinical features among patients with CA who also had HIV. Notably, CD4+ T-cell count was significantly lower in those with CA than in those UA (222.5 v. 571.0 cells/mm$^3$, $p = 0.023$). Three of the 4 patients with HIV and CA had HIV RNA detection. The mean WBC count in these 4 patients was considerably lower than in patients with HIV and UA (6.8 v. 14.9 $\times 10^9$/L). A WBC count lower than 7.4 $\times 10^9$/L was observed exclusively in patients with both HIV and CA. Lower CRP level was also more frequent in these patients (41.0 v. 96.2 nmol/L). Immunosuppression was related to the presence of CA in patients with HIV. Finally, larger appendiceal diameter, which is associated with severe appendicitis in the general population, was also associated with CA in patients with HIV.

There were no hospital deaths in either group. There was no readmission associated with nonoperative management in the HIV-positive group. Thirteen of the patients with HIV continued regular follow-up at the HIV clinic for more than 20 months. None of these patients experienced a recurrence of appendicitis or died from illness during the follow-up period.

Our study showed higher risk of CA among immunosuppressed patients and in patients with HIV who had lower CD4+ T-cell counts. This finding is in agreement with previous reports that CD4+ T-cell count reduction was associated with increased all-cause morbidity and mortality. Low WBC count is another indicator of CA in patients with HIV. Importantly, a CT finding of large appendiceal diameter served as an indicator of CA regardless of the status of HIV infection. These findings highlight the importance of identification of CA and suggest the possibility of conservative treatment among selected patients with HIV. More studies are needed to investigate the effectiveness of conservative management in patients with HIV.

Acknowledgements: The authors thank Dr. You Tajima and Mr. Hirokazu Aoki for their assistance.

Affiliations: All authors are from the Radiology Department, Tokyo Medical University, Tokyo, Japan.

Competing interests: None declared.

Contributors: All authors contributed substantially to writing and/or revising and to the conception and design of the manuscript and approved the final version for publications.

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A comparison of outcomes between laparoscopic and open appendectomy in Canada

Christopher Blackmore, MD
Divine Tanyingo, BSc
Gilaad G. Kaplan, MD, MPH
Elijah Dixon, MD, MSc
Anthony R. MacLean, MD
Chad G. Ball, MD, MSc

This paper was presented at the Digestive Diseases Week (DDW) in Chicago, Illinois, 2014.

Accepted for publication
Oct. 1, 2015

Correspondence to:
C.G. Ball
University of Calgary
Foothills Medical Centre
1403 – 29th St. N.W.
Calgary AB T2N 2T9
ball.chad@gmail.com

DOI: 10.1503/cjs.012715

SUMMARY

The benefit of a laparoscopic approach to appendectomy continues to be debated. We compared laparoscopic (LA) with open appendectomy (OA) for appendicitis in Canada using the Canadian Institute for Health Information database (2004–2008). The odds of female patients undergoing LA were 1.26 times higher than the odds of male patients, and the odds of patients with nonperforated pathology undergoing LA were 1.38 times higher than the odds of those with perforated pathology. Increasing comorbidities were associated with OA. While LA is becoming more frequent, the associated length of stay, postoperative complication rate and mortality are clearly lower than for OA. As a result, we support the continued increase in use of LA with regard to both safety and outcomes.

Appendicitis is one of the most common surgical conditions in North America, affecting 8% of the population within their lifetime. First described by McBurney in 1894, appendectomy remains the standard of care for appendicitis. Until the introduction of the laparoscopic approach by Semm in 1983, however, little had changed with regard to surgical technique for almost a century. Since its initial description as a feasible procedure, a multitude of publications have compared laparoscopic (LA) with open appendectomy (OA). Among these studies, the methodological quality ranges from moderate to poor, with many lacking randomization, few blinding investigators, and most analyzing data without applying intention to treat principles.

