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Mega purchasing leads to a mega mess

The current trend in Canada has been to set up regional or province-wide purchase groups to decrease costs of equipment contracts. Several years ago, I think the government of British Columbia was the first to start the movement, at least in surgery. Certainly, it does make sense on the surface. Bigger purchasing power makes for better savings — Walmart is right, isn’t it? Restriction of implants to a single choice will save money — for the government — and make the bottom line better. Quebec undertook a similar approach with pacemaker purchasing, saving millions of dollars. Newer variations on the pricing scheme may involve allowing other competitors to supply a minority of the implants at a slightly higher price to avoid a monopoly, but that makes no sense. What hospital will allow a surgeon to put in a more expensive implant if the provincial government has only 1 approved implant and budget numbers need to be met? Who determines which hospital or surgeon gets the more expensive implant? The situation really dictates that there will be a single supplier.

There are many difficulties with a single-supplier system, even if it theoretically is only over the course of a 5-year contract. Giving exclusive contracts to a manufacturer will certainly result in some competitors leaving the market, in turn reducing the number of competitors in the next contract round. My hospital has been involved with this type of contract for some time now. I am not convinced it has been a resounding success. For example, we agreed on a price point for long bone nails and switched all inventory over to the supplier of that product. After a cross-country recall for the nails occurred, another company supplied a similar implant while the original supplier rectified the recall. During this time our hospital and probably others paid full price for the implants from the other company, thus evaporating cost savings. Consider a hypothetical example of frequently occurring problems with equipment provided through a supplier contract: failures and performance issues may upset patient care. It is highly unlikely that a hospital would allow the switch from cheaper equipment to more expensive alternatives, regardless of surgeon choice. Sporadic failure could be blamed on chance or on poor surgical technique.

Orthopedic implant prices are already extremely low in Canada. Driving prices lower will result in implant companies abandoning our country; most are already subsidiaries of American branches. There is certainly an existing viewpoint that surgical implants are interchangeable items. It is hard to argue with that view on an evidence-based standard; there is so little head-to-head comparison in the literature that this view cannot be widely disproven. However, the training of surgeons with some devices and their level of familiarity may preclude the same results if the implants and their equipment packs are randomly swapped between cases. The one-implant-fits-all approach limits surgical options and will probably discourage future innovation and new technology.

We are actually leaving medical decisions to the financial side of the hospital administrators. This is not bad in a perfect world — collaboration between surgeons and the administration at the hospital and provincial levels is a good thing. The problem is hospital administrators don’t always talk to surgeons and vice versa. We are heading toward monopoly economics, regardless of how our health care organizations spin the package. It is difficult to see the long-term benefit to patients in any scheme that produces a monopoly, but there may be better ways to manage the problem that are actually cheaper in the long run. There should be a calculated price for the purchase item that is a target for all industry partners. Setting a lowest feasible competitive price for an implant would allow hospitals to purchase an implant from any manufacturer at the target price. The price might be slightly higher than the lowest bid in order to allow competition. At the target price, all companies are allowed to sell to any provincially funded health care resource. This approach does not run any industry partners out of the province or country, does not limit the contract for the next tender to a single supplier and allows easy substitution in the case of any implant flaws, performance issues or recalls. There has to be a better way to manage the procurement of equipment. Unless we get involved, this trend of “mega” purchasing contracts is going to get mega messy.

Edward J. Harvey, MD
Coeditor, Canadian Journal of Surgery
Competing interests: None declared.
DOI: 10.1503/cjs.017814

Reference
Les méga-achats à l’origine d’un méga-gaspillage

Au Canada, la tendance actuelle est aux groupes d’achats régionaux ou provinciaux pour réduire les coûts des contrats d’achat de matériel. Si je me rappelle bien, il y a plusieurs années, le gouvernement de la Colombie-Britannique a été le premier à procéder de cette façon, du moins en ce qui concerne le matériel chirurgical. Bien sûr, à première vue, cela semble合理. Un plus grand pouvoir d’achat permet de meilleures économies — les magasins Walmart n’ont-ils pas la bonne formule ? À l’échelle de la province, cette approche a permis au gouvernement de la C.-B. d’économiser des millions de dollars1. Restreindre les types d’implants à un seul choix permettra effectivement de réaliser des économies — pour le gouvernement — et d’améliorer le bilan. Le Québec a adopté une approche similaire en ce qui concerne l’achat des stimulants cardiaques et a ainsi économisé des millions de dollars. De nouvelles variantes de cette approche de réduction des coûts pourraient éventuellement permettre à des compétiteurs d’offrir certains des implants en moins grande quantité à un prix légèrement plus élevé pour éviter une situation de monopole, mais où serait la logique ? Quel hôpital permettra à un chirurgien d’installer un implant plus coûteux si le gouvernement provincial n’en approuve qu’un seul (moins cher) et que les budgets doivent être respectés ? Qui déterminera quel hôpital ou quel chirurgien aura l’autorisation d’acheter l’implant plus coûteux ? Sous cet angle, il n’y a pas d’autre choix que d’adopter un fournisseur unique.

Or, ce système du fournisseur unique pose plusieurs problèmes même si, en théorie, les contrats ne durent que 5 ans. Accorder des contrats exclusifs à un seul fabricant en forcerait certainement d’autres à se retirer du marché ce qui, en retour, réduira le nombre de fournisseurs à solliciter en vue d’une prochaine ronde de négociation des contrats. Mon hôpital conclut ce genre de contrats depuis un certain temps et je ne suis pas convaincu que la démarche ait été très concluante. Par exemple, nous nous sommes entendus sur un prix fixe pour les dispositifs d’enclouage des os longs et nous avons changé notre stock entier pour utiliser les produits du fournisseur en question. Lorsque ces clous ont fait l’objet d’un rappel à l’échelle du pays, une autre compagnie nous a fourni un implant similaire, tandis que le fournisseur original corrigeait la situation. Pendant ce temps, notre hôpital, et d’autres aussi probablement, ont payé le plein prix pour les implants de l’autre fournisseur et les économies prévues se sont envolées en fumée. Supposons que le matériel d’un fournisseur choisi présente des problèmes récurrents, par exemple, des défaillances et un rendement insatisfaisant : cela peut compromettre la qualité des soins. Il semble très peu probable qu’un hôpital permette le passage d’un équipement moins coûteux à des solutions plus chères, quelles que soient les préferences du chirurgien. Des défaillances sporadiques pourraient être attribuées à la malchance ou à une piétre technique chirurgicale.

Le prix des implants orthopédiques est déjà extrêmement bas au Canada. Faire baisser les prix davantage incitera les fabricants à délaisser le marché canadien. Or, la plupart sont déjà des filiales de sociétés américaines. Certains sont sûrement déjà d’avis que les implants chirurgicaux sont tout ce qu’il y a de plus interchangeable. Il est difficile d’évoquer des normes factuelles face à un tel aveuglement et peu de comparaisons directes existent dans la littérature pour contrer l’argument. Toutefois, comme les chirurgiens apprennent et se familiarisent avec certains dispositifs durant leur formation, les résultats risquent d’être bien différents si les implants et les équipements changent sans préavis d’un cas à l’autre. Cette approche de l’implant « universel » limite les options chirurgicales et découragera probablement l’innovation technologique à l’avenir.

Nous remettons ainsi des décisions médicales entre les mains d’administrateurs hospitaliers motivés par des impératifs économiques. Dans un monde idéal, cela ne serait pas mauvais — la collaboration entre les chirurgiens et les administrations des hôpitaux et des provinces est une bonne chose en soi, mais le problème, c’est que les administrateurs des hôpitaux ne parlent pas toujours aux chirurgiens et vice versa. Peu importe ce qu’en disent les établissements de santé, nous nous dirigeons vers une économie de monopoles. Il est difficile de voir où se trouve l’avantage à long terme pour les patients dans une approche, quelle qu’elle soit, qui engendre un monopole. Il y aurait probablement de meilleures façons de s’attaquer au problème et elles pourraient même se révéler plus économiques au bout du compte. Il faudrait établir un prix cible pour l’achat de matériel et en faire un objectif pour tous les partenaires de l’industrie. Établir le prix concurrentiel réaliste le plus bas possible pour un implant permettrait aux hôpitaux de s’approvisionner auprès de n’importe quel fabricant au prix cible. Le prix pourrait être légèrement plus élevé que la soumission la plus basse pour permettre la concurrence. Au prix ciblé, toutes les compagnies seraient autorisées à proposer leurs produits à n’importe quel établissement de santé public provincial. Cette approche ne chasse pas les partenaires de l’industrie hors de la province ou du pays, ne limite pas les prochains contrats à un seul fournisseur et permet une substitution facile en cas de défaillance des implants, de résultats insatisfaisants ou de rappels. Il doit y avoir une meilleure façon de gérer l’acquisition de matériel. Si nous ne faisons rien, cette tendance aux méga-achats groupés nous mènera tout droit à un méga-gaspillage.

Edward J. Harvey, MD
Co-rédacteur, Journal canadien de chirurgie
Intérêts concurrents : Aucuns déclaré.
DOI: 10.1503/cjs.000315
Référence
Surgical training in Guyana: the next generation

Brian H. Cameron, MD
Carlos Martin, MBBS, PGDipSurg
Madan Rambaran, MBBS

Accepted for publication
Aug. 27, 2014

Correspondence to:
B.H. Cameron, MD
Professor and Head, Division of Pediatric Surgery
Director, International Surgery Desk
McMaster Children’s Hospital
1200 Main St. West, Rm. 4E7
Hamilton ON L8N 3Z5
cameronb@mcmaster.ca

DOI: 10.1503/cjs.010414

SUMMARY

The pioneering surgical training partnership between the Canadian Association of General Surgeons (CAGS) and the University of Guyana has successfully graduated 14 surgeons since 2006. The association has recruited 29 surgeons who have made 75 teaching visits to Guyana, and CAGS involvement has been critical to providing local credibility to the program, organizing the curriculum structure and developing rigorous examinations. The program is now locally sustained, with graduates leading a number of clinical hospital programs. The initial diploma qualification is being reassessed, as other specialties have introduced postgraduate Master of Medicine degree programs. Many graduates are pursuing additional training opportunities overseas, and almost all of those remaining in Guyana have returned to the tertiary centre from the regional hospitals. The program has succeeded in training surgeons and raising the standards of surgical care in Guyana, but broader health system efforts are necessary to retain surgeons in outlying regional hospitals.

Surgical training partnerships are a sustainable way to address the deficiencies of surgical care in low- and middle-income countries. In 2006, the Canadian Association of General Surgeons (CAGS) partnered with the University of Guyana (UG) to train surgeons locally for regional hospitals. Fourteen surgeons have graduated, exceeding the original expectations. However, most are practising in the tertiary centre rather than a regional hospital, and several have migrated. This commentary reflects on lessons and challenges during the evolution of this north–south training partnership.

Guyana is a “land of many waters” on the Caribbean coast of South America with a population of 750,000, and it ranks 118th on the Human Development Index. In 2001, the physician:population ratio was just 1.8:10,000, and surgical care was being provided by a few specialists trained overseas. Some UG graduates who were ambitious to become surgeons moved to Jamaica or Trinidad to complete a 5-year Doctor of Medicine specialist degree through the University of the West Indies (UWI), but most did not return. Local surgical leaders identified the need to train surgeons to replace expatriates and serve the rural population, and they approached CAGS to help start a locally based postgraduate course. The Canadian International Development Agency (CIDA) provided 3 years of funding support.

Recognizing that there was not enough capacity to support a longer training program, the 2.5-year Postgraduate Diploma in Surgery curriculum focused on local diseases and resources. Visitors from CAGS shared teaching with local faculty, and the tutorial format enabled visitors to complete a module during a 2-week visit. Twenty-nine Canadian surgeons made 75 visits to Guyana over 8 years, and Skype sessions provided continuity. Residents were assigned to a regional hospital for 6 months before graduation, which was a key part of the transition to independent practice, and they continued serving there for at least a year.

One of the priorities was to train faculty to take over the program. Small research grants supported faculty and bilateral resident exchange and
conference participation, raising the academic standards. One pilot project led to a CIDA-funded diabetic foot care program that resulted in a 40% reduction in amputations and won an award for best original research from a developing country.7 The Canadian Network for International Surgery (CNIS) Trauma Team Training (TTT) instructor course provided skills in educational leadership, and graduates subsequently trained more than 150 TTT providers.4

The Postgraduate Diploma in Surgery program graduates are now senior registrars and lead hospital programs (e.g., burn unit, trauma, endoscopy), teach medical students and tutor participants in the surgical course modules.

Some of the factors critical to the program’s early success included the locally relevant curriculum, strong local leadership, committed Canadian partners and external funding support. Program sustainability will depend on the oversight provided by the local Postgraduate Education Committee, which has representation from all stakeholders, and Ministry of Health support for the training budget and resident salaries.

The role of the Canadian partners has evolved, and the program is now completely run by local faculty. The imprimatur of CAGS was critical to providing local credibility to the program, recruiting visiting faculty, organizing the curriculum structure and developing rigorous examinations. Several university departments of surgery supported faculty exchange, research projects and clinical fellowship training after graduation, and there is an ongoing need for continued collaborations.

With the end of the formal CAGS partnership and external funding, current trainees and faculty are concerned whether the program can continue in its present form. Maintaining the quality of the training, revising the qualification and retaining graduates are some of the ongoing challenges. Residents have a heavy clinical workload and lack protected academic time. There is no external accreditation process to meet international postgraduate program quality standards, although the Caribbean Accreditation Authority for Education in Medicine and other Health Professions accredits the undergraduate medical program.

The Postgraduate Diploma in Surgery has been recognized by medical councils in Guyana and Montserrat and by the provinces of Ontario and Alberta for clinical fellowships at the University of Ottawa, McMaster University and the University of Calgary, respectively. However, no graduate has yet been promoted to hospital consultant, and the local consensus is that additional overseas clinical experience or qualifications are necessary to become a locally recognized specialist. The introduction of Masters of Medicine degrees in the new postgraduate programs (i.e., emergency medicine, pediatrics, obstetrics, internal medicine) has drawn away applicants from the surgery program. Consideration is being given to upgrade the Postgraduate Diploma in Surgery to a 4-year Master of Medicine program, which will require curriculum revision and additional resources. Other options are to emulate the UWI 5-year Doctor of Medicine program or qualify graduates for fellowship in the nascent Caribbean College of Surgeons. Some graduates are now pursuing additional surgical specialist qualifications in the United Kingdom through distance education.

The training program needs to reconcile graduates’ aspirations with competing national needs. Nine graduates remain in Guyana and provide much of the surgical care in the country, but most have returned to the main tertiary hospital. The World Health Organization is making efforts to strengthen the global health workforce, recognizing that surgeons are only 1 part of the health system. They work with a team of ancillary staff, need equipment and supplies, and require a responsive governance structure. Until these larger health system issues are addressed, the challenge of retaining surgeons in regional hospitals will continue.

Retention efforts by the Ministry of Health have included promotion, salary increments, housing benefits and, more recently, longer return of service bonds. Graduates report that their main reason to consider migration is professional development, and 5 are currently enrolled in further training outside Guyana. The 3 graduates who have migrated to Trinidad and Jamaica are working as surgical house officers and are enrolled in the Doctor of Medicine program at UWI. Their Postgraduate Diploma in Surgery qualification has helped them attain those positions and do well on their examinations, but has not been recognized for any advanced standing in the UWI training program. Two graduates are doing clinical fellowships in Canada while remaining contracted to the Guyana Ministry of Health. There is optimism that most of these graduates will return to Guyana and be the country’s future surgical leaders. The brain drain may reverse as local surgical infrastructure improves.7

The CAGS–Guyana surgical training project has formally ended after 8 years and has succeeded in graduating surgeons who continue to serve Guyana’s needs. The

### KEY POINTS

1. Surgical training partnerships should be locally based and locally relevant.
2. External partners bring credibility, faculty, research opportunities and resources.
3. Local leadership is essential to sustainability, and train-the-trainer courses are critical to faculty development.
4. The qualification must be of international standard to be locally recognized.
5. Young surgeons seek further opportunities for professional development and career advancement.
6. Retention efforts should focus on incentives, and improvement of regional hospital support systems.
current challenges are to upgrade the Postgraduate Diploma in Surgery to a degree equivalent to other new local postgraduate qualifications, outline a career path for graduates that could include promotion to consultant or program director, and retain surgeons in regional hospitals. Canadian surgeons continue to support the development of surgical specialties in Guyana and serve as mentors to graduates as they assume local leadership positions. Some of the principles outlined in this commentary may be applicable to other training partnerships, recognizing that it is the individual relationships and commitment as much as the formal institutional affiliations that are critical to success.

Affiliations: From the CAGS International Surgery Committee, Ottawa, Ont. (Cameron); the Department of Surgery, McMaster University, Hamilton, Ont. (Cameron); the Department of General Surgery, University Hospital of the West Indies, Kingston, Jamaica (Martin); and the Georgetown Public Hospital Corporation, Institute for Health Science Education, Georgetown, Guyana (Rambaran).

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 publication.

References
Association between the appendix and the fecalith in adults

Background: We sought to determine the association between the presence of a fecalith and acute/nonperforated appendicitis, gangrenous/perforated appendicitis and the healthy appendix.

Methods: We retrospectively analyzed appendectomies performed between October 2003 and February 2012. We collected data on age, sex, appendix histology and the presence of a fecalith.

Results: During the study period, 1357 appendectomies were performed. Fecaliths were present in 186 patients (13.7%). There were 94 male (50.5%) and 92 female patients, and the mean age was 32 (range of 10–76) years. The fecalith rate was 13%–16% and was nonexistent after age 80 years. The main groups with fecaliths were those with acute/nonperforated appendicitis ($n=121$, 65.1%, $p=0.041$) and those with a healthy appendix ($n=65$, 34.9%, $p=0.003$). The presence of fecaliths in the gangrenous/perforated appendicitis group was not significant ($n=19$, 10.2%, $p=0.93$). There were no fecaliths in patients with serositis, carcinoid or carcinoma.

Conclusion: Our data confirm the theory of a statistical association between the presence of a fecalith and acute (nonperforated) appendicitis in adults. There was also a significant association between the healthy appendix and asymptomatic fecaliths. There was no correlation between a gangrenous/perforated appendix and the presence of a fecalith. The fecalith is an incidental finding and not always the primary cause of acute (nonperforated) appendicitis or gangrenous (perforated) appendicitis. Further research on the topic is recommended.

Contexte: Nous avons voulu examiner le lien entre la présence d’un fécalome et l’appendicite aiguë/non perforée, l’appendicite gangreneuse/perforée et un appendice sain.


Résultats: Durant la période de l’étude, 1357 appendicectomies ont été effectuées. Des fécalomes étaient présents chez 186 patients (13,7 %). L’étude regroupait 94 hommes (50,5 %) et 92 femmes; l’âge moyen était de 32 ans (entre 10 et 76 ans). Le taux de fécalome était de 13 % à 16 % et non existant après l’âge de 80 ans. Les principaux groupes porteurs de fécalomes étaient ceux qui présentaient une appendicite aiguë/non perforée ($n=121$, 65,1 %, $p=0,041$) et ceux dont l’appendice était sain ($n=65$, 34,9 %, $p=0,003$). La présence de fécalomes dans le groupe souffrant d’appendicite gangreneuse/perforée s’est révélée non significative ($n=19$, 10,2 %, $p=0,93$). Les patients qui souffraient de sérosite, de carcinoidé ou de carcinome ne présentaient pas de fécalomes.

Conclusion: Nos données confirment la théorie d’un lien statistique entre la présence d’un fécalome et une appendicite aiguë (non perforée) chez l’adulte. On a également observé un lien significatif entre un appendice sain et des fécalomes asymptomatiques. On n’a observé aucune corrélation entre un appendice gangreneux/perforé et la présence de fécalomes. Le fécalome est une observation accessoire qui n’est pas toujours la principale cause de l’appendicite aiguë (non perforée) ou de l’appendicite gangreneuse (perforée). Une recherche plus approfondie à ce sujet est recommandée.
It is generally accepted that the main etiology of appendicitis is obstruction due to fecalith in adults and lymphoid hyperplasia in children. It is also accepted that perforated/gangrenous appendicitis is associated with an obstructed appendix secondary to the presence of a fecalith. A standard PubMed search on the topic reveals a plethora of literature on appendiceal fecaliths or coproliths. There are many associated articles documenting fecalith rates ranging from 1.5% to 51%, but certainly no level 1 evidence on the topic.

Trinidad & Tobago is a twin island state located off the northern tip of South America and Venezuela; the islands are the southern-most islands in the Caribbean. The population is diverse owing to a history of invasion by Spain, Portugal, France and Britain and to migration from India, Africa, China, Syria and Lebanon as well as other Arabic nations and Amerindian areas. The composition of the population is estimated as follows: East Indian descent (37%), Afro-Caribbean (36%), mixed races (24%) and white, Arabic, Chinese and Amerindian (3%). We present our data on fecalith rates and acute appendicitis in this population.

**Methods**

We retrospectively collected data from the electronic records of the Department of Pathology at the General Hospital, Port-of-Spain, Trinidad, for all appendectomies performed between October 2003 and February 2012 in patients aged 5–100 years old. Data included demographic information regarding date of collection, age, sex, hospital of origin; details of the morphologic appearance of the specimen; histology; and the presence or absence of a fecalith. The collection of this information is standard protocol at the Department of Pathology, where only 2 pathologists have been appointed to the department in more than 30 years thereby enabling a level of consistency with the accuracy of the morphologic appearances and histopathology reporting. Data were collected from The General Hospital, Port-of-Spain (POSGH), The Sangre Grande District General Hospital (SGH) and The Scarborough Regional Hospital (SRH) in Tobago. Most patients who undergo appendectomy at these institutions have a clinical indication for the procedure and the clinical syndrome of appendicitis. Information regarding race was not collected for our analysis and would have to be documented in a further study. Ethics approval was granted from the relevant authorities.