In a recent meta-analysis by Sauerland and colleagues (56 studies comparing LA versus OA), significant decreases were noted in wound infection rate, length of hospital stay, postoperative pain and time to return to work in patients who received LA. Unfortunately, LA also displayed an increased risk of intra-abdominal abscesses. A recent large database study analyzing the Nationwide Inpatient Sample (NIS; 2006–2008) also identified lower overall morbidity, mortality and shorter hospital stays for LA than OA.

Despite these studies supporting the safety and potential advantages of LA, debate remains in Canada as to the best surgical approach. This is evident by the observation that 28% of appendectomies within the NIS database are still being performed using open techniques. As a result, we used both the Discharge Abstract Database (DAD) from the Canadian Institute for Health Information (CIHI) and Hospital Morbidity Database (HMDB) to compare LA with OA for the treatment of acute appendicitis in Canada. In particular, we assessed the rates of LA versus OA over time (2004–2008) as well as the outcomes for both procedures across pediatric, adult and elderly populations.

Although this Canada-wide analysis of 105 882 patients (2004–2008) displayed similar characteristics to preceding publications comparing LA and OA (mean age 32 yr; male patients 55%; mean length of stay 2.9 d;
3.5 d), this surgical time frame has now anecdotally been shown to result in lower health care expenditures in these regions. 

Aside from patient-specific factors that affect the choice of surgery, we identified geographical differences in the rate of LA. In particular, there is a trend toward the increasing use of LA in western (British Columbia, Alberta, Saskatchewan, Manitoba) and central (Ontario) Canada compared with Atlantic Canada (Prince Edward Island, Nova Scotia, New Brunswick and Newfoundland). Lower rates of LA in Atlantic Canada may relate to surgeon preference or to overall lower health care expenditures in these regions.

In addition to the observed trends in our analysis favouring LA for certain patient populations, our results clearly support the overall safety of LA compared with OA in the Canadian context. Although the overall complication rate was lower in the LA than the OA group (3.2% v. 5.3%), specific complications, such as intra-abdominal abscess and postoperative bowel obstructions, were also reduced in the LA population. To our knowledge, this is the first large database confirmation of these findings. While decreased overall morbidity, mortality and length of stay are supported by prior research, the observed decrease in intra-abdominal abscess in patients who received LA contrasts the results of prior large studies. This important novel finding likely represent changes in the LA technique over time. More specifically, the decreased use of copious irrigation and increased skill of surgeons using this technique are important contributors. Furthermore, in addition to the overall length of stay being shorter among patients undergoing LA than those undergoing OA (2.3 v. 3.5 d), this surgical time frame has now anecdotally been converted into a day procedure among many patients with nonperforated appendicitis.

During the period 2004–2008, there was clearly a linear trend toward increasing use of LA (36% in 2004 v. 59% in 2008). While this pattern closely mirrors those observed in other industrialized nations, the 2008 rate of LA remains comparably lower in Canada than in the United States (59% v. 72%). The trend toward LA likely reflects an increasing acceptance of the lower morbidity and mortality associated with the laparoscopic technique. We expect this trend to continue, with recent literature confirming the superior cost effectiveness of LA.

In summary, our analysis demonstrates an increasing trend toward LA for the treatment of acute appendicitis in Canada. While there remain certain patient characteristics that may influence the decision to choose LA over OA (patient age, female sex and perforation), evidence supports the safety profile for LA. Overall, LA is associated with decreased morbidity, mortality and length of stay. This is particularly relevant to fewer observed intra-abdominal abscesses and postoperative bowel obstructions. Based on these findings, LA appears to be a superb option for the management of acute appendicitis across all patient populations and should be encouraged.

Affiliations: From the Department of Surgery, University of Calgary, Foothills Medical Centre, Calgary, Alta. (Blackmore, Dixon, MacLean, Ball); and the Department of Medicine, University of Calgary, Foothills Medical Centre, Calgary, Alta. (Tanyingo, Kaplan).

Competing interests: None declared.

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

References


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