**Statistical analysis**

We entered the data entered into SPSS software version 20.0 (IBM Statistics). Histologic information was documented and coded based on the presence of acute/nonperforated) appendicitis, gangrenous/perforated appendicitis or a healthy appendix and based on whether the patient had serosal edema/congestion, serositis and/or lymphoid hyperplasia. The presence of a fecalith or other associations, such as carcinoma or carcinoid, was noted for all specimens.

**Results**

There were 1357 appendectomies performed during the study period in 687 male (50.6%) and 670 female patients (49.4%). The mean age of patients was 34 (range 5–91) years. The most common age group affected was the 21–30 group (n = 431, 31.8%) followed by the under-21 group (n = 304, 22.4%), the 31–40 group (n = 236, 17.4%), the 41–50 group (n = 159, 11.7%), the 51–60 group (n = 92, 6.8%), the 61–70 group (n = 68, 5%), the 71–80 group (n = 51, 3.8%), the 81–90 group (n = 14, 1%) and the older than 90 group (n = 2, 0.1%; Fig. 1).

Hospital information was available for 1355 patients; most were from the POSGH (n = 1006, 74.2%), followed by the SRH (n = 175, 12.9%), SGH (n = 172, 12.7%) and other (n = 2, 0.1%).

The mean number of cases per year was 136 (n = 29 in the last 3 months of 2003, n = 192 in 2004, n = 171 in 2005, n = 122 in 2006, n = 163 in 2007, n = 118 in 2008, n = 143 in 2009, n = 219 in 2010, n = 185 in 2011 and n = 15 in the first 2 months of 2012). There were 968 cases of appendicitis (71.3%), of which 136 were gangrenous, necrotic or perforated. There were 183 patients with serosal edema, 20 with serositis and 88 with lymphoid hyperplasia. These patients were included in the total sample (137). Some specimens contained more than 1 factor on histology. Fecaliths were present in 186 patients (13.7%).

In the fecalith subset analysis, there were 94 male (50.5%) and 92 female patients with a mean age of 32 (range 10–76) years. The following are the fecalith rates in each age group: 14.8% (< 21 yr), 15.8% (21–30 yr), 19.9% (31–40 yr), 13.2% (41–50 yr), 13.0% (51–60 yr), 14.7% (61–70 yr), 3.9% (71–80 yr); there were no fecaliths in the 81–90 group (n = 14, 1%) and the older than 90 group (n = 2, 0.1%; Fig. 1).

From a histological perspective, we analyzed only the patients with fecaliths (n = 186). A Pearson χ² test showed a significant association between the presence of fecaliths and acute appendicitis in this population.

**Fig. 1.** Age distribution of the entire study population compared to those with fecaliths.
and acute/nonperforated appendicitis \((n = 121, 65.1\%, p = 0.041; \text{Table 1})\) and healthy appendices \((n = 65, 34.9\%, p = 0.003; \text{Table 2})\). There was no significant association between the presence of fecaliths and gangrenous/perforated appendicitis \((n = 19, 10.2\%, p = 0.93; \text{Table 3})\).

Subgroup analyses using the Pearson \(\chi^2\) test under the crosstabs option revealed a significant association between the presence of fecaliths and serosal edema \((n = 37, 19.9\%, p = 0.006; \text{Table 4})\) but not lymphoid hyperplasia \((n = 11, 5.9\%, p = 0.73; \text{Table 5})\). These were subsets of the overall group of 186 patients and were not additional or discrete cases. Some of these patients had a combination of factors.

There were no fecaliths in patients with serositis, carcinoid or carcinoma.

**DISCUSSION**

The first description of the vermiform appendix causing a perityphilitic suppuration was reported by Fitz\(^1\) in 1886. This was followed by a landmark article by Wangensteen and Bowers\(^2\) in 1937, in which the theory of the obstructive component was discussed as a causative factor for acute appendicitis. Subsequently, there were a few articles exploring the association between the appendix and the fecalith written by Durcharme and colleagues\(^3\) in 1966 and Gill and Cudmore\(^4\) in 1975 explaining the etiology and outcomes.

In 1985, Jones and colleagues\(^5\) postulated that appendicitis was more common in developed than in developing regions, and appendiceal fecaliths are thought to have an etiologic role in the disease. The geographic distribution of appendiceal fecaliths was investigated by systematic, intraoperative palpation of the appendix in patients in Toronto, Canada, and Johannesburg, South Africa. The incidence of fecaliths found on pathologic sectioning of the appendix in patients with appendicitis in both cities were compared. In the Canadian population, the prevalence of fecaliths in patients whose appendices were palpated incidentally was 32\% versus 52\% for those with appendicitis. In the South African population, the prevalence of fecaliths in patients whose appendices were palpated incidentally was 4\% versus 23\% for those with appendicitis. The difference in prevalence of incidental appendiceal fecaliths in the 2 populations was statistically significant, showing a higher prevalence in developed than in developing countries as well as a higher prevalence in patients with appendicitis. The authors concluded that low-fibre diets consumed in developed countries lead to fecalith formation and predisposes those populations to appendicitis.\(^5\)

In 1990, Nitecki and colleagues\(^6\) conducted a study to determine the association between appendiceal fecaliths or appendiceal calculi and the presence of acute appendicitis. They found that fecaliths were 6 times more common than calculi, but that calculi were more often associated with perforated appendicitis or perappendiceal abscesses (45\%) than fecaliths (19\%).\(^6\)

Consensus dictates that the main etiology of appendicitis is obstruction secondary to fecalith formation within the lumen of the appendix in adults. Other uncommon causes may include parasites, undigested plant or fruit residues, trauma and foreign bodies.\(^7\) Appendicitis in children is closely associated with lymphoid hyperplasia and may be often due to viral causes. It is also assumed that perforated, gangrenous or necrotic appendicitis is associated with an obstructed appendix secondary to the presence of a fecalith, as shown by Alaeedeen and colleagues\(^8\) in 2008; they assessed 388 patients and found a fecalith rate of 31\%. The appendix was perforated in 57\% of patients who had a fecalith versus 36\% of

---

**Table 1. Significance of having a fecalith and acute (nonperforated) appendicitis**

<table>
<thead>
<tr>
<th>Appendicitis</th>
<th>No fecalith</th>
<th>Fecalith</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No appendicitis</td>
<td>324</td>
<td>65</td>
<td>389</td>
</tr>
<tr>
<td>Appendicitis</td>
<td>847</td>
<td>121</td>
<td>968</td>
</tr>
<tr>
<td>Total</td>
<td>1171</td>
<td>186</td>
<td>1357</td>
</tr>
</tbody>
</table>

*Pearson \(\chi^2\) (asymp sig 2-sided), \(p = 0.041\).

**Table 2. Significance of having a fecalith and a healthy appendix**

<table>
<thead>
<tr>
<th>Appendix</th>
<th>No fecalith</th>
<th>Fecalith</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not healthy</td>
<td>882</td>
<td>121</td>
<td>1003</td>
</tr>
<tr>
<td>Healthy</td>
<td>289</td>
<td>65</td>
<td>354</td>
</tr>
<tr>
<td>Total</td>
<td>1171</td>
<td>186</td>
<td>1357</td>
</tr>
</tbody>
</table>

*Pearson \(\chi^2\) (asymp sig 2-sided), \(p = 0.003\).

**Table 3. Significance of having a fecalith and a gangrenous (perforated) appendix**

<table>
<thead>
<tr>
<th>Type of appendicitis</th>
<th>No fecalith</th>
<th>Fecalith</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not gangrenous/necrotic</td>
<td>1054</td>
<td>167</td>
<td>1221</td>
</tr>
<tr>
<td>Gangrenous/necrotic</td>
<td>117</td>
<td>19</td>
<td>136</td>
</tr>
<tr>
<td>Total</td>
<td>1171</td>
<td>186</td>
<td>1357</td>
</tr>
</tbody>
</table>

*Pearson \(\chi^2\) (asymp sig 2-sided), \(p = 0.93\).

**Table 4. Significance of having a fecalith and serosal edema**

<table>
<thead>
<tr>
<th>Edema</th>
<th>No fecalith</th>
<th>Fecalith</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No serosal edema</td>
<td>1025</td>
<td>149</td>
<td>1174</td>
</tr>
<tr>
<td>Serosal edema</td>
<td>146</td>
<td>37</td>
<td>183</td>
</tr>
<tr>
<td>Total</td>
<td>1171</td>
<td>186</td>
<td>1357</td>
</tr>
</tbody>
</table>

*Pearson \(\chi^2\) (asymp sig 2-sided), \(p = 0.006\).

**Table 5. Significance of having a fecalith and lymphoid hyperplasia**

<table>
<thead>
<tr>
<th>Lymphoid hyperplasia</th>
<th>No fecalith</th>
<th>Fecalith</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No lymphoid hyperplasia</td>
<td>1094</td>
<td>175</td>
<td>1269</td>
</tr>
<tr>
<td>Lymphoid hyperplasia</td>
<td>77</td>
<td>11</td>
<td>88</td>
</tr>
<tr>
<td>Total</td>
<td>1171</td>
<td>186</td>
<td>1357</td>
</tr>
</tbody>
</table>

*Pearson \(\chi^2\) (asymp sig 2-sided), \(p = 0.73\).
patients without a fecalith. However, there are differing opinions on the topic, bringing into question the theory of the appendicular fecalith (for an example, see the study by Maenza and colleagues on “the myth of a fecalith.”). A PubMed search reveals a plethora of literature on the topic “appendicitis and fecolith” or “appendicitis and coprolith.”

In 2008, Sgourakis and colleagues examined the role of coprostasis and coproliths in recurrent appendicitis. Of 427 histology reports, 294 showed acute appendicitis, 56 showed acute recurrent appendicitis, 34 showed subacute recurrent appendicitis, 28 showed chronic appendicitis and 15 showed noninflamed appendicitis. Coprostasis was observed in 58 patients (13.58%), and the presence of coprolith was observed in 6 (1.4%). The authors concluded that coprostosis, but not coproliths, is a contributing factor to acute exacerbations of chronic appendicitis.

In addition, Makaju and colleagues provided data from Kathmandu in 2010 on 518 appendectomy specimens. They found a fecalith rate of 1.54%. Histology revealed that 180 (34.75%) cases were early acute appendicitis, 250 (48.26%) were acute suppurative appendicitis and 88 (16.99%) cases acute gangrenous appendicitis. Their study did not confirm the existing popular notion that luminal obstruction is the pathogenetic hallmark for acute appendicitis. Another supporting 10-year study by Chandrasegaram and colleagues in Australia on appendectomies that were positive for fecaliths, worms, endometriosis or appendiceal tumours showed the fecalith rate to be 3.6% of 4670 specimens, with 39.5% of patients having appendicitis. The findings of these studies did not support the fecalith/coprolith theory.

A recent study by Singh and Mariadason showed that of 1014 emergency appendectomy specimens the fecalith rate was 18.1% in appendicitis specimens and 28.6% in negative specimens, a rate similar to that found in the present study. Fecalith prevalence for positive cases was 29.9% (79 of 264) in pediatric patients and 13.7% (99 of 722) in adults. Furthermore, fecalith prevalence was 39.4% in perforated appendicitis but only 14.6% in nonperforated appendicitis (27.5% v. 12.0%, respectively, in adults and 56.1% v. 22.7%, respectively, in children). The authors concluded that fecalith prevalence was too low to consider it the most common cause of nonperforated appendicitis and that fecaliths are more prevalent in pediatric than in adult appendicitis.

Regarding the use of computed tomography in patients with appendicitis and fecaliths, Huwart and colleagues reported that the appendix was visualized in 82% of cases and a fecalith found in 13%. They concluded that the fecalith was found in a significant number of healthy patients and that the presence of a fecalith did not represent a specific sign for appendicitis. These more recent studies support the theory that the fecalith is merely an incidental finding and that it is not always causative for appendicitis.

We found that the male:female fecalith ratio was 1:1 in our population, which had a mean age of 32 years. The fecalith prevalence rate ranged from 11.9% to 15.8% in patients aged 10–76 years (14.8% in the under-21 group, 15.8% in the 21–30 group, 11.9% in the 31–40 group, 13.2% in the 41–50 group, 13.0% in the 51–60 group and 14.7% in the 61–70 group), dropped in patients aged 71–80 years (3.9%) and was nonexistent in patients older than 80 years (Fig. 1).

From a histological perspective, considering only the patients with fecaliths (n = 186), we found that the presence of a fecalith was significant in patients with acute/nonperforated appendicitis (n = 121, 65.1%, p = 0.041) and, quite interestingly, in patients with healthy appendices (n = 65, 34.9%, p = 0.003). We performed subgroup analyses involving overlapping factors in this group of 186 patients: gangrenous/perforated appendix, serosal edema and lymphoid hyperplasia. There was no statistical correlation between the presence of a fecalith and having a gangrenous/perforated appendix (n = 19, 10.2%, p = 0.93; Tables 1–3).

In addition, there were no fecaliths in patients with serositis, carcinoid or carcinoma. We do expect some degree of error in reporting the fecaliths over the study period; however, because there have only been 2 senior pathologists in the department of pathology in the last 30 years, we expect an adequate level of consistency in reporting. Moreover, patients would undergo surgery only once indicated by a clinical picture of appendicitis. Therefore, although the negative appendectomy rate was estimated to be 28%, appendices were still indicated to be removed at the time of surgery and had nothing to do with the palpation of a fecalith, as is done in many centres worldwide. Of note, most of the appendectomies at our hospital are performed by residents in training and senior house officer–level staff, who have usually been in practice for fewer than 5 years.

**Conclusion**

The data we presented confirm the theory of a statistical association between the presence of a fecalith and acute appendicitis, but also show contradictory information whereby having a healthy, asymptomatic appendix was also strongly associated with the presence of a fecalith. Interestingly, there was no significant correlation between gangrenous/perforated appendix and the presence of a fecalith. We conclude that the fecalith is merely an incidental finding and is not the primary cause of acute (nonperforated) or gangrenous (perforated) appendicitis, but merely an association. We postulate that the underlying cause is most often related to some other factor when fecaliths are found in patients with perforated or gangrenous appendices. This study is relevant to current surgical practice in the United Kingdom, North America and Europe, where there are increasing migrant West Indian, East Indian and African populations, and is useful for clinical
and radiologic decision-making since our populace is a multicultural racial composition. With so many differing views the only way forward is to encourage further research on the topic to bring firm conclusions to the table.

Acknowledgements: We acknowledge the tireless work of the late Dr. Neville Jankey, Consultant Pathologist, General Hospital, Port-of-Spain, who was one of the main contributors to the database.

Affiliation: From the Department of Surgery, General Hospital, Port-of-Spain, Trinidad, West Indies.

Competing interests: None declared.

Contributors: All authors designed the study, acquired the data and wrote the article. M. Ramdass, Q. Young Sing, D. Milne and J. Mooteeram analyzed the data. S. Barrow reviewed the article. All authors approved the final version for publication.

References

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Cause of death in patients awaiting bariatric surgery

Joshua M. Lakoff, MD
James Ellsmere, MD, MSc
Tom Ransom, MD, MSc
Accepted for publication
June 2, 2014
Early-released Dec. 1, 2014

Background: Obesity is associated with increased mortality. Bariatric surgery is becoming an important treatment modality for obesity, with an associated reduction in mortality. There are few data available on the incidence and cause of death in referred patients while they are waiting for bariatric surgery.

Methods: We retrospectively examined all cases of death in patients who were referred for bariatric surgery assessment but who had not yet undergone bariatric surgery at a tertiary care centre in Halifax, Nova Scotia. The wait list comprised patients referred for surgery between March 2008 and May 2013. All cases of death were reviewed to determine age, sex, time of referral, time spent on the wait list, cause of death, comorbidities and body mass index (BMI).

Results: Of the 1399 patients referred, 22 (1.57%) died before receiving surgery. The mean age of these patients was 62.7 (range of 32–70) years. The average time from referral to death was 21.6 months, and the average BMI was 51.5. The most frequent cause of death was cancer, followed by cardiac and infectious causes.

Conclusion: This study provides useful information about mortality and causes of death among patients awaiting bariatric surgery at our centre. Our results will help guide the development of a judicious system for triage in light of long wait times.

Contexte : L’obésité est associée à une mortalité accrue. La chirurgie bariatrique devient une modalité thérapeutique importante pour traiter l’obésité et elle est associée à une réduction de la mortalité. On dispose de peu de données sur l’incidence et la cause du décès chez les patients référés qui sont en attente d’une chirurgie bariatrique.

Méthodes : Nous avons examiné rétrospectivement tous les cas de patients référés qui sont décédés en attente d’une chirurgie bariatrique dans un centre de soins tertiaires de Halifax (Nouvelle-Écosse). La liste d’attente comprenait des patients référés pour chirurgie entre mars 2008 et mai 2013. Nous avons passé en revue tous les décès pour déterminer l’âge, le sexe, la date de la référence, le temps passé sur la liste d’attente, la cause du décès, les comorbidités et l’indice de masse corporelle (IMC).

Résultats : Parmi les 1399 patients référés, 22 (1,57 %) sont décédés avant de subir leur chirurgie. L’âge moyen de ces patients était de 62,7 ans (entre 32 et 70 ans). L’intervalle moyen entre la référence et le décès a été de 21,6 mois et l’IMC moyen était de 51,5. La cause de décès la plus fréquente était le cancer, suivi des causes cardiaques et infectieuses.

Conclusion : Cette étude procure des renseignements utiles sur la mortalité et les causes de décès chez les patients en attente d’une chirurgie bariatrique dans notre établissement. Ces résultats permettront de mieux orienter la création d’un système de triage adéquat, compte tenu de la longueur des temps d’attente.

The obesity epidemic is upon us. Approximately two-thirds of North Americans have a body mass index (BMI) above the reference range of 18.5–24.9. In a recent analysis of weight trends in Canadians, there was a 200% increase in obesity (BMI ≥ 30) from 1985 to 2011. The rate of change was greater for each successively higher BMI class. In 2011, 18.3% of Canadians were obese; this percentage is expected to increase to 21% by 2019. In Atlantic Canada, the problem is worse, as shown by an obesity rate...
that is significantly higher than the national average. The medical costs of people with a BMI of 30 or greater have been shown to be 30% greater than those of people with a BMI under 25. In 2006, the direct cost of obesity on the Canadian health care system was approximately $6 billion, which corresponds to 4.1% of total health expenditures. Obesity is also strongly associated with increased risk of death across all age groups, races and sexes. In Canada, 9.3% of deaths were attributable to overweight and obesity in 2000. In a collaborative analysis of 57 prospective studies, each 5 kg/m² increase in BMI was associated with a 30% higher mortality. A BMI of 30–35 was associated with a reduction in median survival of 2–4 years, and this reduction was 8–10 years for a BMI of 40–45. While pharmacologic and lifestyle measures produce modest weight loss, bariatric surgery has been shown to produce a substantial and sustained weight loss as well as improvement or resolution of obesity-related comorbidities. In the Swedish Obese Subjects study, a prospective controlled trial evaluating bariatric surgery in 2010 obese participants compared to usual care in 2037 matched obese controls, the primary end point, mortality, was reduced by 29% in those who received surgery.

The current indications for bariatric surgery are based on the National Institutes of Health (NIH) consensus conference in 1991. The requirements include a BMI of 40 or greater or a BMI of 35 or greater combined with a clinically important comorbidity, such as diabetes, hypertension or dyslipidemia. While there is no formal list of clinically important comorbid conditions, it is sufficient that the patient’s quality of life and overall health is affected. Over time, indications for bariatric surgery have become even more inclusive. In February 2011, the U.S. Food and Drug Administration announced that the Lap-Band, an adjustable gastric band, was approved for use in the United States for patients with a BMI of 30 or more who had an associated comorbidity. The International Diabetes Federation released a position paper in March of 2011 stating that surgery should be considered for patients with a BMI of 30–35 when diabetes cannot be adequately controlled by an optimal medical regimen. With rising obesity rates and loosening eligibility criteria, Canadian provincial health care systems are struggling to handle the surging demand for bariatric surgery.

In 2007, the estimated average Canadian wait time for bariatric surgery was more than 5 years; this estimate was based on 1313 surgeries performed at 12 major Canadian centres. It has been estimated that 5.8% of Canadians — approximately 2 million people — may be eligible for bariatric surgery. Based on data from the Canadian Health Measures Survey, 1.5 million obese Canadian adults met the eligibility criteria for bariatric surgery in 2007–09. Of those, only 0.1% underwent publicly funded bariatric surgery. Accordingly, the number of surgeries being offered in Canada has increased over time, particularly in Quebec and Ontario. Furthermore, a number of private centres offering adjustable gastric banding have been established. In 2009, there were 30 clinics across Canada (18 public and 12 private) and 53 surgeons performing this procedure. It was found that the average wait time for surgery in a private clinic was 1 month and that the average out-of-pocket cost was approximately $16 000. It is uncertain at the present time how many patients are using the private clinics in Canada or paying for surgery in the United States or further abroad, where prices may be considerably different.

As might be expected, patients who are eligible for surgery tend to have higher rates of comorbidities and inferior self-rated mental health and quality of life than ineligible patients. When surveyed, 86% of patients on a wait list for bariatric surgery reported worsening physical symptoms during the wait, and almost half felt that the waiting affected their quality of life. Given that the relative risk of death after bariatric surgery is reduced in as little as 5 years, we may be placing obese individuals at higher risk by delaying surgery. The goal of the present study was to determine how many patients were referred for bariatric surgery at our institution and to estimate an approximate wait time for surgery. Also, recognizing the higher disease burden in this population, we aimed to determine the number and cause of any deaths among patients awaiting bariatric surgery.

**Methods**

As part of a quality assurance effort, we examined patient referrals for bariatric surgery at our tertiary care centre in Halifax, NS, from March 2008 to May 2013. We reviewed the charts of patients who died while waiting for surgery to identify the time of referral for bariatric surgery, the referring physician and his/her specialty, the patient’s age at death, sex, birth date, height, weight, BMI, comorbidities and cause of death. The bariatric surgery eligibility criteria at our centre are based on the NIH consensus conference, and this information was made available to referring physicians through a bariatric surgery referral template. Patients were considered to be on the wait list from the time the referral was received. At a later stage, the surgeon and nurse practitioner further assess the suitability of the patients on the wait list for surgery. The main sources of information were the referral letters, death summaries, death certificates, inpatient progress notes, ambulatory clinic letters and diagnostic test reports. The Department of Vital Statistics provided data on cause of death when this information was not available in the patients’ charts.

**Statistical analysis**

We used the $\chi^2$ test to compare mortality in our cohort to the reported Canadian all-cause mortality.
RESULTS

There were 1399 referrals for evaluation for bariatric surgery between March 2008 and May 2013. Twenty-two deaths were observed in the cohort of patients who were referred. The average age at death was 62.7 (range 32–70) years. Fifty-nine percent of deaths occurred in men. The demographic and clinical characteristics of patients who died are listed in Table 1. The average BMI for the group was 51.5 (range 35.0–64.9). In terms of type of physician generating the referrals, 31% came from endocrinologists, 38% from general practitioners, 23% from other internists and 7.7% from surgeons. The average time from referral to death was 21.6 months.

Figure 1 illustrates the type and frequency of patient comorbidities. The average number of comorbidities per patient was 6.9. The less common comorbidities, such as pancreatitis, renal stones and cholelithiasis, occurred in fewer than 3 patients each, and they are not included in Figure 1.

Information on cause of death was not available for 5 of 22 patients. Overall mortality in our study was 1.57%, which is a significant 3.21-fold increase (p < 0.001) compared with the all-cause, age-standardized mortality of 0.49% reported for Canadians in 2011.20 Figure 2 demonstrates the cause of death by category. The most common cause of death was cancer, occurring in 5 patients (23%); the subtypes were esophageal, breast, lung, melanoma and cancer of unknown primary (presumed pancreatic). Cardiac-related deaths occurred in 4 patients (18%). Three patients died of infectious causes (14%), including 1 patient who died of methicillin-resistant Staphylococcus aureus (MRSA) pneumonia and sepsis, 1 patient who died of MRSA cellulitis and sepsis, and 1 patient who died of sepsis from an infected hip shortly after a total hip replacement. Two patients died from pancreatitis (9%), 2 from respiratory causes (9%) and 1 from renal disease (5%).

DISCUSSION

This case series examined the number of deaths that occurred in our cohort of patients referred for bariatric surgery. Of the 1399 referrals received, 22 deaths occurred before the patients received bariatric surgery. This mortality of 1.57% is 3-fold higher than in the age-standardized general population. From this data, we were able to estimate an approximate wait time for surgery from the time of referral. Given the current rate of 80 laparoscopic sleeve gastrectomies performed per year at our centre and 1399 referrals, it would take approximately 17.5 years to handle the current volume, assuming no further referrals are received. Granted that not all patients referred for bariatric surgery are appropriate candidates, this figure is nonetheless well above the national wait time of 5.2 years described in 2007.14

As one might expect, Canadian patients awaiting bariatric surgery describe the experience as stressful, anxiety-provoking and frustrating, with many expressing anger toward the health care system.21 At present, there is no universally accepted and judicious approach to triaging patients for bariatric surgery. In a recent survey of patients awaiting bariatric surgery, most patients felt that those with more functional impairment and greater clinical severity should have a higher priority on the wait list. Most patients also disagreed with out-of-pocket payment for faster access to bariatric surgery.22 The aim of our study was to identify the causes of death in this population to gain a better understanding of who is at highest risk.

Table 1. Patient demographic and clinical characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Mean (range)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of deaths</td>
<td>22</td>
</tr>
<tr>
<td>Sex, male:female</td>
<td>13:9</td>
</tr>
<tr>
<td>Age at death, yr</td>
<td>62.7 (32–70)</td>
</tr>
<tr>
<td>Body mass index</td>
<td>51.5 (35.0–64.9)</td>
</tr>
<tr>
<td>Average time from referral to death, mo</td>
<td>21.6</td>
</tr>
</tbody>
</table>

*Unless otherwise indicated.

Fig. 1. The comorbidities of the 22 deceased patients in our series. Less common comorbidities (n < 3) are not shown. “Vascular” includes coronary artery disease, peripheral vascular disease and stroke. “Respiratory” includes obstructive sleep apnea, asthma and obesity hypoventilation syndrome. CKD = chronic kidney disease; GERD = gastresophageal reflux disease.

Fig. 2. Cause of death among patients in our series. The number of cases for each cause of death category is shown. The cause of death could not be determined in 5 patients.
A 2009 study by Christou and Efthimiou examined the bariatric surgery wait list at another Canadian centre. The patients who died on their wait list were similar to our own cohort in terms of the average age, BMI, sex ratio and number of comorbidities. In our cohort, the 3 primary causes of death were cancer, cardiac death and infection. The cancer-related deaths were from metastatic breast, melanoma, lung, esophageal as well as a cancer of unknown primary that was presumed on autopsy to be pancreatic cancer. According to the chart and referral, none of the cancers was present at the time of enrolment onto the wait list. From a large prospective study involving more than 500,000 adults in the United States, it has been estimated that overweight and obesity account for 14% of all cancer deaths in men and 20% of all cancer deaths in women. The Prospective Studies Collaboration found that for each 5 kg/m² increase in BMI above the reference range there was an associated 10% increase in cancer-related mortality. The specific cancer sites with the highest rates were liver, breast, colon, endometrium, kidney and prostate. The authors also reported a 39% higher incidence in mortality from ischemic heart disease for each 5 kg/m² increase in BMI above the reference range. In our study, the infection-related deaths were from sepsis resulting from pneumonia, cellulitis and surgical site infection following hip replacement. Obesity is considered to be a state of chronic inflammation and has been shown to negatively impact host defence and immune function. Not only is there a higher risk of skin infections and cellulitis in general, but the risk of surgical site infection is increased up to 5-fold in obese individuals, although this increase may correlate more closely with percent body fat than BMI.

This study highlights the characteristics of patients who died after referral for bariatric surgery, demonstrating a 3-fold higher mortality than in the general population. Our results allow us to understand the number and types of comorbidities as well as the increased frequency of cancer, cardiac and infectious causes of death in this population. Future studies will be focused on identifying how this cohort of deceased patients compares to the remainder of the referred patients at our centre. Given the limited resources and the trends in obesity, we wish to focus attention on issues of wait list management. Our objectives are to develop an equitable strategy to better triage this vulnerable population for bariatric surgery.

Affiliations: From the Departments of Internal Medicine, Division of Endocrinology and Metabolism (Lakoff, Ransom) and General Surgery (Ellmere), Dalhousie University, Halifax, NS

Competing interests: None declared.

Contributors: All authors designed the study and analyzed the data, which J. Lakoff acquired. J. Lakoff wrote the article, which all authors reviewed and approved for publication.

References


The evolution of trauma surgery at a high-volume Canadian centre: implications for public health, prevention, clinical care, education and recruitment

Chad G. Ball, MD, MSc
Debanjana Das, MD
Derek J. Roberts, MD
Christine Vis, RN
Andrew W. Kirkpatrick, MD, MSc
John B. Kortbeek, MD

This manuscript was presented at the Trauma Association of Canada (TAC) scientific conference on Apr. 12, 2013, in Whistler, BC.

Accepted for publication June 18, 2014

Early-released Dec. 1, 2014

Correspondence to:
C.G. Ball
Department of Surgery
University of Calgary
Foothills Medical Centre
1403-29th St. NW
Calgary AB T2N 2T9
Ball.Chad@gmail.com

DOI: 10.1503/cjs.001314

Background: Trauma centres continue to evolve with respect to clinical care and their impact on public health. Despite improvements in patient outcomes, operative volumes, and therefore maintenance of surgical skills, has become a challenging issue. We sought to determine whether injury demographics and treatments at a high-volume centre changed over time.

Methods: We used the Alberta Trauma Registry to analyze all severely injured (injury severity score [ISS] ≥ 12) patient admissions over a 16-year period (1995–2011).

Results: Of the 12 879 severely injured patients requiring admission, there was a 1.5-fold increase in the annual admission rate despite population normalization (p = 0.001). Over the 16-year interval, patients were older with a subsequent lower mortality (p = 0.001) and length of hospital stay (p = 0.007). In patients with the most severe ISS (≥ 48), there was no change in mortality (27%, p = 0.26). In 2011, falls were the most common mechanism compared with motor vehicle crashes (41% v. 23%; p < 0.001); this was a complete reversal compared with 1995 (25% v. 41%). Motorized recreational vehicle and motorcycle injuries also increased (p < 0.001). The mean number of operations performed by trauma surgeons decreased (laparotomies: 67 [17%] in 1995 v. 47 [5%] in 2011, p < 0.001). Thoracotomies and tracheotomies remained unchanged (p = 0.19).

Conclusion: Clinical care has improved despite an increasing overall volume of severely injured patient admissions. The number of operative interventions performed by trauma surgeons continues to decrease concurrent to a change in injury mechanisms. Despite these improvements, maintenance of technical skills among trauma surgeons has become an important issue.

Contexte : Les centres de traumatologie continuent d’évoluer au plan des soins cliniques et de leur impact sur la santé publique. Malgré certaines améliorations, les résultats pour les patients, le volume opératoire et par conséquent, le maintien des habiletés chirurgicales sont devenus un enjeu délicat. Nous avons voulu déterminer si les caractéristiques démographiques et les traitements en traumatologie ont évolué avec le temps dans un centre qui traite un volume élevé de cas.


Résultats : Chez les 12 879 grands blessés ayant dû être hospitalisés, nous avons noté une augmentation selon un facteur de 1,5 du taux annuel d’admissions, malgré une normalisation de la population (p = 0,001). Au cours de cet intervalle de 16 ans, les patients ont graduellement été plus âgés, et la mortalité (p = 0,001) et la durée des séjours hospitaliers (p = 0,007) ont subéquemment diminué. Chez les patients présentant les IGB les plus élevés (≥ 48), on n’a noté aucun changement de la mortalité (27 %, p = 0,26). En 2011, les chutes ont été la cause la plus fréquente des traumatismes, par rapport aux accidents de la route (41 % c. 23 %, p < 0,001), ce qui s’est révélé être un renversement complet par rapport à 1995 (25 % c. 41 %). Le nombre de blessures subies avec des véhicules motorisés récréatifs et des motocyclettes a aussi augmenté (p < 0,001). Le nombre moyen d’interventions effectuées par les chirurgiens en traumatologie a diminué (laparotomies : 67 [17 %] en 1995 v. 47 [5 %] en 2011, p < 0,001). Le nombre de thoracotomies et de trachéotomies est resté inchangé (p = 0,19).

Conclusion : Les soins cliniques se sont améliorés malgré l’augmentation du volume global d’hospitalisations de patients grièvement blessés. Le nombre d’interventions chirurgicales effectuées par les chirurgiens en traumatologie continue de diminuer parallèlement à une évolution des causes de traumatismes. Malgré ces améliorations, le maintien des habiletés techniques des chirurgiens en traumatologie est devenu un enjeu important.
Ver the past 16 years, important advances in the care of injured patients have occurred. These include, but are not limited to, the development of regionalized trauma referral centres,1,2 recruitment of trauma fellowship-trained surgeons (trauma team leaders [TTLs]), integration of trauma nurse specialists, improvements in the fidelity of diagnostic imaging,3–5 evolution of hybrid/RAPTOR treatment suites6 and numerous clinical advances, such as percutaneous techniques for arresting ongoing hemorrhage and repairing vascular structures,7 damage control resuscitation,8 nonoperative therapies for solid organ injuries and improved methodologies for achieving same-hospital-stay abdominal fascial closure. This list does not even begin to reflect additional updates in the field of surgical critical care.

Despite a perceived reduction in operative caseloads over time, clinicians at many high-volume centres believe they are receiving an ever increasing total volume of referrals with a subsequent improved survival rate for patients in the most severely injured subgroup. The development of acute care surgery (ACS) in the United States,9 and therefore the acquisition of additional nontrauma operative cases, has been a reflection of both this overall reduction in operative case volumes for faculty and trainees alike and of the challenge to recruit the best residents to the field of trauma surgery itself. Although most ACS services in Canada do not currently incorporate the care of injured patients (i.e., limited to all nontrauma surgical emergencies),10 the issues of faculty operative/technical skill maintenance and resident trainee career choices remain very relevant. Similarly, public health ventures, such as prevention programs, require reflection upon changing injury mechanisms, clinical care and overall volumes.

The aim of our study was to determine how injury demographics and treatment spectrum at a high-volume centre have evolved over time (i.e., volume, severity, length of stay, therapies).

**Methods**

**Study population and data sources**

We analyzed aggregated population-level data from the Alberta Trauma Registry over a 16-year period (1995–2011). This registry has been previously validated for accuracy.11 The study population consisted of all adults (age ≥ 16 yr) admitted to the Foothills Medical Centre (FMC) after major trauma (injury severity score [ISS] ≥ 12) during the study period. The FMC is a university-affiliated, level 1 trauma centre that provides tertiary care services to all of southern Alberta, southeast British Columbia and southwest Saskatchewan.

**Statistical analysis**

Using the Alberta Trauma Registry, standard trauma admission (FMC) and treatment epidemiology as well as outcomes data were collected and evaluated. Count data were summarized as frequencies or proportions. A combination of descriptive statistics with linear regression adjusted per year were used to analyze the data. We considered 2-sided \( p \) values < 0.05 to represent statistical significance for all evaluations. Two-way scatter plots with overlayed least squares regression fit linear lines were used to illustrate the temporal changes over time. All statistical testing was performed using Stata/IC version 12.0 (Stata Corp.).

**Results**

**Patient, injury and transport demographics**

Over the 16-year study period, among a mean population of 1.1 million people residing in the City of Calgary (2.4 million in the FMC catchment area), 12 879 patients with severe injuries were admitted to the FMC (median 827 patients/yr). When normalized by regional population increases, FMC trauma admissions were observed to have increased 1.5-fold over these 16 years. In comparison to 402 admissions in 1995, the trauma service peaked at 1118 admissions in 2008 (\( p = 0.001 \); Fig. 1).

Patients were on average older (mean 44 yr) at the end of the 16-year interval (41 yr in 1995 v. 49 yr in 2011, \( p < 0.001 \); Fig. 2). The average ISS remained unchanged (mean 25, \( p = 0.84 \)) except in patients undergoing a laparotomy (28 in 1995 v. 35 in 2011, \( p = 0.011 \)). Similarly, the percentage of patients presenting to the FMC with hypotension (systolic blood pressure ≤ 90 mm Hg) remained constant over the study interval (mean 6.1%, \( p = 0.44 \)).

The time of admission to the FMC was also unchanged (03:23, \( p = 0.53 \)). The mode of transport remained consistent (74% via ground ambulance, 16% via helicopter, 5% via fixed wing, 5% via walk-in/private vehicle; \( p = 0.39 \)). The number of patients presenting with injuries that occurred at the workplace was also stable (5%/yr, \( p = 0.59 \)). The specific type of injuries did not change over the study interval (\( p = 0.44 \)).
Mechanism of injury

The mechanism of severe injury changed dramatically over the study period. While motor vehicle crashes (MVCs) were the most common cause in 1995 (41%), this decreased by almost half by 2011 (23%, \( p < 0.001 \); Fig. 3). Conversely, falls nearly doubled in frequency (25% in 1995 v. 41% in 2011) to become the most common mechanism of injury (\( p < 0.001 \); Fig. 3). Motorized recreational vehicle (e.g., all-terrain vehicles [ATVs], dirt bikes, snowmobiles) injuries (1% in 1995 v. 4% in 2011, \( p < 0.001 \)) and motorcycle injuries (3% in 1995 v. 8% in 2011, \( p < 0.001 \)) increased significantly. The frequency of penetrating (e.g., gunshots, stab wounds) injuries remained stable (mean 4%/yr, \( p = 0.24 \)).

Operative interventions

The mean number of operative interventions for the trauma service decreased significantly over the study interval. The rate of laparotomies decreased from 67 (17%) in 1995 to 47 (5%) in 2011 (\( p < 0.001 \); Fig. 4). Thoracotomy and tracheostomy procedures remained unchanged (12/yr and 67/yr, respectively; \( p = 0.19 \)).

Outcome measures

The mean length of stay in hospital decreased significantly over the study interval (17 d in 1995 v. 13 d in 2011, \( p = 0.007 \)); however, length of stay in the intensive care unit (ICU) remained unchanged (3 d in 1995 v. 2 d in 2011, \( p = 0.14 \)). Among all injured patients, the majority (mean 67%/yr) were discharged home. Most of the remaining patients were transferred to a rehabilitation (14%) or acute care (13%) facility. This ratio remained unchanged over the study interval (\( p = 0.49 \)). Mortality among the study population decreased (15% in 1995 v. 11% in 2011, \( p = 0.001 \)). In patients with a high ISS (\( \geq 48 \)), there was no change in mortality over the study interval (mean 27%, \( p = 0.26 \)). The specific rate varied by surgeon. Mortality among patients undergoing a laparotomy also increased over time (17% in 1995 v. 21% in 2011, \( p = 0.024 \)).

Discussion

From 1995 to 2011, 12 879 severely injured patients were admitted to the trauma service at the FMC. The year-specific volumes increased in nearly a linear manner to a peak admission total observed in 2008. Although this increase in volume is partially reflective of an absolute increase in the local population, when normalized for regional population changes, the observed 1.5-fold increase remains indicative of concurrent influences. Given the lack of any additional level 1 trauma centres in the region, in addition to a policy of absolute acceptance of all injured patients (regardless of inpatient bed status or service patient volume), we believe that this increase in volume is most reflective of a more complete catchment of injured patients in a large heterogeneous geographic region.
In addition to an increase in overall volume, patients were also significantly older. With a mean age approaching 50 years, patients now present with more comorbidities and a diminished physiologic reserve in scenarios of critical illness,\textsuperscript{12–14} Although our registry has been historically poor at documenting preinjury health issues, anecdotal experience clearly indicates that we are caring for an older, sicker populace of severely injured patients.\textsuperscript{13,14} This observation, in addition to the challenges of caring for this population, have been documented in numerous publications throughout North America.\textsuperscript{12,15}

The advancing patient age is also likely reflected in the massive increase in the number of severely injured patients admitted after falls. This single mechanism is now the most common etiology for admission by a substantial volume. Conversely, the proportion of MVC-related admissions has decreased substantially over the past 16 years. This evolution most likely reflects the population-based public health benefits from improvements in both motor vehicle and civil engineering as well as from injury prevention legislation. Interestingly, a notable increase in motorized recreational vehicle (ATVs, motorcycles) trauma was also identified. As previously outlined, we believe this is likely a reflection of increased disposable income in an area of economic affluence.\textsuperscript{16} Active public health program measures for both fall prevention and recreational vehicle safety are now underway at our centre (media and legislation).

Despite the increasing age of injured patients, both the overall length of stay in hospital and mortality decreased significantly over the study interval. When taking into account the stability in the proportion of patients presenting with hypotension and in their associated ISS, prehospital transport and discharge destination, the noted improvement in mortality is likely secondary to improved volume outcomes within the trauma centre itself. This includes, but is not limited to, increased frequency of nonoperative therapies, increased expertise in trauma-specialized nursing and critical care as well as in rehabilitation therapy and system processes. It was interesting to note that there appeared to be no improvement in mortality among the most critically ill patients (ISS ≥ 48). This score represents the most severely injured subgroup in any trauma system and is arguably a measure of trauma surgeon/TTL performance at the most sensitive and critical time points.

Although trauma surgeons cared for more injured patients per year, the overall number of operative interventions decreased dramatically over the study period. More specifically, the number of laparotomies showed a relative reduction of 70% to approximately 5% of all trauma admissions. This observation represents a significant improvement in patient care and follows evidence-based guidelines consistent with the proliferation of nonoperative therapies. While other types of operative cases (e.g., thoracotomy, tracheostomy) remained stable, this significant decrease in operative experience among trauma surgeons represents a sensitive skill maintenance issue. More specifically, trauma surgeons are required to perform potentially complex operative therapies in physiologically challenged patients on an increasingly occasional basis. Although clinicians may practise preoperative decision-making via simulators and triage scenarios, actual operative technique and rapid intraoperative decision-making relies on limited preceding exposure and maintenance of advanced technical skills (i.e., elective practices).\textsuperscript{17,18} This issue is also highlighted by the observation that both the mean ISS and mortality of patients who required a laparotomy increased over time. The issue of limited ongoing experience is also apparent to trainees who have increasingly deflected away from making career choices to become trauma surgeons.\textsuperscript{19} These 2 dominant issues (operative case load and skill maintenance) have been significant factors in the development of ACS services in the United States.\textsuperscript{8,18–20} In Canada, one can make a similar argument that in centres where ACS is not directly integrated with the trauma service owing to volume concerns (most centres), maintenance of skills must be maintained by active involvement in a critical threshold of ACS service weeks and complex cases. The exception to this principle may potentially occur when an atypical trauma surgeon of note has a large, complex intra-abdominal elective practice.

**Limitations**

Our study has important limitations. First, as a result of the aggregated or ecological nature of the data, our results can only be interpreted as associations on a population level and, therefore, not causative at the individual level. Second, although we observed a decrease in mortality, specific assertions as to causal relationships cannot be reliably confirmed. Third, we cannot accurately comment on the impact of alcohol consumption over the study interval. In a recent study\textsuperscript{21} only 63% of our patients were tested. Of these, 30% had a blood alcohol level above the legal limit. It is unclear if this rate has changed over time. Finally, although the data trends support anecdotal concerns for recruitment and operative skill maintenance, there is no direct evidence available at the present time to confirm these possibilities. A national manpower analysis is currently underway by our group to better understand these issues.

**CONCLUSION**

Despite an increasing overall volume of severely injured patient admissions, the number of operative interventions performed by trauma surgeons has decreased substantially. This represents a potential issue with regard to both the maintenance of technical skills and to the recruitment of high-quality residents to the field itself. With the continued advancement of percutaneous and nonoperative therapies, these issues may become even more problematic. A strong association between trauma and ACS services (regardless of
whether their actual delivery is distinct or combined) will offer benefits with regard to both of these challenges. From an overall trauma system point of view, however, the quality of patient care has improved within the setting of increased patient volumes and age as well as comorbidities and changes in mechanism of injury. Future public health prevention strategies should reflect the increased prevalence of costly falls and recreational vehicle injuries.

Affiliations: From the Departments of Surgery (Ball, Das, Roberts, Kirkpatrick, Kortbeek), Regional Trauma Services (Ball, Vis, Kirkpatrick, Kortbeek), and Critical Care Medicine (Kortbeek), University of Calgary and the Foothills Medical Centre, Calgary, Alta.

Competing interests: None declared.

Contributors: C. Ball, D. Das and D. Roberts designed the study. C. Ball, D. Das and C. Vis acquired the data, which C. Ball, D. Das, D. Roberts, A. Kirkpatrick and J. Kortbeek analyzed. C. Ball, D. Das and C. Vis acquired the data, which C. Ball, D. Das.

References
Tension plate for treatment of olecranon fractures: new surgical technique and case series study

Background: Our aim was to determine the effectiveness of a new surgical technique for olecranon fractures using a tension plate (TP) designed by the operating surgeon.

Methods: We included patients with olecranon fractures treated between September 2010 and August 2013 in our study. Treatment involved a new implant and operative technique, which combined the most favourable characteristics of 2 frequently used methods, tension band wiring and plate osteosynthesis, while eliminating their shortcomings. The new method was based on the newly constructed implant.

Results: Twenty patients participated in our study. We obtained the following functional results with our TP: median flexion 147.5° (interquartile range [IQR] 130°–155°), median extension 135°/deficit 10° (IQR 135°–145°), median pronation 90° (IQR 81.3°–90°), median supination 90° (IQR 80°–90°). Implant-related complications were noted in 1 patient, and implants were removed in 3 patients. The mean functional Mayo elbow performance score was 94.8 (range 65–100). The removal of the implant was considerably less frequent in patients operated using the new method and implant than in patients operated using conventional methods at our institution (p < 0.001). Mean duration of follow-up was 8 months.

Conclusion: Our TP for the treatment of olecranon fractures is safe and effective. Functional results are very good, with significantly decreased postoperative inconveniences and need to remove the implant. Less osteosynthetic material was used for TP construction, but stability was preserved.
Olecranon fractures account for 10% of all fractures of the upper extremities. These fractures occur in cases of direct hit in the elbow region or of a pull of the triceps brachii muscle through its distal attachment site on the olecranon during a fall on a partially stretched arm. Only 5%–7% of these fractures occur without substantial displacement of fractured fragments, while more than 93% include fragment dislocation that requires active surgical intervention. Given that these are intra-articular fractures, it is very important to achieve precise anatomic fragment reduction and stable osteosynthesis and to start with early mobilization and physical therapy. Nowadays a number of operative methods are used; 2 of the most frequent are tension band wiring and osteosynthesis with a plate and screws. The method of tension band wiring is the most frequently used method of surgical treatment in cases of olecranon fractures. Despite maximal care, precision of surgical work and the expertise of the surgeon, up to 60% of patients experience varying degrees of migration and protrusion of the osteosynthetic material and associated pain, personal unease and slow rehabilitation with reduced mobility. The second most frequently used operative technique is osteosynthesis with conventional plate and screws. It has been suggested that using this method to treat comminutive and/unstable fractures (Mayo classification II B and III A and B), for which the use of tension band wiring is not advisable, reduces the frequency of complications related to the migration of osteosynthetic material and the associated pain and unease. Yet, the use of a large number of screws to achieve stability increases the probability of subcutaneous protrusion of screw heads (more pronounced subjective hardships and the need for earlier removal of the implant) and increases the possibility of tissue reaction against the considerable quantity of foreign objects implanted during the operation. The purpose of our study was to determine the effectiveness of a new technique of surgical treatment for olecranon fractures using a new tension plate (TP) designed by the operating surgeon (B.L.).

**Methods**

**Patients**

We recruited patients presenting to the department of surgery, Split University Hospital Centre, Split, Croatia, for the surgical treatment of olecranon fractures between September 2010 and August 2013. Inclusion criteria were Mayo classification II–III olecranon fractures as well as fractures of the proximal ulna involving the region up to 3 cm distal to the trochlear notch. Exclusion criteria were pre-existing injuries of the elbow, distal brachial or proximal antebrachial region, pre-existing neurologic damage or illness of the arm involved, congenital deformities or diseases of the musculoskeletal system and systemic neurologic conditions.

Patients underwent the new surgical technique and received the newly developed implant (TP). The same surgeon (B.L.) performed all the operations. We compared the incidence of implant removal in the present cohort with that in 49 patients who had surgery using the conventional techniques, mostly tension band wiring, at our hospital between April 2006 and November 2012 (control group). We obtained informed consent from all patients, and the study protocol was approved by the Ethical Committee of Split University Hospital Centre.

**Outcome measures**

The primary aim of our study was to achieve adequate functional results (i.e., not worse than results of tension band wiring or conventional plating), with reduced difficulties related to the bulging and migration of osteosynthetic materials. We also aimed to reduce the quantity of inserted osteosynthetic material in relation to the quantity required for conventional plating. The functional range of movement in the operated elbow that we sought to achieve was flexion ≥ 128°, extension ≥ 116°, and pronation and supination ≥ 72°, which corresponds to the average functional status when the current surgical techniques are applied. Our goal was that 40% or more of our patients would have no marked subjective difficulties; this percentage is comparable to that for patients treated with tension band wiring or conventional plating.

**Surgery**

Surgery was performed with the patient in prone position and under general anesthesia and without the application of a tourniquet. The fracture was exposed through a posterior midline incision curving around the tip of the olecranon. In case of more copious bleeding in the olecranon bursa, excision of the bursa was performed. The Kirschner wires were always “anchored” in the opposite (anterior) cortex of the ulna. After radiographic confirmation of the position of the fragments, the TP was introduced on the dorsal (posterior) surface of the ulna (Fig. 1). The TP forms the basis of the new operative technique. This implant has a number of innovations. The existence of 2 holes (diameter 2 mm) on the proximal part enables application of the Kirschner wires (diameter 1.8 mm) through the implant. The tip of the hook is narrower and shorter; the base width of the tip is 5 mm, it has a steep angle of 35°, and the base-to-tip length is 7 mm, allowing easier penetration in the bony structure of the olecranon without disturbing previously achieved fragment reduction. The curve of the plate is contoured according to the shape of the olecranon, and the body of the plate is slightly curved in a tubular manner, with the total length of the...
plate measuring 82 mm, allowing it to be used in most cases of olecranon and proximal ulnar fractures. There is an opening for the distal “guiding” screw used to achieve interfragmentary compression. Finally there is only 1 hole (centered 6 mm proximal to the end of the plate) through which the distal screw fastens the plate onto the ulna (Fig. 2). Drainage of the operation area was regularly performed, with the drain usually being removed after 24 hours. Postoperative immobilization was never used.

Follow-up

Obligatory radiological and clinical follow-ups were carried out 1, 3 and 6 months after the surgery. During these visits, we obtained anteroposterior and lateral radiographs of the operated elbow (Fig. 3). Classical goniometry was used to evaluate postoperative range of motion of the injured and healthy elbow joints. We assessed the function of the extremity by measuring the range of flexion, extension, pronation and supination of the forearm, and we compared these values with those for the uninjured extremity of the same patient and with the reference values in literature to assess the success of the operative method and of the implant applied. Approximately 6 months after the surgery, the patients were interviewed about their general impression and their possible difficulties (hardships present or not); in the presence of hardships we tried to assess them quantitatively (mild, moderate, intense). For this investigation we used the Mayo elbow performance score questionnaire, which takes into consideration objective (range of motion, stability of the joint) as well as subjective (existence and intensity of pain, daily functions of the joint) parameters for the appraisal of joint function.

Statistical analysis

We analyzed the data using Microsoft Excel version 11.0 for Windows. The normality of the distribution of continuous variables was tested using the Shapiro–Wilk test. Medians and interquartile ranges (IQRs) were used as measures of central tendency and variability when the distribution significantly deviated from normal. We used the χ² test to analyze the significance of between-group differences in frequency of categorical variables, and the φ coefficient of association was used as the standardized measure of effect size in case of statistically significant differences. Group difference is continuous, but variables that were not normally distributed were analyzed using the Mann–Whitney U test. The Shapiro–Wilk test did not indicate a significant difference in age distribution, so means and standard deviations were used as measures of central tendency and variability. To make our results more comparable to those from other studies (for the sake of possible future meta-analysis), we used means with 95% confidence intervals (CIs) for comparison with noninferiority margins. We considered results to be significant at $p < 0.05$. 

Fig. 1. Intraoperative placement of the tension plate.

Fig. 2. Tension plate (A) holes for distal "guiding" and for distal screw, and (B) 2 holes enabling application of the Kirschner wires.
Results

A total of 26 patients were surgically treated for olecranon fractures during our study period. Six of them were excluded: 4 patients met 1 or more exclusion criteria and 2 refused to participate. Our final sample comprised 20 patients (10 men and 10 women) with a mean age of 49.2 (range 19–84) years. Ten patients had fractured the left and 10 had fractured the right olecranon. Fourteen patients had Mayo classification IIA, 4 had IIB and 1 had IIIB fractures; the remaining patient had a Monteggia fracture on the ulna just distal to the trochlear notch. Patient demographic and clinical characteristics are summarized in Table 1. The mean duration of follow-up was 8 (range 3–24) months.

In case of all functional tests, maximum values were at the level of physiologic maximum. The average time required for fractures to heal was 9 (range 8–14) weeks. The best results were obtained for pronation and supination, for which mean values were close to and median values were at the level of physiologic maximum. Mean flexion was above the noninferiority margin, while its lower limit was only 0.1° below the noninferiority margin. For all other functional test results, the lower limits of the CIs were above the noninferiority margin (Tables 2 and 3). To examine further functional test results, we determined the proportion of patients whose functional test results were at or above the noninferiority margin (functional loss of ≤ 20%; Table 4). Proportions of patients whose functional test results were at the levels of physiologic maximums were also determined. The mean functional Mayo elbow performance score was 94.8 (range 65–100). None of the patients had extension deficit of more than 20%, and 7 of 20 had no extension deficit at all (35.0%, 95% CI 12.1%–57.9%). Complete recovery of pronation and supination was achieved in 14 of 20 patients (70.0%, 95% CI 48.0%–92.0%). Three patients reported subjective problems (15.0%, 95% CI 0.0%–32.2%). In the postoperative period, 1 patient experienced a surgical site infection. In another patient with an accompanying comminutive fracture of the coronoid, a hypertrophic callus developed in the coronoid region, and extensive ectopic calcifications in the joint region were observed. Although these changes had no direct influence on the successful healing of the olecranon fracture, the final functional outcome was compromised, so we decided to remove the implant. One patient reported typical objective and subjective symptoms of the migration of osteosynthetic material, and after the implant removal he achieved a satisfactory functional result. We compared the prevalence of implant extraction in this cohort with that in our control group. In the control group, 23 of 49 patients (46.9%) were men, 28 of 49 (57.1%) had a left elbow injury, and the median age was 47 (IQR 29–62) years. The implants were removed in 3 patients who underwent the new operative treatment, while hardware was extracted in 31 patients in the control group (Table 5). Implant extraction was significantly less prevalent in patients from the present series than in the control group (p < 0.001).

Fig. 3. Radiographs of a patient with a Monteggia fracture: (A) preoperative radiograph, (B) lateral radiograph 3 months after the surgery, and (C) anteroposterior radiograph 3 months after the surgery.


**Discussion**

The aim of operative treatment for olecranon fractures is to establish normal anatomy and function in the elbow joint in such a way that the newly established regular intra-articular and extra-articular relations are stably fixed. This enables early mobilization of the elbow involved, thus contributing to a decrease of posttraumatic stiffness of the joint. There are a number of methods to achieve this; among them, the most frequently used are tension band wiring and the conventional plating method. The most widely adopted method of tension band wiring achieves healing by transforming the posterior pulling force (created by the triceps muscle during contraction) into an anterior intra-articular interfragmentary compression on the joint surface. The usual complications of this method are infections, delayed healing, fracture healing in an unfavourable position and, somewhat less frequently, ulnar nerve palsy. However, the most frequent complication is a migration of the Kirschner wires and subcutaneous protrusion of knots on the tension band wiring, which causes pain, weakened function, interruption in physical therapy and problems with the healing of the surgical wound. Although the fracture healing and functional results are usually satisfactory, the frequent difficulties experienced by the patients, most commonly caused by the migration of the osteosynthetic material, substantially compromise this method and lead to an additional operation to remove the implant. With the conventional olecranon plate, these disturbances are usually accompanied by an intense local reaction due to the use of a substantial quantity of osteosynthetic material (especially the use of many screws), which also causes a feeling of unease and often leads to the subsequent removal of the implant. For osteosynthesis with plate and screws, somewhat more frequent is a secondary dislocation of the proximal fragment with the loss of correct intra-articular relations.

With this information in mind, our aim was to achieve a state of adequate reposition, stable fixation and interfragmentary compression, together with reduction of difficulties caused by subsequent migration of the implant, which could lead to another operation for removal of osteosynthetic material, by introducing innovation in the construction of the implant as well as in operative technique. We regularly penetrated Kirschner wires into the opposite cortex of the ulna, since our earlier experience was in agreement with that reported in studies by Mullett and colleagues and Huang and colleagues. These studies showed that this procedure almost doubles the firmness of the construction itself. In the present study, we observed no secondary loss of the reposition of the proximal fragment, which was held in position by 3 pivotal points (the tip of the TP plate and 2 Kirschner wires). The absence of postoperative dislocation of the fragments is especially important when one bears in mind that postoperative immobilization was never used (except the standard bandaging material during the first 24 h after the surgery), although the use of a removable splint is widely adopted manner of aftercare in similar fracture cases. In addition, there were no signs of a postponed or delayed healing process, nor of late dislocation of the fragments. Since we considered the olecranon bursa to be a sort of natural “buffer zone” between the olecranon and the support on which the patient rested the elbow, we removed it only in cases of a marked haemorrhage into the bursa or of penetrating injuries with the penetration channel passing through the bursa itself. However, the results of our study indicate the somewhat exaggerated importance of the bursa in mechanical protection of the elbow; of the 5 patients in whom we had to remove the olecranon bursa during the operation, only 1 experienced mechanical irritation from the osteosynthetic material when resting the elbow on a solid support. On the contrary, the only patient who reported subjective difficulties caused by the migration of the osteosynthetic material had an intact bursa.

<table>
<thead>
<tr>
<th>Table 1. Demographic and clinical characteristics of the study cohort (n = 20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
</tr>
<tr>
<td><strong>Sex</strong></td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td><strong>Fracture type</strong></td>
</tr>
<tr>
<td>IIA</td>
</tr>
<tr>
<td>IIB</td>
</tr>
<tr>
<td>Monteggia</td>
</tr>
<tr>
<td><strong>Side</strong></td>
</tr>
<tr>
<td>Left</td>
</tr>
<tr>
<td>Right</td>
</tr>
<tr>
<td><strong>Bursa removed</strong></td>
</tr>
<tr>
<td>15 (75)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 2. Results of functional tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Result</td>
</tr>
<tr>
<td>Flexion</td>
</tr>
<tr>
<td>Extension</td>
</tr>
<tr>
<td>Pronation</td>
</tr>
<tr>
<td>Supination</td>
</tr>
</tbody>
</table>

CI = confidence interval; IQR = interquartile range; SD = standard deviation.
Given the results of bone grafting reported by Cervera-Irimia and colleagues, who reported a considerably higher frequency of subjective difficulties in 58 patients with surgically treated olecranon fractures (before their implant was removed). We compared the functional results of the present cohort with those reported by Rommens and colleagues; who reported an average healing time of 10 weeks for comminuted olecranon fractures. We compared the functional results of the present cohort with those reported by Rommens and colleagues in patients with comminuted fractures, we considered doing the same in 3 patients with significant comminution but opted against bone grafting as the degree of comminution in our patients was not sufficient to warrant this procedure. Erturer and colleagues reported in the literature. Oh and colleagues reported an average healing time of 10 weeks, which is in accordance with the results reported in the literature. Oh and colleagues reported an average healing time of 10 weeks for comminuted olecranon fractures (before their implant was removed).

## Table 3. Results of functional tests: physiologic maximums, noninferiority margins and median values of obtained results

<table>
<thead>
<tr>
<th>Result</th>
<th>Physiologic maximum</th>
<th>Noninferiority margin</th>
<th>Median (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexion</td>
<td>160</td>
<td>128</td>
<td>147.5 (130.0–155.0)</td>
</tr>
<tr>
<td>Extension</td>
<td>145</td>
<td>116</td>
<td>135.0 (135.0–145.0)</td>
</tr>
<tr>
<td>Pronation</td>
<td>90</td>
<td>72</td>
<td>90.0 (85.0–90.0)</td>
</tr>
<tr>
<td>Supination</td>
<td>90</td>
<td>72</td>
<td>90.0 (80.0–90.0)</td>
</tr>
</tbody>
</table>

CI = confidence interval.

## Table 4. Proportion of patients with functional deficit of 20% or less, and those with no deficit

<table>
<thead>
<tr>
<th>Result</th>
<th>Deficit 20% or less, n = 20</th>
<th>No deficit, n = 20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexion</td>
<td>16 (80.0) [60.8–99.2]</td>
<td>3 (15.0) [0.0–32.2]</td>
</tr>
<tr>
<td>Extension</td>
<td>20 (100.0) [99.8–100.0]</td>
<td>7 (35.0) [12.1–57.9]</td>
</tr>
<tr>
<td>Pronation</td>
<td>18 (90.0) [75.6–100.0]</td>
<td>14 (70.0) [48.0–92.0]</td>
</tr>
<tr>
<td>Supination</td>
<td>18 (90.0) [75.6–100.0]</td>
<td>14 (70.0) [48.0–92.0]</td>
</tr>
</tbody>
</table>

CI = confidence interval.

## Table 5. Operative treatment by sex, side of an injured elbow and implant extraction

<table>
<thead>
<tr>
<th>Variable</th>
<th>New treatment</th>
<th>Conventional surgery</th>
<th>p value*</th>
<th>Effect size†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>10 (50.0)</td>
<td>23 (46.9)</td>
<td>0.82</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>10 (50.0)</td>
<td>26 (53.1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>20 (100)</td>
<td>49 (100)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Side</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left</td>
<td>10 (50.0)</td>
<td>28 (57.1)</td>
<td>0.59</td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td>10 (50.0)</td>
<td>21 (42.9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>20 (100)</td>
<td>49 (100)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extraction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>17 (85.0)</td>
<td>18 (36.7)</td>
<td>&lt; 0.001</td>
<td>0.44</td>
</tr>
<tr>
<td>Yes</td>
<td>3 (15.0)</td>
<td>31 (63.3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>20 (100)</td>
<td>49 (100)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*χ² test. †Standardized measure of effect size; φ coefficient of association.

## Conclusion

Use of a TP for the treatment of olecranon fractures is safe and effective. Functional results are very good, with a significant decrease of postoperative subjective inconveniences and of the need to remove the implant. In addition, less osteosynthetic material is required to achieve a stable construction.

**Affiliations:** From the Departments of Surgery (Luksić, Boschi, Bekavac) and Paediatric Surgery (Juric, Pogorelic), Split University Hospital Centre, Spinciceva, Split, Croatia

**Competing interests:** None declared.
Contributors: B. Lukšić, I. Juric and V. Boschi designed the study. Z. Pogorelic acquired the data, which B. Lukšić, I. Juric and J. Bekavac analyzed. B. Lukšić, I. Juric and Z. Pogorelic wrote the article, which all authors reviewed and approved for publication.

References
Physician level reporting of surgical and pathology performance indicators: a regional study to assess feasibility and impact on quality

Background: There is increased awareness that, to minimize variation in clinician practice and improve quality, performance reporting should be implemented at the provider level. This optimizes physician engagement and creates a sense of professional responsibility for quality and performance measurement at the individual and organizational levels.

Methods: Individual provider level reporting was implemented within a provincial health region involving 56 clinicians (general surgeons, surgical oncologists, urologists and pathologists). The 2 surgical pathology indicators chosen were colorectal cancer (CRC) lymph node retrieval rate and pT2 prostate cancer margin positivity rate. Surgical resections for all prostate and colorectal cancer performed between Jan. 1, 2011, and Mar. 30, 2012, were included. We used a pre- and postsurvey design to obtain physician perceptions and focus groups with program leadership to determine organizational impact.

Results: Survey results showed that respondents felt the data provided in the reports were valid (67%), consistent with expectations (70%), maintained confidentiality (80%) and were not used in a punitive manner (77%). During the study period the pT2 prostate margin positivity rate decreased from 57.1% to 27.5%. For the CRC lymph node retrieval rate indicator, high baseline performance was maintained.

Conclusion: We developed a robust process for providing physicians with confidential, individualized surgical and pathology quality indicator reports. Our results reinforce the importance of individual physician feedback as a strategy for improving and sustaining quality in surgical and diagnostic oncology.

Contexte : On prend de plus en plus conscience que, pour minimiser la variation des pratiques médicales et en améliorer la qualité, il faut instaurer la production de rapports de rendement des fournisseurs de soins. Cette démarche renforce l'engagement des médecins et crée un sentiment de responsabilité professionnelle à l'endroit du contrôle de la qualité et des évaluations de rendement à l'échelle individuelle et organisationnelle.

Méthodes : Une région sanitaire provinciale regroupant 56 médecins (chirurgiens généraux, chirurgiens oncologues, urologues et anatomopathologistes) a instauré la production de rapports individuels pour ses fournisseurs de soins. Les 2 indicateurs retenus dans le cas de l’anatomopathologie chirurgicale ont été le taux d’ablation des ganglions lymphatiques dans le cancer colorectal (CCR) et le taux de positivité des marges dans le cancer de la prostate de stade pT2. Les résections chirurgicales pour tous les cancers de la prostate et colorectaux effectuées entre le 1er janvier 2011 et le 30 mars 2012 ont été incluses. Nous avons utilisé un préquestionnaire et un postquestionnaire pour obtenir la perception des médecins, et des groupes de discussion avec les responsables des programmes pour mesurer l’impact à l’échelle organisationnelle.

Résultats : Selon les réponses aux questionnaires, les participants ont estimé que les données fournies dans les rapports étaient valides (67%), conformes aux attentes (70%) et respectueuses de la confidentialité (80%), et n'avaient pas été utilisées de manière punitive (77%). Durant la période de l'étude, le taux de positivité des marges du cancer de la prostate de stade pT2 est passé de 57,1 % à 27,5 %. Dans le cas de l'autre indicateur, le taux d’ablation des ganglions lymphatiques dans le CCR, on a maintenu le rendement de base élevé.

Conclusion : Nous avons élaboré une marche à suivre rigoureuse pour fournir aux médecins des rapports confidentiels et individuels concernant les indicateurs de qualité chirurgicaux et anatomopathologiques. Nos résultats rappellent l’importance d’une approche individuelle auprès des médecins comme stratégie d’amélioration et de maintien de la qualité en oncologie chirurgicale et diagnostique.
Clinical practice guidelines provide an evidence-based foundation for the delivery of high-quality patient care, monitoring of patient outcomes and minimizing the degree of variation in clinical practices. As quality improvement processes are implemented, it is increasingly appreciated that in order to minimize variation in individual practice, performance reporting must be implemented at the provider level. This optimizes physician engagement and also creates a sense of professional responsibility for quality and performance measurement.

Cancer Care Ontario (CCO), the provincial government’s cancer advisor, is responsible for the organization of cancer care services, creation of treatment guidelines and standards, and monitoring of cancer system performance. The Ontario Cancer Plan, authored by CCO, includes a commitment to improving patient outcomes through high-quality care. One way CCO accomplishes this is by giving detailed information to providers to inform evidence-based quality improvement. To support this, CCO has developed sophisticated and robust information management and information technology processes that collect and analyze data from across the provincial cancer system.

Currently, CCO quality monitoring focuses on system level indicators, providing aggregate quality data for groups of providers. The timely availability of quality data has been used at the regional and hospital level to facilitate dialogue regarding performance as compared with established standards and guidelines and has helped to guide quality improvement. Several systematic reviews were used to guide this study. Davis and colleagues revealed that physicians have limited ability to self-assess and that external means of assessment are useful in promoting optimal practice. Reviews conducted by Grimshaw and colleagues and O’Brien and colleagues demonstrated that the most effective strategies for changing clinician practice were those used in combination with educational outreach, the use of reminders, local opinion leaders and timely feedback. A systematic review on the effects of audit and feedback concluded that feedback is more effective when baseline performance is low, when reports are inclusive of specific targets and when it is provided on a consistent basis. Specific to performance information, Lemire and colleagues state that dissemination of performance data in itself is not sufficient to impact quality and that success depends on the cumulative impact of a multifaceted approach. The importance of providing physicians with timely information about their practices supports the Institute for Healthcare Improvement framework for engaging physicians in quality and safety by encouraging the use of data in a nonpunitive manner to allow for reflection on practice and promotes both system and individual responsibility for quality.

The purpose of our study was to determine whether providing contemporaneous quality data at the provider level is more likely than system level data to result in behavioural change and improved quality. The specific goals of this study were to develop a process for providing confidential individualized surgical and pathology quality indicator reports to physicians, to determine the level of physician acceptance and satisfaction with the reports and to determine the impact of individualized reports on physicians’ practices in terms of quality in cancer surgery and pathological assessment.

**Methods**

**Sample**

All 4 hospitals within a regional health authority in Ontario were included in the project, with the physician sample including all surgeons performing cancer resections for prostate or colorectal cancer (CRC) surgeries ($n = 35$) and all pathologists involved in the pathological interpretation of prostate or CRC surgery ($n = 19$). Surgical resections for all prostate and CRC surgeries performed between Jan. 1, 2011, and Mar. 30, 2012, were included. As this evaluation was undertaken for the purposes of program review quality assurance, ethics review was not required, as stipulated under Article 2.5 of the Canadian Tri-Council Policy Statement on the Ethical Conduct for Research Involving Humans.

**Identification of indicators for reporting**

The 2 surgical-pathology indicators chosen were lymph node retrieval rate in CRC and pT2 prostate cancer (organ confined disease) margin positivity rate (R1 margin status). Both indicators are supported by evidence-based guidelines developed and promoted by CCO, including surgical and pathology recommendations to enhance a standardized approach to surgical and pathology practice. They are also the 2 indicators with which surgeons and pathologists have the most familiarity based on previously released aggregate regional reports. Finally, as they are important data points needed to make decisions about adjuvant therapy, they are good, immediate surrogates for long-term quality, such as disease-free and overall survival.

The CRC lymph node retrieval rate quality indicator is defined as the proportion of CRC resection reports where removal of at least 12 lymph nodes documented in the synoptics pathology report based on the provincial target of 90% of all colon cancer resections having 12 or more nodes examined and reported. This target is consistent with the Commission on Cancer quality measure and endorsed by the National Quality Forum.

The quality indicator for prostate surgery is the percentage of organ confined (pT2) radical prostatectomy cases where the margin was reported as positive, with a provincial target established at less than 25%. This target was established by the content expert members of the Prostate Cancer Surgery and Pathology Expert Panel as a result of extensive review of the literature.
The indicator results were collected by querying a centralized database of cancer pathology synoptic reports. This Pathology Synoptic Reporting (ePath) database contained within the Ontario Cancer Registry enables access to population-based synoptic pathology reports and generation of reports based on unique identifiers, which facilitates timely access to information depicting overall clinical practice and the ability to audit individual case and provider level information.16

Creation of infrastructure

Prior to the launch of the project, each hospital signed a memorandum of understanding that outlined the requirement for the establishment of a surgical pathology oncology quality of care committee (SPOQCC). Each SPOQCC was a subcommittee of the hospital’s quality of care committee or medical advisory committee, depending on the governance structure within the particular hospital. To enable open, honest dialogue and ensure anonymity of the reports, the SPOQCCs functioned under the umbrella of the Quality of Care Information Protection Act (QCIPA). Specific to Ontario, the intent of QCIPA is to support open dialogue regarding quality of care without concern that the information may be used for disciplinary action, legal action or other proceedings.17 While each hospital had autonomous discretion with respect to membership, the recommendation was to include the designated CCO regional lead for surgery; the CCO regional lead for pathology and laboratory medicine; and the individual hospitals’ chief of surgery, chief of pathology, chief of staff and representatives from the departments of pathology and surgery, specifically the divisions of general surgery and urology; and the oncology program directors.

Compilation of hospital report and dissemination to SPOQCC

Cancer Care Ontario provided the regional surgical and pathology leads with a report generated from ePath, specifically the pathology and operative reports for surgical specimens in which fewer than 12 lymph nodes were identified (in patients with CRC) or in which a histologically positive margin was identified (in the case of pT2 prostate cancer). In order to maintain the anonymity and confidentiality of the information, 1 individual (M.B.) who was authorized by the regional vice president of the Cancer Program and who signed a confidentiality agreement was tasked with creating an aggregate report with all physician and patient identifiers removed.

Case review and validation

Suboptimal cases (e.g., those requiring further review) were defined as any pT2 radical prostatectomy specimens having a positive resection margin or colorectal specimens having fewer than 12 nodes within the examined specimen. The admitting history, operative note and pathology report were then collected from the participating hospital. Prior to validation, the reports were redacted of any identifiers (i.e., personal health information, hospital, physician).

The pathology regional lead (D.D.) first reviewed the pathology reports from suboptimal cases to ensure the specimens were handled and reported according to established guidelines and standards. If the pathology lead could not verify that the specimen had been dealt with appropriately, the case was deemed to have a pathology-related deficiency and was not considered for surgical review.

Suboptimal cases that passed the pathology validation step were then forwarded to the surgical regional lead (C.M.) for review. Exclusion criteria for cases removed from the surgical analysis were as follows: colon or rectal resections done for locally recurrent disease (in which the natural lymph node draining basin may have already been removed); palliative resections14 (wherein a radical resection was not indicated or appropriate); rectal resections done after long-course neoadjuvant radiation18–20 (as low lymph node yield is commonly observed in this setting); and resections done on an emergent basis, such as those required for perforation or acute obstruction (as the lack of a preoperative diagnosis or the importance of dealing with the acute critical clinical situation may have precluded a definitive radical resection).

This validation step was essential to produce credible individualized physician quality reports; for example, 22 of 48 flagged suboptimal cases were excluded from the surgeons’ scores because of pathology-related issues or for appropriate clinical reasons. We believe that failure to remove these cases would have negatively impacted the degree of physician confidence and satisfaction with the information contained in the reports.

During the course of the project, workload requirements (e.g., no. of cases reviewed and amount of time required) were documented by each of the regional leads to determine the workload impacts of the validation process.

SPOQCC review

Once all suboptimal cases had been processed and reported appropriately, a hospital-specific aggregate report was generated and forwarded to the respective SPOQCCs for review.

The data contained in the reports were hospital-specific and anonymous; no identifiers (patient or physician) were included. Additional aggregate information was provided to allow for comparison of results to those of other hospitals in the region and to provincial results.

The regional leads presented and reviewed these reports with the SPOQCCs. Once the report was accepted by the committees, individualized reports were then prepared and forwarded to the pathologists and surgeons (Fig. 1).
**Generation of individualized reports**

The individualized report included the total number of cases completed; for cases of colon and rectal cancer, it included the number and percentage of cases that had fewer than 12 lymph nodes harvested, and for prostatectomy specimens, it included the number and percentage of specimens that had a positive resection margin. The report contained data that enabled the physician to compare his/her performance with regional data (therefore allowing comparison with immediate peers) and with the provincial averages. The reports were provided by registered mail or electronically, as per the stated preference of the individual physicians (Fig. 2).

**Stakeholder engagement**

In order to optimize physicians’ understanding of the project, a multipronged stakeholder engagement strategy was used. Prior to implementation, the regional leads for surgical oncology and pathology made presentations to physician groups (e.g., surgeons, pathologists, urologists) at each of the hospital sites. In addition, presentations were made at all of the medical advisory committees, quality of care committees and senior leadership committees. The intent of the presentations was to provide information about the project (e.g., intent, process) and address any concerns regarding confidentiality.

**Assessment of physicians’ perceptions**

In addition to the education sessions, all physicians ($n = 54$) were invited to complete a preimplementation survey designed to obtain information regarding their knowledge of the project, perceptions regarding the value added and the degree of confidentiality or anonymity of the reports. The 11-item survey asked participants to rate their level of agreement using a 5-point Likert scale (1 = strongly disagree and 5 = strongly agree). For physicians with email contact information, all communication regarding the survey was sent via an email that included the link to the web-based survey. For all others, communication was sent by fax to the clinicians’ offices and provided a secure fax number for returning completed paper surveys. Reminder notices were sent out every 2 weeks to those who had not yet returned the survey. A similar process was used for the

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**Fig. 1.** Process map for surgical and pathology reporting. SPOQCC = surgical pathology oncology quality of care committee.

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postimplementation physician survey conducted in March 2013, which focused on determining the physicians’ actual experiences of receiving individualized quality reports.

The postimplementation evaluation strategy also involved conducting semistructured focus groups with the members of the 4 distinct SPOQCCs to obtain their unique perspectives on the benefits and challenges of individual physician level reporting, lessons learned and strategies for future implementation.

**Assessment of organizational impacts**

To determine the degree of organizational impacts, focus groups were conducted with the members of the 3 site-specific SPOQCCs at the end of the pilot project. To facilitate optimal participation, the focus groups were scheduled to occur at the end of the regularly scheduled SPOQCC meeting, included all SPOQCC members in attendance, and were facilitated by a member of the CCO project team who participated via teleconference. As the regional leads were also the champions for the pilot project, they did not participate in the focus groups to allow for optimal engagement of the SPOQCC members and to maintain the confidentiality of comments shared. A semistructured interview process was used to guide the discussion. The sessions were audiotaped, with the permission of the participants, and additional notes were taken by the facilitator to capture comments and suggestions. Conventional content analysis was used for coding and identification of common themes.

**Results**

A total of 437 cancer resections (78 prostate, 241 colon and 118 rectal cases) were included in the review process. Fifty cases (11%) were suboptimal in terms of margin status (pT2 prostate) or lymph node yield (colon and rectum). Sixty percent of all suboptimal cases were associated with prostate cancer resections followed by rectal cases (22%) and colon cases (18%). Twenty-one cases (42%) were excluded from physician level reports based on previously determined clinical exclusion criteria or data error issues (e.g., wrong case assigned to physician). Of the remaining 29 suboptimal cases eligible for inclusion in physician level reporting, 7 (25%) were pathologist-related and 22 (75%) were surgeon-related. Five rounds of individual physician level reports, inclusive of one-quarter of data, were disseminated to the relevant physicians. Workload measurement reports revealed that the time required to review cases was less than 5 minutes in most cases, with only 4 surgical case reviews requiring 11–15 minutes each.

**Impact on practice patterns over time**

Over the course of the study, there was a noted improvement in the regional pT2 prostate margin positivity rate, which decreased from 57.1% to 27.5%. Hospital B demonstrated a dramatic improvement, with a decrease from 66.7% to 25%, thus meeting the provincial target (Fig. 3). Hospitals C and D (combined because the urology and pathology staff were the same for the 2 hospitals) showed no significant change in the percent of involved margins in pT2 prostate cancer resections over the course of the pilot project. As a percentage of hospital-specific urology staff, the urological surgical members of these 2 hospitals had the poorest attendance at engagement sessions held before and during the pilot project (Fig. 3).

For the CRC lymph node retrieval rate indicator, baseline performance was consistently high, with a regional rate of 96%. This was maintained and improved over the course of the study, with 2 sites achieving a 100% retrieval rate (Fig. 4).
Fig. 3. Percent of synoptic pT2 radical prostatectomies with involved margins (Q4 2010/11–Q4 2011/12).

Fig. 4. Percentage of synoptic colorectal cancer (CRC) resection reports with 12 or more lymph nodes examined (Q4 2010/11–Q4 2011/12).
Physician satisfaction

Survey response rates (56%) were similar pre- and postimplementation. Postimplementation respondents included colorectal surgeons (60%), pathologists (30%) and urologists (10%). The low response rate from urologists was disappointing, as 60% of all suboptimal cases were associated with prostate cancer surgeries. When comparing surveys, the preimplementation (anticipated) and postimplementation (actual experience) results were similar. Postimplementation results (based on combined responses of “strongly agree” and “agree”) show that respondents felt that the data provided in the individualized reports were valid (67%) and consistent with expectations (70%), that their confidentiality was maintained (80%) and that the information was not used in a punitive manner (77%). Notwithstanding the latter observation, only 47% indicated they were confident that the data would not be used in a punitive manner in the future.

In terms of relevance to personal and organizational performance, respondents to the postimplementation survey reported that having access to the personalized report could improve the quality of their practices (77%), improve organizational performance (87%) and improve patient outcomes (83%). Somewhat paradoxically, while the peer comparison data were felt to be useful (77%), only 48% of respondents indicated they would voluntarily provide the reports as part of professional peer review processes. Specific to the issue of validation, 40% were aware that the information was validated before generation of individual reports; 90% indicated that this process was important, very important or essential to the overall process. Preferred frequency of report generation was twice a year (41%), once a year (38%) and quarterly (21%), with hardcopy (53%) as the preferred method for receiving the reports, followed by secure email (37%) and Internet access (10%; Tables 1 and 2).

Organizational impact

Three focus groups were conducted with the site-specific SPOQCCs, including a total of 11 participants (75% of total SPOQCC membership), 9 of whom were physicians and 2 of whom were program administrative leaders. Two main themes emerged from the focus groups: process and quality. Overall, the participants stated that the SPOQCC structure and processes worked well. The recommended membership provided sufficient content expertise, and the presentation of data that were deidentified of physician information enabled dialogue focused on overall quality rather than individual

<table>
<thead>
<tr>
<th>Table 1. Pre- and postimplementation physician survey results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preimplementation, n = 31 (57%)</td>
</tr>
<tr>
<td>Item</td>
</tr>
<tr>
<td>I have confidence that the quality indicator data provided will be valid.</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>I have confidence that the methods used for sharing the indicator reports will maintain confidentiality.</td>
</tr>
<tr>
<td>I am comfortable knowing that my individual results were reviewed by the surgical lead.</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>I am comfortable knowing that my individual results were reviewed by the pathology lead.</td>
</tr>
<tr>
<td></td>
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<tr>
<td>I have confidence that this information will not be used in a punitive manner.</td>
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<tr>
<td>I see the relevance of having access to my personalized report to my practice.</td>
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<tr>
<td>I see the relevance of having access to indicator reports to organizational performance.</td>
</tr>
<tr>
<td>I see the relevant of having access to indicator reports to patient outcomes.</td>
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provider performance. Scheduling the SPOQCC meetings proved to be a significant barrier to the timeliness of providing reports to physicians, as the established process was to provide anonymized data to the SPOQCCs before sending out individual reports to the physicians. The participants also valued the SPOQCCs as an opportunity for focused discussions on quality at the regional and organizational levels. The presentation of results was deemed useful in determining areas of strength and areas for improvement, with dialogue focusing on how best to use the data to inform decision-making regarding strategies to sustain or improve performance. The SPOQCC forums were viewed as a mechanism for creating a quality culture that is supportive of open dialogue regarding the link between practice, quality and patient outcomes.

**Discussion**

In recent years there has been increasing focus on quality and performance indicators, as evident in programs and initiatives such as the Cancer System Quality Index (CSQI), the Quality Oncology Practice Initiative (QOPI), and the National Clinical Audit and Patient Outcomes Programme (NCAPOP).

The CSQI, produced by the Cancer Quality Council of Ontario, is an annual, system-wide monitor that tracks the quality and consistency of 25 key cancer system performance indicators. The CSQI report contains aggregate level data only, with comparisons against pre-established, consensus-based targets. The QOPI is a voluntary quality improvement program developed by the American Society for Clinical Oncology. Twice a year, participating practices undergo a retrospective review of patient charts, with quality measures calculated and reported back to the physicians for the purpose of performance improvement. Studies on practices enrolled in the QOPI initiative have shown positive results in terms of performance improvements. In the United Kingdom, the NCAPOP is a national clinical audit project that collects data supplied by clinicians on compliance with evidence-based standards and provides benchmarked reports to help participants identify necessary improvements.

These programs focus on aggregate data only (CSQI) or data that is voluntarily provided by physicians (QOPI, NCAPOP). The deemed benefits of the approach taken in this project are the following.

1. The use of a centralized, population-based data repository (ePath) as the data source for the reports, rather than data voluntarily submitted by individual physicians, provides a strong foundation for the validity of the data used.
2. The presentation of results at the regional, hospital and provider levels allows for analysis of variation in practice patterns within and across each level.
3. The reports were not a single, stand-alone strategy. The creation of a central forum (SPOQCC) for the specific

<table>
<thead>
<tr>
<th>Table 2. Postimplementation physician survey items: remediation, validation and next steps</th>
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<tbody>
<tr>
<td><strong>Item</strong></td>
</tr>
<tr>
<td>In the event of performance that is outside established quality parameters, what is the best method for individual remediation?</td>
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<tr>
<td>If you were to be peer reviewed by [College of Physicians and Surgeons of Ontario], would you voluntarily provide the assessor your individual data/reports?</td>
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<td></td>
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<tr>
<td>Were you aware that the information was independently validated before generation of the individual reports?</td>
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<td></td>
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<tr>
<td>How important is an external validation process to physician confidence in the accuracy of the information in the individual reports?</td>
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<td></td>
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<tr>
<td>How often should the reports be generated?</td>
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<tr>
<td>What is your preferred method of distribution of the reports?</td>
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<tr>
<td>What additional indicators should be considered for addition to individualized reports (check all that apply)?</td>
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purpose of focusing on quality allowed for a more multifaceted approach to creating a culture of quality beyond the generation of reports.

4. The reports are used to guide decision-making at the regional, organizational and individual physician levels regarding practice and outcomes.

The results of our study reinforce the importance of individual feedback as a valuable strategy for improving and sustaining quality in surgical and diagnostic oncology. The feedback and any subsequent remediation process must have a goal of overall quality improvement for all members and be conducted in the true spirit of quality improvement rather than being deemed as punitive in nature and intent. The provision of timely feedback is congruent with the rapid-learning health care initiative where real-time clinical data are used to support a focus on quality improvement and patient safety.29 The original goals of our study were achieved, in that we were able to develop a robust process for providing valid, confidential individualized surgical and pathology quality indicator reports to physicians.

Limitations

The limitations of this study include the small sample (56 physicians). The small number of prostatectomy cases over the course of the entire pilot project ($n = 63$) and the number of cases within each quarter limited the use of analyses that could be conducted owing to insufficient statistical power. Although significant change management strategies were applied before the launch of the pilot project, the very poor response rate from the urologist group limits the application of findings to the area with the greatest need for improvement. Consideration for targeted follow-up with nonrespondents may have enhanced participation. Based on the results and experience in this region, there will be specific strategies, including education sessions and presentations by known content experts and author(s) of the relevant practice guideline(s), to engage the urologist community when expanding into other regions.

Conclusion

While implementation of this pilot project was facilitated by the small size of our region, the processes and principles can be applied to other jurisdictions, with process redesign considerations made to address the volume of cases and number of physicians involved. Based on the success of this pilot project, expansion of physician level reporting to other regions in Ontario is currently underway in regions with larger surgical volumes and greater numbers of physicians. This expansion will enable further evaluation of the effectiveness of the processes implemented here, the impacts on physician satisfaction and quality of practice and opportunities for process redesign.

Affiliations: From Cancer Care Ontario, Toronto, Ont. (McFayden, Lankshear, Divaris, Hunter, Irish); Trillium Health Partners, Mississauga, Ont. (McFayden, Srigley); Grand River Hospital, Kitchener, Ont. (Divaris, Berry); and the Princess Margaret Cancer Centre, Toronto, Ont. (Irish).

Competing interests: None declared.

Contributors: C. McFayden, S. Lankshear and A. Hunter designed the study. C. McFayden, D. Divaris and M. Berry acquired the data, which C. McFayden, S. Lankshear, D. Divaris, A. Hunter, J. Srigley and J. Irish analyzed. C. McFayden and S. Lankshear wrote the article, which all authors reviewed and approved for publication.

References


Increased health services use by severely obese patients undergoing emergency surgery: a retrospective cohort study

Suzana Küpper, MD
Constantine J. Karvellas, MD, SM
Rachel G. Khadaroo, MD, PhD
Sandy L. Widder, MD, MHA
on behalf of the Acute Care and Emergency Surgery (ACES) Group

Background: The aim of this study was to assess perioperative outcomes in obese patients undergoing emergency surgery.

Methods: We retrospectively reviewed the charts of all adult (>17 yr) patients admitted to the acute care emergency surgery service at the University of Alberta Hospital between January 2009 and December 2011 who had a body mass index (BMI) of 35 or higher. Patients were divided into subgroups for analysis based on “severe” (BMI 35–39,9) and “morbid” obesity (BMI ≥ 40). Multivariate logistic regression was performed to identify predictors of in-hospital mortality after controlling for confounding factors.

Results: Data on 111 patients (55% women, median BMI 39) were included in the final analysis. Intensive care unit (ICU) support was required for 40% of patients. Postoperative complications occurred in 42% of patients, and 31% required reoperation. Overall in-hospital mortality was 17%. Morbidly obese patients had increased rates of reoperation (40% v. 23%, p = 0.05) and increased lengths of stay compared with severely obese patients (14.5 v. 6.0 d, p = 0.09). Age (odds ratio [OR] 1.08 per increment) and preoperative ICU stay (OR 12) were significantly associated with in-hospital mortality after controlling for confounding, but BMI was not.

Conclusion: Obese patients requiring emergency surgery represent a complex patient population at high risk for perioperative morbidity and mortality. Greater resources are required for their care, including ICU support, repeat surgery and prolonged ICU stay. Future studies could help identify predictors of reoperation and strategies to optimize nutrition, rehabilitation and resource allocation.

Contexte : Cette étude avait pour objet d’évaluer les résultats périopératoires chez des patients obèses soumis à une chirurgie d’urgence.


Résultats : L’analyse finale a porté sur les données concernant 111 patients (55 % de femmes, IMC médian 39). Il a fallu faire appel à l’Unité des soins intensifs (USI) pour 40 % des patients. Des complications postopératoires sont survenues chez 42 % des patients et 31 % ont nécessité une réopérations. Dans l’ensemble, la mortalité perhospitalière a été de 17 %. Les patients atteints d’obésité morbide ont présenté des taux plus élevés de réopérations (40 % v. 23 %, p = 0.05) et des séjours hospitaliers plus longs comparativement aux patients souffrant d’obésité grave (14.5 c. 6.0 jours, p = 0.09). L’âge (rapport des cotes [RC] 1.08 par palier) et un séjour préopératoire à l’USI (RC 12) ont été significativement associés à la mortalité perhospitalière après contrôle des facteurs de confusion, mais non l’IMC.

Conclusion : Les patients obèses qui ont besoin d’une chirurgie urgente forment une population de patients complexe exposée à un risque élevé de morbidité et de mortalité périopératoires. Leurs soins requièrent plus de ressources, y compris recours à l’USI, reprise de la chirurgie et prolongation du séjour à l’USI. D’autres études pourraient aider à recenser les prédicteurs des réopérations et à trouver des stratégies d’optimisation de la nutrition, de la réadaptation et de l’attribution des ressources.
Obesity is a growing problem worldwide. According to the World Health Organization, the prevalence of obesity nearly doubled between 1980 and 2008. The most recent data indicate that 12% of the world’s population is obese; the Americas have the highest prevalence of obesity at 26.7%. Obesity is associated with several comorbidities, including diabetes mellitus, dyslipidemia, ischemic stroke and ischemic heart disease. Worldwide, it is estimated that excess body weight (overweight or obese) is responsible for 2.8 million deaths and 35.8 million disability-adjusted life years lost per year.¹ Given these associations, obesity has been theorized to be a risk factor for surgery. Many studies have investigated the impact of obesity on outcomes following elective surgery across various disciplines. These studies assessed a broad range of outcomes, including complication rates, duration of surgery, blood loss, length of stay (LOS) in hospital, hospital costs, mortality and disease-specific outcomes. Overall, results are conflicting: some studies are equivocal,²⁻⁴ some show worse outcomes⁵⁻¹⁰ and others provide evidence of an “obesity paradox,” wherein patients who are overweight or mildly obese have better outcomes than those with a healthy weight.¹¹⁻¹⁴ Studies assessing obesity and outcomes specifically within general surgery have been similarly inconclusive.²⁻⁴

While most studies have assessed the impact of obesity on outcomes following elective surgery, few studies published to date have investigated the impact of obesity on emergency surgery. Patients requiring emergency surgery constitute a different population than those undergoing elective surgery. Given the emergent need for intervention and the subsequently minimized opportunity for preoperative selection and optimization, this population represents a much broader demographic than elective patients, likely carrying a more clinically important burden of comorbid illness. For this study, we hypothesized that obesity would be associated with increased perioperative morbidity and subsequently longer LOS. Accordingly, our objectives were to determine whether morbid obesity (body mass index [BMI] ≥ 40) compared with severe obesity (BMI 35–39.9) has a significant impact on in-hospital or 30-day mortality in patients undergoing emergency surgery and a significant impact on perioperative complications or LOS in hospital and in the intensive care unit (ICU).

METHODS

The reporting of this study follows the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement for observational studies.¹⁵ The health research ethics boards at the University of Alberta approved this study before commencement, with the requirement for individual informed consent being waived.

Design and setting

This study consisted of a retrospective chart review of obese patients admitted to the acute care emergency surgery service at the University of Alberta Hospital (Edmonton, Alta.) between Jan. 1, 2009, and Dec. 31, 2011.

Participants

Patients were selected based on the following inclusion criteria: need for urgent or emergent surgery, BMI of 35 or higher and age older than 17 years. For the purposes of this study, urgent surgery was considered to be any operation performed on a patient with an acute surgical condition who was admitted through the emergency department. These operations included, but were not limited to, exploratory laparotomy, cholecystectomy, incision and drainage/débridement, appendectomy and herniorrhaphy. Patients were excluded if they were younger than 18 years, had a BMI less than 35 or had elective surgery.

Variables

The exposure of interest was emergency surgery. Primary outcomes included complications, need for reoperation, admission to the ICU, LOS in hospital and in the ICU and mortality (in hospital and 30-d). For the purpose of this analysis, the patients were subdivided into 2 groups for comparison of outcomes: severe obesity (BMI 35–39.9) and morbid obesity (BMI ≥ 40). This subdivision based exclusively on BMI criteria allowed for assessment of and adjustment for potential confounders, such as age, sex or comorbidities.

Data sources and collection

Data were extracted from patient medical records and included age, sex, BMI, LOS, comorbidities, procedure required, duration of surgery, operative blood loss, intraoperative complications, perioperative complications and mortality. Comorbidities were subcategorized into “average” (e.g., hypertension, hyperlipidemia) and “high-risk” comorbidities (e.g., coronary artery disease or myocardial infarction, cerebrovascular disease, chronic renal failure, diabetes mellitus and congestive heart failure) using the Goldman risk index.¹⁶ Perioperative complications were also subdivided according to severity based on the Clavien–Dindo classification system.¹⁷

Operational definitions

As per the Clavien–Dindo classification,¹⁷

- Grade 1 refers to any deviation from normal postoperative care not requiring specific pharmacological or procedural intervention;
• Grade 2 refers to any complication requiring pharmacological intervention;
• Grade 3 refers to any complication requiring surgical, endoscopic or radiological intervention; and
• Grade 4 refers to any life-threatening complication requiring ICU support.

Statistical analysis

We performed our statistical analysis using SPSS software version 19 (2010). In cases of missing data values, data were not replaced or estimated. Data were analyzed using descriptive statistics to characterize demographics and other clinical variables. Categorical variables were compared using the \( \chi^2 \) test or Fisher exact test (if expected cell count < 5). For continuous variables, normally distributed variables are reported as means with standard deviations; these were compared using a Student \( t \) test. Non-normally distributed continuous data are reported as medians with interquartile ranges (IQRs); these were compared using the Wilcoxon rank sum test. Mortality was defined as a dichotomous outcome: deceased at hospital discharge or at 30 days. A 2-sided significance level of < 0.05 was used for all comparisons.

In order to control for variables that may confound the effect of BMI on in-hospital mortality, we performed a multivariable logistic regression analysis. The prespecified prognostic variables included age, sex, BMI, preoperative stay in the ICU and any high-risk comorbidity. One model was built using BMI as a categorical variable (BMI 35–39 v. BMI \( \geq 40 \)), and the second was built using BMI as a continuous variable. Model performance was assessed using the \( \chi^2 \) statistic and area under the receiver operator curve (AUROC). Multivariate associations are reported as odds ratios (ORs) with 95% confidence intervals (CIs).

RESULTS

Participants and descriptive data

Baseline characteristics of the 111 patients included in this cohort are shown in Table 1. The median age of these patients was 53 (IQR 17–85) years, and the median BMI was 39 (35–83). Fifty-five percent were women. Ninety-seven (87%) patients had at least 1 comorbidity, while 43 (39%) had at least 1 high-risk comorbidity. Admitting diagnoses included 48 patients (43%) admitted with bowel-related pathology, 23 (21%) with biliary disease, 5 (14%) with appendicitis, 17 (15%) with soft tissue infections (soft tissue abscess or necrotizing infection) and 8 (9%) with other diagnoses (trauma, peptic ulcer disease, intra-abdominal abscess or bleeding). Twenty-one patients (19%) were in the ICU preoperatively. The operations performed were exploratory laparotomy (35%), cholecystectomy (21%), appendectomy (14%), incision and débridement (16%), herniorrhaphy (13%) and other (1%).

Outcome data

Following surgery, 44 (40%) patients required ICU admission, and 34 (31%) patients required reoperation. Forty-seven (42%) patients had postoperative complications, 22 of which (20%) were severe (Clavien–Dindo grade 3/4). Overall median LOS was 9 (4–24) days. Seventy-five (68%) patients were discharged home, while 20 (18%) were discharged to another institution. Thirty-day mortality was 11% (\( n = 13 \)), while overall in-hospital mortality was 17% (\( n = 19 \)).

Univariate comparison of BMI groups (35–39.9 v. \( \geq 40 \))

The results of our comparison between 61 patients with a BMI of 35–39.9 and 50 patients with a BMI of 40 or
higher are shown in Table 2. Overall, there were no statistically significant differences in the demographic characteristics or comorbidities, including high-risk comorbidities ($p > 0.15$ for all comparisons). There were no significant differences in operating factors, including time in the operating theatre and requirement for blood products. Postoperatively, there were no differences in admission to or LOS in the ICU or in the number or severity of complications. While the difference in rates of reoperation did not reach statistical equivalence, there was a trend toward higher rates of reoperation among morbidly obese patients than in severely obese patients ($\text{BMI} \geq 40$, 20 of 50 patients, 40% v. $\text{BMI} 35–39.9$, 14 of 61 patients, 23%, $p = 0.05$). There was also a significant increase in LOS for patients with a BMI of 40 or higher (median 14.5, IQR 6–39 v. median 6, IQR 3–15.5 d, $p = 0.009$). There were no significant differences in unadjusted in-hospital or 30-day mortality between the groups ($p > 0.30$ for both).

### Table 2. Comparison of emergent surgical patients with severe ($\text{BMI} 35–39$) and morbid obesity ($\text{BMI} \geq 40$)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Group, no (%) or median [IQR]</th>
<th>$p$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Severe, $n = 61$</td>
<td>Morbid, $n = 50$</td>
</tr>
<tr>
<td>Age, yr</td>
<td>52 [37–64]</td>
<td>55 [42–63]</td>
</tr>
<tr>
<td>Sex, female</td>
<td>30 (49)</td>
<td>31 (62)</td>
</tr>
<tr>
<td>Comorbidities</td>
<td>2 [1–4]</td>
<td>3 [1–5]</td>
</tr>
<tr>
<td>Coronary artery disease</td>
<td>8 (13)</td>
<td>9 (18)</td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>6 (9.8)</td>
<td>2 (4)</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>18 (29)</td>
<td>18 (36)</td>
</tr>
<tr>
<td>Chronic renal failure</td>
<td>5 (8.1)</td>
<td>4 (8)</td>
</tr>
<tr>
<td>Stroke</td>
<td>1 (1.6)</td>
<td>4 (8)</td>
</tr>
<tr>
<td>Composite (any)</td>
<td>20 (33)</td>
<td>23 (46)</td>
</tr>
<tr>
<td>Operative factors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time in operating theatre, min.*</td>
<td>85 [54–135]</td>
<td>104 [57–156]</td>
</tr>
<tr>
<td>Blood products</td>
<td>11 of 60 (18)</td>
<td>11 (22)</td>
</tr>
<tr>
<td>Intraoperative complications</td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>52 (85)</td>
<td>43 (86)</td>
</tr>
<tr>
<td>Cardiovascular event</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Bleeding</td>
<td>1 (16)</td>
<td>3 (6)</td>
</tr>
<tr>
<td>Injury to adjacent structure</td>
<td>5 (8.2)</td>
<td>3 (6)</td>
</tr>
<tr>
<td>Conversion to open procedure</td>
<td>3 (4.9)</td>
<td>1 (2)</td>
</tr>
<tr>
<td>Postoperative complications*</td>
<td>0 [0–1.5]</td>
<td>0 [0–2.25]</td>
</tr>
<tr>
<td>Clavien–Dindo Grade 3/4 complications</td>
<td>12 (20)</td>
<td>10 (20)</td>
</tr>
<tr>
<td>Reoperation</td>
<td>14 (23)</td>
<td>20 (40)</td>
</tr>
<tr>
<td>Patient in ICU</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preoperatively</td>
<td>11 (18)</td>
<td>10 (20)</td>
</tr>
<tr>
<td>Postoperatively</td>
<td>21 (34)</td>
<td>23 (46)</td>
</tr>
<tr>
<td>Lengths of stay</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In intensive care*</td>
<td>0 [0–3]</td>
<td>0 [0–9.5]</td>
</tr>
<tr>
<td>In hospital*</td>
<td>6 [3–15.5]</td>
<td>14.5 [6–39]</td>
</tr>
<tr>
<td>Mortality</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In hospital</td>
<td>9 (15)</td>
<td>10 (20)</td>
</tr>
<tr>
<td>30 d</td>
<td>5 (8.2)</td>
<td>7 (14)</td>
</tr>
</tbody>
</table>

$\text{BMI} =$ body mass index; ICU = intensive care unit; IQR = interquartile range.

*Continuous variables analyzed using nonparametric (Wilcoxon rank sum) methods.

**Multivariable analysis: predictors of in-hospital mortality**

We performed multivariable logistic regression analysis on the cohort of 111 patients to determine if the probability of in-hospital mortality was affected by prespecified prognostic variables based on physiologic plausibility and variables that achieved a statistical significance of $p = 0.10$ on univariable logistic regression (Table 3). This model included the following variables: age, sex, preoperative ICU support and high-risk comorbidities. Using 2 separate models, BMI was treated as a binary variable in model 1 ($\text{BMI} \geq 40$ v. $\text{BMI} 35–39.9$) and as a continuous variable in model 2. After controlling for confounding, neither a BMI of 40 or higher (model 1) or incremental increases in BMI (model 2) conferred a significant effect on in-hospital mortality (adjusted $p > 0.15$ for both). In model 1, variables that had a significant association with in-hospital
mortality included age (OR 1.08 per increment, 95% CI 1.02–1.13) and preoperative stay in the ICU (OR 12.76, 95% CI 3.32–49.02). In model 2, age (OR 1.08 per increment, 95% CI 1.02–1.14) and preoperative stay in the ICU (OR 11.79, 95% CI 3.10–44.84) were significantly associated. Both models performed well (model 1 AUROC: 0.88, and model 2 AUROC: 0.89).

**Discussion**

**Key results**

In this study, obese patients (BMI > 35) had high rates of morbidity and mortality with emergency surgery. Postoperative complications were common (42%); a substantial number of patients required postoperative critical care (40%). In-hospital mortality was high (17%). Comparing patients with morbid obesity (BMI ≥ 40) to patients with severe obesity (BMI 35–39.9), morbidly obese patients were more likely to require reoperation (40% v. 23%) and had significantly longer LOS (14.5 v. 6 d). However, substantially higher BMI did not appear to impact in-hospital mortality, either on unadjusted analysis or after adjusting for confounding variables (both p > 0.15). Independent covariates associated with increased in-hospital mortality included advanced age (OR 1.08 per incremental year) and requirement for ICU care before surgery (OR 12).

**Comparison with previous studies**

There is a paucity of data on the outcomes of obese patients following emergency surgery. Many studies have assessed the outcomes of obese patients undergoing elective surgery with conflicting results. Wakefield and colleagues found an increased risk of complications with obese patients undergoing intestinal surgery. However, in a study of Veterans Affairs surgical patients, Herrera and colleagues found no difference in the rate of postoperative complications. Conversely, Mullen and colleagues found evidence for an obesity paradox when they investigated 118 707 patients undergoing nonbariatric general surgery; the lowest mortality was in the overweight and moderately obese groups. The authors did, however, find increasing rates of wound infections with increasing BMI.

Regarding emergency surgery, there is some evidence on outcomes from mixed BMI populations. Weissman and Klein assessed the differences between emergency and elective postoperative patients requiring critical care. Emergency patients were found to have more severe pre-existing illnesses, required prolonged postoperative mechanical ventilation, required longer ICU stays and had higher mortality. Becher and colleagues compared 25 770 patients undergoing emergency surgery with 98 867 patients undergoing nonemergent surgery and found significantly higher rates of complications and mortality in the emergent group (22.8% v. 14.2% and 6.5% v. 1.4%, respectively). These rates of complications and mortality are notably lower than that in our study population. Ingraham and colleagues assessed outcomes following emergency general surgery procedures in a mixed BMI population; their rates of morbidity and mortality are also significantly lower than ours.

**Interpretation**

We hypothesized that obesity would be associated with increased perioperative morbidity and LOS. Our results support this hypothesis in the form of higher rates of reoperation and longer LOS in morbidly obese patients. Furthermore, our rates of perioperative morbidity and mortality are significantly higher than those described above in the studies on mixed BMI populations. Thus, while our high rates of morbidity and mortality may be due in part to an increased burden of pre-existing illness (comorbidities and acute illness), it is likely they are also partially due to obesity.

The reasons behind the adverse effect of obesity on outcomes are not entirely clear. We theorize that some of the negative effect of obesity may be accounted for by malnutrition. While obesity involves excess caloric intake, several studies have shown a high prevalence of

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**Table 3. Predictors of in-hospital mortality in 111 patients with BMI greater than 35 who underwent urgent surgery**

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Unadjusted*</th>
<th>p value</th>
<th>Model 1*</th>
<th>p value</th>
<th>Model 2*</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>1.07 (1.03–1.12)</td>
<td>0.001</td>
<td>1.08 (1.02–1.13)</td>
<td>0.009</td>
<td>1.08 (1.02–1.14)</td>
<td>0.009</td>
</tr>
<tr>
<td>Sex, female</td>
<td>1.99 (0.69–5.68)</td>
<td>0.20</td>
<td>1.37 (0.38–4.89)</td>
<td>0.63</td>
<td>1.25 (0.34–4.53)</td>
<td>0.74</td>
</tr>
<tr>
<td>ICU preoperatively</td>
<td>15.81 (4.96–50.35)</td>
<td>&lt; 0.001</td>
<td>12.76 (3.32–49.02)</td>
<td>&lt; 0.001</td>
<td>11.79 (3.10–44.84)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>CHR</td>
<td>4.48 (1.55–12.93)</td>
<td>0.006</td>
<td>1.04 (0.26–4.08)</td>
<td>0.96</td>
<td>1.12 (0.28–4.43)</td>
<td>0.87</td>
</tr>
<tr>
<td>BMI &gt; 40</td>
<td>1.44 (0.54–3.89)</td>
<td>0.47</td>
<td>1.812 (0.52–6.38)</td>
<td>0.35</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>BMI</td>
<td>1.03 (0.98–1.09)</td>
<td>0.22</td>
<td>—</td>
<td>—</td>
<td>1.05 (0.98–1.13)</td>
<td>0.17</td>
</tr>
<tr>
<td>χ²</td>
<td>—</td>
<td>—</td>
<td>34.077</td>
<td>&lt; 0.001</td>
<td>34.92</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>AUROC</td>
<td>—</td>
<td>—</td>
<td>0.88 (0.81–0.95)</td>
<td>&lt; 0.001</td>
<td>0.89 (0.82–0.96)</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

AUROC = area under the receiver operator curve; BMI = body mass index; CHR = high-risk comorbidities; ICU = intensive care unit.

*Data presented as medians (with interquartile ranges).
micronutrient deficiencies in obese patients across a broad range of both vitamins and minerals. Malnourished patients have slower healing, more complications, increased LOS, increased hospital costs and greater mortality. Micronutrients may serve particularly important roles in recovery from illness, and supplementation of these micronutrients has been shown to reduce infectious complications, morbidity and mortality. Thus, it is possible that premorbid micronutrient deficiencies, constituting malnutrition in obese patients, lead to impaired healing. A diminished ability to heal may explain the substantial need for ICU support, reoperation and the high mortality observed in our study.

The increased LOS we observed in morbidly obese patients is consistent with findings reported in the literature. Padwal and colleagues examined the impact of severe obesity on rehabilitation time, LOS and hospital costs in a tertiary care rehabilitation hospital. When compared with controls who had a healthy BMI, the severely obese group had longer total LOS (37 vs. 98 d, \( p = 0.028 \)) and rehabilitation LOS (37 vs. 56 d, \( p = 0.037 \)). However, there were also significantly higher rates of diabetes, hypertension, renal failure and neurologic disease in the obese group. Another study from Australia found significant differences in LOS for obese patients; however, while medical patients stayed close to 4 days longer, surgically managed patients actually spent less time in hospital (−0.3 d, \( p = 0.029 \)). The authors of that study hypothesized that this decrease in LOS was secondary to increased rates of interhospital transfer for surgical patients. There are many potential factors contributing to the increased LOS that we observed. The increased rate of reoperation among morbidly obese patients likely extends the course of illness, the convalescence period and correspondingly, the LOS. In addition, given our relatively low rate of interhospital transfer, LOS is also probably extended by extra efforts and resources spent on mobilization and rehabilitation following acute surgical illness.

Limitations

The results of this study must be considered in the context of the following limitations. It is a retrospective, single-centre design, which predisposes results to possible selection bias. The data acquired are limited to what can be extracted from pre-existing, occasionally incomplete records. However, we believe there is substantial validity in studying this population in a retrospective fashion, as it would be difficult to study it prospectively. In addition, we did not have comparison data for patients with a healthy BMI who underwent emergent surgery owing to the nature of the acute care and emergency surgery registry that was used for this study. We attempted to address this by a comparison of BMI subgroups. Our subgroup comparison yielded several significant differences in outcomes attributable to increased BMI. We speculate that these differences would be further magnified in comparison to patients with a healthy BMI. Furthermore, to date this is the largest study published that specifically addresses emergent surgery in the obese population. Finally, given the small number of deaths in this study, we were able to adjust for only a limited number of covariates in our multivariable analysis based on previous literature and physiologic plausibility. We concede that there may be other confounding factors (known and unknown) for which we were unable adjust in our analysis (e.g., time to source control).

Generalizability

The results of this study are readily generalizable given the broad demographics of the patient population and could have important implications for the management of obese patients with acute surgical illnesses. To begin with, an improved understanding of the projected course in hospital will facilitate discussions with patients and their families regarding the clinical situation, interventions required (including the possibility of intensive care), prognosis and goals of care. Clinicians need to be vigilant for complications and the need for repeat operation. Addressing potential malnutrition in this population will be difficult. Studies have shown that preoperative enteral or parenteral nutrition improves outcomes in certain malnourished populations. However, there is no evidence to support preoperative nutrition in this population specifically. Moreover, given that these patients are undergoing emergent procedures, there is unlikely to be time to allow for substantial preoperative nutritional optimization. Postoperative nutritional supplementation is also of uncertain benefit. Early parenteral therapy has not been shown to improve outcomes and may, in fact, worsen outcomes. In addition, a recent randomized controlled trial assessing early enteral feeding after emergency abdominal surgery did not show any reduction in complications or LOS when compared with traditional enteral feeding. The optimal approach to nutrition in this population remains unclear and further studies are needed.

In addition, a strong emphasis should be placed on early and aggressive mobilization of obese patients. An organized, multidisciplinary approach in this regard may help decrease the LOS of obese patients requiring emergency operations. Finally, these results have important implications on resource allocation issues given the requirement for multiple surgical procedures and the extended LOS.

Conclusion

Obese patients requiring emergency surgery represent a complex patient population at high risk for perioperative morbidity. Substantial resources are required for their care, including intensive care support, repeat surgical
intervention and prolonged ICU stay. Future studies could help identify predictors of reoperation as well as strategies to optimize nutrition, rehabilitation and resource allocation.

Affiliations: From the Division of General Surgery, Department of Surgery (Kupper, Khadaroo, Widder); Division of Gastroenterology, Department of Medicine (Karvellas); and Division of Critical Care Medicine (Karvellas, Khadaroo, Widder), University of Alberta, Edmonton, Alta.

Grant support: R. Khadaroo and S. Widder receive funding from the M.S.I. Foundation.

Competing interests: None declared.

Contributors: S. Kupper, R. Khadaroo and S. Widder designed the study. S. Kupper and S. Widder acquired the data, which S. Kupper, C. Karvellas and S. Kupper analyzed. All authors wrote and reviewed the article and approved the final version for publication.

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The use of early immobilization in the management of acute soft-tissue injuries of the knee: results of a survey of emergency physicians, sports medicine physicians and orthopedic surgeons

Mark Sommerfeldt, MD, BScPT
Martin Bouliane, MD
David Otto, MD
Brian H. Rowe, MD, MSc
Lauren Beaupre, PT, PhD

Accepted for publication
July 23, 2014

Correspondence to:
L. Beaupre
2-50 Corbett Hall
University of Alberta
Edmonton AB T6G 2G4
lbeaupre@ualberta.ca

DOI: 10.1503/cjs.004014

Background: Evidence-based guidelines on the use of immobilization in the management of common acute soft-tissue knee injuries do not exist. Our objective was to explore the practice patterns of emergency physicians (EPs), sports medicine physicians (SMPs) and orthopedic surgeons (OS) regarding the use of early immobilization in the management of these injuries.

Methods: We developed a web-based survey and sent it to all EPs, SMPs and OS in a Canadian urban centre. The survey was designed to assess the likelihood of prescribing immobilization and to evaluate factors associated with physicians from these 3 disciplines making this decision.

Results: The overall response rate was 44 of 112 (39%): 17 of 58 (29%) EPs, 7 of 15 (47%) SMPs and 20 of 39 (51%) OS. In cases of suspected meniscus injuries, 9 (50%) EPs indicated they would prescribe immobilization, whereas no SMPs and 1 (5%) OS would immobilize ($p = 0.002$). For suspected anterior cruciate ligament injuries, 13 (77%) EPs, 2 (29%) SMPs and 5 (25%) OS said they would immobilize ($p = 0.005$). For lateral collateral ligament injuries, 9 (53%) EPs, no SMPs and 6 (32%) OS would immobilize ($p = 0.04$). All respondents would prescribe immobilization for a grossly unstable knee.

Conclusion: We found that EPs were more likely to prescribe immobilization for certain acute soft-tissue knee injuries than SMPs and OS. The development of an evidenced-based guideline for the use of knee immobilization after acute soft-tissue injury may reduce practice variability.


Méthodes : Nous avons conçu un sondage Web et l’avons fait parvenir à tous les urgentologues, médecins du sport et chirurgiens orthopédistes d’un centre urbain canadien. Le sondage visait à évaluer la probabilité que l’immobilisation soit prescrite et à dégager les facteurs associés à ce type de décision chez les praticiens de ces 3 disciplines.

Résultats : Le taux de réponse global a été de 44 sur 112 (39 %) : 17 urgentologues sur 58 (29 %), 7 médecins du sport sur 15 (47 %) et 20 chirurgiens orthopédistes sur 39 (51 %). Dans les cas où l’on soupçonnait une blessure du ménisque, 9 urgentologues (50 %) ont indiqué qu’ils prescriraient l’immobilisation, contre aucun médecin du sport et 1 (5 %) chirurgien orthopédiste ($p = 0.002$). Dans les cas où l’on soupçonnait une blessure du ligament croisé antérieur, 13 urgentologues (77 %), 2 médecins du sport (29 %) et 5 chirurgiens orthopédistes (25 %) ont affirmé qu’ils immobiliseraient ($p = 0.005$). Dans les cas de blessure au ligament collatéral latéral, 9 urgentologues (53 %), aucun médecin du sport et 6 chirurgiens orthopédistes (32 %) immobiliseraient ($p = 0.04$). Tous les répondants ont dit prescrire l’immobilisation pour un genou manifestement instable.

Conclusion : Nous avons constaté que les urgentologues étaient plus susceptibles de prescrire l’immobilisation pour certains traumatismes aigus affectant les tissus mous du genou comparativement aux médecins du sport et aux chirurgiens orthopédistes. La formulation de lignes directrices factuelles sur le recours à l’immobilisation du genou après un traumatisme aigu des tissus mous pourrait réduire la variabilité des pratiques.
Injury to the knee is a common cause of disability after sports-related injuries, yet they are often managed in a single visit with a physician. Accurate recognition and appropriate early treatment are critical in minimizing further injury and facilitating recovery. The treatment of acute soft-tissue injuries of the knee is guided by knowledge of the phases of healing. In order to protect injured tissues and alleviate pain, complete knee joint immobilization (using either a nonhinged knee brace or splint) is used by some physicians as part of the initial management of these injuries. However, the early work has demonstrated the harmful effects of prolonged joint immobilization: motion loss, muscle atrophy, decreased synthesis of proteoglycans in cartilage and decreased bone mass. Clinically, the loss of range of motion is thought to be the most harmful effect to the knee because it prolongs rehabilitation, impairs activities and can delay anterior cruciate ligament (ACL) reconstruction, if required. Striking a balance between the protection of healing tissues and the prevention of the deleterious effects of immobilization is challenging. For most acute soft-tissue knee injuries, complete immobilization is not required; if immobilization is used to alleviate pain and swelling, it should be of limited duration. Patellar dislocation is hypothesized that EPs would be more likely to report pre-

**Methods**

**Design**

A descriptive web-based survey was sent to all EPs, SMPs and OS in a large Canadian health zone (Edmonton, Alta.) using a modified Dillman technique. Because a population-based sampling approach was used, no sample size calculations were performed.

**Setting**

Edmonton is the capital of the province of Alberta and has approximately 1 million inhabitants served by 6 acute care EDs and 5 hospitals with orthopedic consultant coverage. There is a main academic sports medicine clinic (the Glen Sather Clinic) and 2 other sports medicine clinics within the city. Since 2009, hospital care within the province has been managed by a single administrative entity — Alberta Health Services (AHS). The University of Alberta is home to residency training programs in orthopedic surgery and emergency medicine. Sports medicine training occurs as an additional certification year through the College of Family Physicians of Canada (CFPC).

**Questionnaire**

Following a critical literature review, the survey was developed using standardized methodology and an iterative process. The survey was developed by a panel of 2 OS physicians with fellowship training in sports training in medicine (D.O., M.B.), 1 EP (B.R.) and 1 orthopedic surgery resident (M.S.). A survey expert assisted in the formation of questions and response options. A combination of open and closed-ended questions as well as Likert scale and ranking questions were included. After formulation of the survey, it was completed in full by each panel member to ensure questions were structured appropriately. Owing to the small numbers of physicians to whom the survey was ultimately sent, it was not circulated on a trial basis to individuals not involved in its formulation. The final survey (Appendix, available at cajnsurg.ca), which contained 19 questions, was designed to evaluate patient and physician factors that may be associated with the use of early immobilization after acute soft-tissue knee injury.

**Standardized definitions**

In the survey, acute soft-tissue injuries of the knee were defined as injuries that do not result in fractures (with some exceptions, as explained below), extensor mechanism disruption or knee dislocation. Examples of such injuries include ligament injury, meniscus injury and patellar dislocation. This definition was meant to capture those injuries that an EP would discharge from the ED with arrangements made for outpatient follow-up. Fractures not excluded from our definition were those commonly associated with soft-tissue injuries, such as osteochondral or avulsion fractures. Knee immobilization was defined as the prescription of a device that does not allow motion of the knee, such as a nonhinged brace or splint.
Survey methods

We obtained email addresses from the University of Alberta’s Department of Emergency Medicine and Division of Orthopedic Surgery as well as the 3 sports medicine clinics in the metropolitan Edmonton area. Physicians received an initial explanatory email and then weekly invitations to respond until they did so or until the survey time period of 3 weeks expired.

The Academic Information and Communication Technologies (AICT) department from the University of Alberta distributed the survey and completed data collection, maintaining anonymity of respondents. The study was approved by the University of Alberta Health Research Ethics Board. Implied consent was assumed if the clinicians completed the survey.

Statistical analysis

The likelihood of prescribing immobilization was assessed using a 7-point Likert scale. To dichotomize the analysis, responses of 1–4 were interpreted as a preference not to immobilize and responses of 5–7 were considered a preference to immobilize. The decision to allocate the response “4” to the “preference not to immobilize” group was made to place emphasis on the decision to immobilize. In reviewing the data, we determined that the number of respondents who selected “4” was small. Further analysis demonstrated that changing the preference not to immobilize category to include responses of 1–3 and the preference to mobilize category to include responses of 4–7 did not change our findings. Dichotomous variables were reported as proportions. Associations between physician specialty and likelihood of prescribing immobilization were examined using χ² tests. Continuous variables are reported as means ± standard deviations or medians with interquartile ranges (IQRs) as appropriate and compared using 1-way analysis of variance (ANOVA). Given the numerous tests performed, we considered results to be significant at p ≤ 0.01. All analyses were performed using Predictive Analytics Software version 19.0 (SPSS, Inc.).

RESULTS

Demographics and practice patterns

We sent our survey to 112 physicians: 58 EPs, 15 SMPs and 39 OS. The overall response rate was 44 of 112 (39%): 17 of 58 (29%) EPs, 7 of 15 (47%) SMPs and 20 of 39 (51%) OS. The OS had spent more years in practice (median 13.0, IQR 9.3–23.5 yr) than EPs (median 10.0, IQR 3.0–15.5 yr) and SMPs (median 10.0, IQR 2.0–20.0 yr). Over a 4-week period, SMPs reportedly saw an average of 12.9 ± 11.9 patients with acute soft-tissue knee injuries compared with 6.9 ± 3.9 seen by EPs and 5.6 ± 4.9 seen by OS. All of the EPs and none of the SMPs or OS reported seeing patients within 24 hours of the injury, whereas 60% of SMPs and 46% of OS reported seeing patients within 7 days (p < 0.001).

Diagnosis and physical exam

Five of 6 (83%) SMPs and 9 of 20 (45%) OS were confident in their diagnoses after interviewing the patient, whereas 12 of 16 (75%) EPs and 10 of 20 (50%) OS were somewhat confident. Confidence in the diagnosis increased after examination of the patient, with 6 of 7 (85%) SMPs, 15 of 20 (75%) OS and 7 of 17 (41%) EPs reporting confidence in their diagnoses. Only 2 of 17 (12%) EPs felt unsure of the diagnosis (Table 1). Overall, 39 of 44 (89%) respondents reported always or almost always inspecting the limb, palpating the knee and assessing range of motion and cruciate stability. Thirtysix of 44 (82%) reported always or almost always assessing neurovascular status and collateral ligament stability. The assessment of strength, menisci, gait and function varied greatly within and among the disciplines.

Likelihood of prescribing immobilization

In cases of suspected meniscus injuries, more EPs (50%) indicated they would prescribe immobilization than SMPs (0%) and OS (5%; p = 0.002; Table 2). For suspected ACL injuries, more EPs (77%) would immobilize the knee than SMPs (29%) or OS (25%; p = 0.005). For lateral collateral ligament injuries, the differences among the groups in the use of immobilization did not reach the level of statistical significance determined a priori (53% of EPs, 0% of SMPs and 32% of OS, p = 0.04). When suspecting an isolated medial collateral ligament (MCL) injury, no differences were found among the groups in the use of immobilization (47% of EPs, 14% of SMPs and 35% of OS, p = 0.31). For combined ACL and MCL injuries, no differences were found among the groups in the use of immobilization (77% of EPs, 43% of SMPs and 40% of

Table 1. Diagnostic confidence level of physicians after history taking and after physical examination

<table>
<thead>
<tr>
<th>Confidence level</th>
<th>Group, %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EP</td>
</tr>
<tr>
<td>After history-taking</td>
<td></td>
</tr>
<tr>
<td>Not confident</td>
<td>13</td>
</tr>
<tr>
<td>Somewhat confident</td>
<td>75</td>
</tr>
<tr>
<td>Confident</td>
<td>13</td>
</tr>
<tr>
<td>After physical exam</td>
<td></td>
</tr>
<tr>
<td>Not confident</td>
<td>12</td>
</tr>
<tr>
<td>Somewhat confident</td>
<td>47</td>
</tr>
<tr>
<td>Confident</td>
<td>41</td>
</tr>
</tbody>
</table>

EP = emergency physicians; OS = orthopedic surgeons; SMP = sports medicine physicians.
For patellar dislocations, the differences among the groups in the use of immobilization did not reach statistical significance (77% of EPs, 100% of SMPs and 55% of OS, \( p = 0.06 \)). When diagnosis was uncertain, 47% of EPs indicated they would immobilize compared with 14% of SMPs and 25% of OS; this difference was not significant (\( p = 0.20 \)). For a grossly unstable knee, most (41 of 43) respondents would prescribe immobilization (\( p = 0.34 \)). Once having prescribed immobilization, 12 of 15 (80%) EPs and 4 of 6 (67%) SMPs recommend follow-up within 7 days, whereas 7 of 9 (78%) OS recommended follow-up later than 1 week.

**Reasons for immobilization**

Pain relief and protection of soft tissues was selected as the first or second reason to immobilize by 72% of respondents, regardless of specialty. Conversely, concern for motion loss was selected as the first or second reason not to immobilize by 66% of respondents. No evidence of effectiveness was ranked first or second by 39%.

**Discussion**

Knee injuries are common presentations to the ED, and decisions regarding immobilization can be difficult. The development of knee stiffness is a potentially devastating consequence for a patient who is treated unnecessarily with prolonged knee immobilization. Motion loss can delay rehabilitation, impair function and delay surgery if it is required. Unfortunately, there are no evidence-based, accepted and specific guidelines regarding the use of knee immobilization after acute soft-tissue knee injury. Therefore, it is not surprising that practice variation was identified in this survey of knee immobilization practices across disciplines.

The results of our survey suggest that for certain injuries, EPs seem more likely to prescribe immobilization than SMPs and OS. Given the reported confidence in diagnosis and the thorough physical exams being performed by all groups, it seems unlikely that this difference is due to diagnostic uncertainty. One possible reason for the reported difference is that EPs reportedly assess these patients earlier than SMPs and OS. This is likely a direct result of the access patients have to an ED compared with an SMP or OS in the Canadian health system. The injured knees of these patients are likely in different phases of healing at the time of assessment. Patients presenting to an ED likely have greater pain and functional impairment. This may cause an EP to be more likely to provide treatment in the form of immobilization.

While immobilization of short duration is unlikely to lead to detrimental effects, patients who are prescribed complete immobilization may inadvertently remain immobilized for a longer period of time than intended. This may be the result of waiting for a follow-up appointment, misunderstanding the instructions of the treating physician or loss to follow-up. Whatever the reason, prolonged inadvertent immobilization should be avoided.

As indicated by our results, practice variability is apparent both among and within the different physician groups. For example, even a substantial number of OS reportedly recommend immobilization for injuries, such as ACL injuries and meniscus tears — injuries for which immobilization is not recommended.

Despite the need to consider each subcategory of injury as a unique entity, current evidence suggests that for most acute soft-tissue knee injuries (except grossly unstable knee injuries and patellar dislocations), complete immobilization is not required and its use should be limited. Some authors suggest hinged knee braces be used to splint knees that are unstable in the coronal plane to provide protection to the healing tissues while allowing motion.

In light of our results, there is a need for clarification and distribution of current recommendations. This could

**Table 2. Percentage of respondents likely to prescribe immobilization, by group**

<table>
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</thead>
<tbody>
<tr>
<td>Suspected meniscal injury*</td>
<td>77</td>
<td>23</td>
<td>29</td>
<td>71</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td>ACL injury*</td>
<td>53</td>
<td>47</td>
<td>0</td>
<td>100</td>
<td>5</td>
<td>95</td>
</tr>
<tr>
<td>LCL injury</td>
<td>47</td>
<td>53</td>
<td>14</td>
<td>86</td>
<td>35</td>
<td>65</td>
</tr>
<tr>
<td>MCL injury</td>
<td>77</td>
<td>23</td>
<td>43</td>
<td>57</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>ACL/MCL injury</td>
<td>77</td>
<td>23</td>
<td>100</td>
<td>0</td>
<td>55</td>
<td>45</td>
</tr>
<tr>
<td>Patellar dislocation</td>
<td>47</td>
<td>53</td>
<td>14</td>
<td>86</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td>Diagnosis uncertain</td>
<td>100</td>
<td>0</td>
<td>86</td>
<td>14</td>
<td>90</td>
<td>10</td>
</tr>
</tbody>
</table>

ACL = anterior cruciate ligament; EP = emergency physicians; LCL = lateral collateral ligament; MCL = medial collateral ligament; OS = orthopedic surgeons; SMP = sports medicine physicians.

*\( p < 0.01 \).
be addressed through the development of an evidence-based guideline on the use of knee immobilization. Knowledge translation activities following the development of guidelines may further assist in preventing unnecessary knee immobilization and decreasing practice variation. Such efforts may prove to be a worthwhile and cost-effective endeavour for both our patients and our health care system.

Limitations

Despite robust survey methods, there are limitations associated with our survey. First, reliability and validity testing were not performed. Second, the survey was conducted in a northern Canadian metropolitan centre, and these results may not be generalizable to other Canadian or international centres. The low response rate and local sampling resulted in a small sample size, consequently decreasing the precision of our estimates.

Conclusion

We found that EPs were more likely to prescribe immobilization for certain acute soft-tissue knee injuries than SMPs and OS; however, EPs reportedly see patients earlier postinjury than SMPs and OS. The development of an evidenced-based guideline for the use of knee immobilization after acute soft-tissue injury may reduce practice variability.

Acknowledgements: The authors thank the University of Alberta Department of Emergency Medicine and Division of Orthopedic Surgery for their cooperation with this survey. The study team thanks the physicians from all groups who participated in the study. B. Rowe was supported by a Tier I Canada Research Chair in Emergency-based Medicine from the Canadian Institutes of Health Research (CIHR). L. Beaupre receives salary support through a Population Health Investigator Award from Alberta Innovates — Health Solutions and a New Investigator Award (Patient Oriented Research) from CIHR.

Affiliations: Department of Surgery (Sommerfeldt, Bouliane, Otto), Department of Emergency Medicine (Rowe) and Department of Physical Therapy (Beaupre), University of Alberta, Edmonton, Alta.

Competing interests: All authors designed the study. M. Sommerfeldt, B. Rowe and L. Beaupre acquired and analyzed the data, which M. Bouliane also analyzed. M. Sommerfeldt, B. Rowe and L. Beaupre wrote the article, which all authors reviewed and approved for publication.

Contributors: All authors designed the study. M. Sommerfeldt, B. Rowe and L. Beaupre acquired and analyzed the data, which M. Bouliane also analyzed. M. Sommerfeldt, B. Rowe and L. Beaupre wrote the article, which all authors reviewed and approved for publication.

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Do revision total hip augments provide appropriate modularity?

Matthew G. Teeter, PhD
Douglas D. R. Naudie, MD
James L. Howard, MD, MSc
Richard W. McCalden, MD, MPhil(Edin)
Steven J. MacDonald, MD

Accepted for publication: July 23, 2014

Correspondence to:
M.G. Teeter
London Health Sciences Centre
University Hospital
339 Windermere Rd.
London ON N6A 5A5
matthew.teeter@lhsc.on.ca

DOI: 10.1503/cjs.005514

Background: Porous metal acetabular augments have become widely used to fill bony defects in patients undergoing revision total hip arthroplasty. The objective of this study was to determine whether the currently offered size range of the augments is appropriate for surgical needs.

Methods: We reviewed the cases of all patients at 1 centre with a porous revision shell, and when an augment was used we recorded the patient and implant characteristics.

Results: We reviewed the cases of 281 patients, and augments were used in 24. Augment diameter was skewed toward the small end ($p < 0.001$), although thickness was not ($p = 0.05$); 21 of 24 augments were those with the smallest 3 diameters and thicknesses.

Conclusion: Given the sizes used, the full range of inventory provided by the manufacturer may be unnecessary, as surgeons will likely attempt a larger shell before a larger augment.

Revision total hip arthroplasty is substantially more complex than primary arthroplasty, with bone defects surrounding the implant being a common occurrence. Traditionally, segmental bony defects have been filled with bone graft, either in combination with a jumbo cementless cup or, in the case of large defects, with a cage to bridge these defects. However, in the past decade porous metal acetabular augments have been developed as an alternative.1 These augments integrate (or unitize) with the acetabular component of the implant (the acetabular cup) and are screwed into the surrounding bone, filling the defect (Fig. 1). Although augments were initially marketed by a single implant manufacturer, multiple versions of these porous metal (tantalum or titanium alloys) augments are now available from other manufacturers. Midterm results suggest that the augments are effective for filling the bony defect and provide stable fixation.2,3

The augments, like the implants themselves, follow the principle of modularity, meaning they are available in a range of sizes to fit a variety of patient scenarios. Although the range of implant sizes has been widely studied, particularly with respect to issues such as wear, loosening and dislocation,1,4–6 the issue of whether the augments are currently offered in an appropriate range of sizes

R

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to fill common defects has not been addressed. Of the papers reviewing authors’ experience with acetabular aug-
ments, only 1 study7 has described the sizes used — only partially — and identified 2 consecutively grouped sizes (size 58, 10- and 20-mm thicknesses) as the most commonly
used from a single manufacturer.

The objective of our study was to review acetabular aug-
ment usage in patients undergoing revision hip surgery fol-
lowed prospectively at 1 centre to determine whether the currently offered modularity of the augments is appropriate for surgical needs. We hypothesized that the size of aug-
ments used would be clustered around a small range at the small to intermediate end of the scale, with few or no aug-
ments at the largest end of the scale being used.

**METHODS**

We queried a clinical database that records all surgical pro-
cedures performed at our institution to identify patients who received a Trabecular Metal revision acetabular cup (Zimmer) between 2007 and 2013. For the patients identi-
fied in our database search, we reviewed the radiographs to con-
firm the presence of a Trabecular Metal acetabular aug-
ment. Where an augment was present, we recorded patient
demographic characteristics, including age, sex, body mass
index (BMI), reason for the revision, and whether a further
revision occurred. Each case was classified based on the
Paprosky and Gross bone defect classification scales. We
also recorded implant characteristics, including augment
diameter and thickness, cup diameter and the number of
screws used to secure the augment and the cup. Our Insti-
tutional Research Board approved the study.

Trabecular Metal acetabular augments, shaped as a partial
hemisphere, are currently offered in 4 thicknesses: 10 mm,
15 mm, 20 mm and 30 mm. At 10 mm and 15 mm, the sizes
(diameters) available are 50, 54, 58, 62, 66 and 70. At 20 mm
and 30 mm, the available sizes are 50, 54, 58, 62 and 66
(no size 70). Originally more sizes were available, with 2 mm
gaps rather than 4 mm gaps between sizes. For the purposes
of our analysis, in cases when the size documented in the
patient’s chart was no longer available, we recorded the next
largest size (i.e., size 48 became size 50, size 52 became 54,
and size 56 became size 58). There was no change to the
range of thicknesses offered.

**Statistical analysis**

Standard descriptive statistics were calculated for all categor-
ies of patient and implant characteristics. We performed a χ²
test to measure the augment size usage against a standard
even distribution. Linear regression between implant and
patient characteristics was performed, including factors such
as bone defect class, augment diameter, augment thickness,
cup diameter, number of screws used (both in the augment
and cup), patient age and patient BMI.

**RESULTS**

Among 281 patients who received a porous metal revision cup
during our study period, 24 also had an augment, for a usage
rate of 8.5%. The mean patient age at the time of surgery was
74.3 ± 10.2 (range 52–88) years, and the mean BMI was 27.1
± 4.2 (range 20.8–33.8). Of the 24 patients, 7 were men and
17 were women. All cases were revised (and a cup with augment implanted) for either aseptic loosening (n = 19) or infection (n = 5). Ten patients were undergoing a first revision, 8 were having a second revision, 4 were having a third revision and 2 were having a fourth revision. The mean duration of follow-up was 3.2 years. There was no subsequent re-revision in which the cup or augment was removed for any of these patients. There was no use of bulk allograft in any of the cases. Using the Gross classification, there were 2 cases of type III, 18 cases of type IV and 4 cases of type V defects. Using the Paprosky classification, there were 17 cases of type IIIA, 3 cases of type IIIB and 4 discontinuity cases.

The median augment diameter (Table 1) was 54 (range 48–62) mm, and the median thickness was 15 (range 10–30) mm, with 2.2 ± 0.8 (range 0–4) screws used per augment. The majority of augments (n = 20) were used in “oblong” mode to fill cavitory defects, with only 4 used in “flying buttress” mode to fill segmental defects. The mean cup diameter was 64 (range 54–76) mm, with 4.0 ± 1.2 (range 2–7) screws used per cup. The augment diameter was skewed toward the small end (p < 0.001), but thickness was not (p = 0.05). Of the 24 augments used, 21 augments were the 3 smallest diameters and thicknesses, and no augments were the largest diameters (66 mm or 72 mm).

Augment diameter positively correlated with cup diameter (r² = 0.22, p = 0.021; Fig. 2A), while augment thickness negatively correlated (Fig. 2B) with cup diameter (r² = 0.25, p = 0.014). Augment thickness also positively correlated (Fig. 2C) with the number of augment screws used (r² = 0.21, p = 0.026). There were no other significant correlations between implant or patient characteristics. There was no correlation between either the Gross or Paprosky defect classification and augment size or thickness.

**Discussion**

The majority of augments were clustered at the smallest size combinations available; the majority of augments used were the thinnest (10 mm) model available. Interestingly, the single most frequent size combination (size 58, 10 mm thickness) was consistent with the only other mention of augment size available in the literature.7 Also of interest was that the manufacturer had already decreased the range of sizes of acetabular augments available since the implants were first introduced at our institution, grouping together multiple sizes such that there are 4 mm increments rather than 2 mm increments between diameters. Although more women than men (17 v. 7) received augments, this did not appear to have an effect on size; the largest augments were used only in women, and some of the men received the smallest augments (size 50, 10 mm thickness).

While we found a seemingly low overall augment usage rate of 8.5% (24 of 281 patients), this too was consistent with the literature. One study8 reported an augment usage...
rate of 7.6% (34 of 448 patients), and other centres have reported on augment usage samples ranging from 23 to 46 patients.2,3,9,10 This low augment usage rate means that in 91.5% of cases, the revision acetabular cup on its own is sufficient. Based on the defect classification, the patients whose cases we reviewed all had the most severe types of defects. At our institution, augments are generally not used outside of these worst case scenarios owing to cost. Instead, surgeons prefer to use as large a cup as possible before the addition of an augment. This is supported by the inverse association found between cup diameter and augment thickness; surgeons appeared to select the largest possible cup before adding an augment. The advantages of so-called “jumbo cups” have been described as a simple procedure that maximizes cup–bone contact and potentially restores the centre of hip rotation. Such cups have been reported to last as long as 15 years.11,12 The use of jumbo cups and augments has replaced the use of bulk allografts at our institution.

Other correlations included increasing augment diameter with increasing cup diameter and increasing screw usage with increasing augment thickness. A wider cup will naturally be more suitable than a narrower cup for a wider augment. Increased screw usage with thicker augment could suggest that surgeons felt less sure of the augment’s bony fixation with thicker dimensions. Interestingly, screw usage did not correlate with augment diameter or cup diameter, so it was not the case that more screws were used simply because there was more room to use them.

As technology advances in additive manufacturing (also known as 3-dimensional printing), there may be a greater role for custom, patient-specific acetabular revision cups (and augment) that incorporate and ideally improve upon the stability of the cup–augment combination. These would be designed to better fill the bony defect and attach with appropriate fixation based on the bone remaining, regardless of what the defect looks like. Such structures are already being designed to have mechanical strength and porosity that more closely mimics bones and can be manufactured using selective laser melting or electron beam melting technologies.13,14

Limitations

Limitations of this study are that it represents a single centre and that only 1 acetabular augment product was examined. However, the sample size in this study is consistent with that in other studies reviewing these augment, and while other manufacturers now have similar product offerings, the augment used in our study was the first available and is the most widely used to date. The principles of sizing are likely consistent with other similar products.

Conclusion

Given the small range of acetabular augment sizes used, the full range of inventory provided by the manufacturer may not need to be routinely stocked in the same amounts, as surgeons will likely attempt a larger cup before a larger augment. There may also be a role for introducing additional augment shapes to better fill bony defects, perhaps involving custom designs rather than maintaining a wide augment size range, many of which are never used.

Affiliations: All authors are from the Division of Orthopaedic Surgery, London Health Sciences Centre, London, Ont.

Competing interests: None declared by M. Teeter. D. Naudie is a consultant for Smith & Nephew, Stryker and Zimmer, and he has received speaker fees from Pfizer, Sanofi-Aventis, Smith & Nephew, Stryker and Zimmer. J. Howard is a consultant for DePuy, Smith & Nephew and Stryker, and he has received speaker fees from DePuy and Stryker. R. McCalden is a consultant for and has received speaker fees from Smith & Nephew. S. MacDonald is a consultant for DePuy.

Contributors: M. Teeter, R. McCalden and S. MacDonald designed the study. M. Teeter, D. Naudie and J. Howard acquired the data, which D. Naudie, J. Howard, R. McCalden and S. MacDonald analyzed. M. Teeter wrote the article, which all authors reviewed and approved for publication.

References

Radiographic evaluation of the ankle syndesmosis

Stephen Croft, MD
Andrew Furey, MD
Craig Stone, MD
Carl Moores, MD
Robert Wilson, BSc


Accepted for publication: July 23, 2014

Correspondence to: S. Croft
Office of Surgical Education
H 1826 - Health Sciences Centre
300 Prince Philip Dr.
St. John’s NL A1B 3V6
scroft@mun.ca

DOI: 10.1503/cjs.004314

Background: Radiographic measurements to document ankle anatomy have been suggested in recent literature to be inadequate. Focus has been put on stress views and computed tomography; however, there are also issues with these modalities. An orthogonal view that could be used both statically and dynamically could help determine syndesmotic stability. The purpose of this study was to determine a parameter on a normal lateral ankle radiograph that will increase the reliability of standard radiography in diagnosing syndesmotic integrity.

Methods: Three orthopedic surgeons reviewed 80 lateral ankle radiographs. Thirty of those radiographs were reviewed on a second occasion. Rotation of the radiographs was determined by evaluating the overlap of the talar dome. Four radiographic parameters were measured 1 cm above the tibial plafond: fibular width, tibial width, and anterior and posterior tibiofibular intervals.

Results: Seventy-two radiographs were determined by consensus to be adequate. Means and ratios were documented to determine the relationship of the fibula to the tibia. Interrater reliability ranged from moderate to near-perfect, and the intrarater reliability was documented for each ratio. The anterior tibiofibular ratio was shown to be strong to near-perfect. It demonstrates that 40% of the tibia should be seen anterior to the fibula at 1 cm above the tibial plafond.

Conclusion: The anterior tibiofibular ratio provides an orthogonal measure for the syndesmosis that, in conjunction with those parameters previously documented, could clinically and economically improve the diagnosis of syndesmotic disruptions.
Ankle sprains and fractures are among the most common musculoskeletal injuries.\textsuperscript{1,2} It is essential that we have the most up-to-date and relevant information at our disposal when we are treating such injuries. Over the past 20–30 years, radiographic evaluation of the ankle has been thoroughly investigated. There have been radiographic measurements established to document ankle anatomy; in 1983, Pettrone and colleagues\textsuperscript{4} examined 146 displaced ankle fractures and determined significant prognostic features.\textsuperscript{4} The objective measurements that were used in their study continue to be used in today’s research as well as in clinical practice. There are components of the ankle, however, that are poorly described by our standard diagnostic imaging.

Once an ankle is deemed to require radiography, the standard is to complete anteroposterior (AP), lateral and mortise views. When critically analyzing those images, the most clinically important soft tissue component of the ankle is the syndesmosis. The syndesmosis is a ligamentous complex that includes 4 ligaments: the anterior inferior tibiofibular ligament, the posterior inferior tibiofibular ligament, the interosseus tibiofibular ligament/membrane and the inferior transverse tibiofibular ligament. It unites the distal tibia and fibula, and injuries to the syndesmosis can lead to severe acute and chronic morbidity.\textsuperscript{1,2}

Radiographic parameters to determine a syndesmotic injury have historically been described in the AP and mortise views. On a mortise view, the medial joint space should be less than 4 mm, and the superior joint space should be within 2 mm medially of its width laterally. Tibiofibular overlap on the AP view should be greater than 10 mm, and the space between the medial wall of the fibula and the incisural surface of the tibia should be less than 5 mm.\textsuperscript{1-3} Recent literature has suggested, however, that evaluation of the syndesmosis on static AP and mortise views is not adequate to determine if there is a syndesmotic injury present.\textsuperscript{4-11} It has been suggested that current diagnostic criteria used specifically for syndesmotic injuries are of minimal value and that further criteria should be developed.\textsuperscript{5,6,9}

Ankle arthroscopy, computed tomography (CT) or magnetic resonance imaging (MRI) have been suggested as alternatives to standard radiography to ensure proper diagnosis of syndesmotic injuries;\textsuperscript{7-10,12} however, none of these options is clinically or economically practical. A potential solution is to add an orthogonal parameter on the lateral radiograph to those being used in the AP and mortise views, thereby increasing their effectiveness. Orthogonal views are used as a diagnostic tool for most other fractures. Although the lateral ankle radiograph has been evaluated for many years in the fracture setting, it is only recently that specific parameters are being developed on that view. The purpose of this study was to determine a parameter on a normal lateral ankle radiograph that would increase the reliability of standard radiography in diagnosing syndesmotic integrity.

**METHODS**

Three orthopaedic surgeons (A.F., C.M., C.S.) reviewed 80 lateral ankle radiographs. Thirty of those radiographs were reviewed on a second occasion more than 2 months later. The radiographs were retrospectively gathered through the Picture Archiving and Communication System (PACS) system at our institution. We obtained ethics approval through the Health Research Ethics Authority.

We considered radiographs to be acceptable based on what would be acceptable in an intraoperative environment: radiographs centred at the talar dome, demonstrating neutral rotation/superimposition of the talus. Inclusion criteria were patients who were skeletally mature with absence of radiographic disease, as documented by a radiologist. We excluded films that demonstrated prior ankle surgery, fractures or end-stage ankle arthrosis.

We documented 4 measurements: tibial and fibular widths (TW, FW), the anterior tibiofibular interval (ATFI, defined as the anterior cortex of the fibula to the anterior cortex of the tibia) and the posterior tibiofibular interval (PTFI, defined as the posterior cortex of the tibia to the posterior cortex of the fibula; Fig. 1). Measurements were documented 1 cm above the centre of the tibial plafond.\textsuperscript{8,12} Ratios were determined in order to assess the positional relationship of the tibia relative to the fibula.

![Fig. 1. Lateral ankle radiograph. The line segment A–B shows the tibial plafond, C–D shows the posterior tibiofibular interval, D–E shows the fibular width, E–F shows the anterior tibiofibular interval, and C–F shows the tibial width. All measurements were made 1 cm above the midpoint of the tibial plafond.](image)
Statistical analysis

Statistical analysis was completed using SPSS software version 19 (SPSS Inc.). We used descriptive statistics, intraclass correlation with inter- and intraobserver reliability and an independent $t$ test with Pearson correlation to assess associations between age, sex, and side. Intraclass correlation was interpreted as poor at 0–0.2, fair at 0.3–0.4, moderate at 0.5–0.6, strong at 0.7–0.8 and near perfect at greater than 0.8.13

RESULTS

Eighty radiographs were selected; 8 were excluded based on our given criteria. The 72 remaining radiographs were from 35 men and 37 women with a mean age of 44 years; 33 showed the right ankle and 39 showed the left ankle (Table 1). Descriptive statistics are shown in Table 2.

Four ratios to describe the relationship of the tibia and fibula were determined: PTFI:TW, ATFI:TW, PTFI:(PTFI+FW) and ATFI:(ATFI+FW). The respective means ± standard deviations were 0.17 ± 0.06, 0.39 ± 0.09, 0.27 ± 0.06, 0.46 ± 0.07. We conducted an independent sample $t$ test using Pearson correlation to determine the association between each ratio and age, sex and side (Table 3).

Lainless et al.4–11 Nielson and colleagues6 and Hermans and colleagues7 compared the standard radiographic measurements for ankle fractures with MRI findings. They found that radiographic measurements for syndesmosis injury did not correlate with MRI findings. In 2004, Beumer and colleagues5 demonstrated that, although previously used parameters to

DISCUSSION

The syndesmosis is the most significant ligamentous complex of the ankle.1–3 Disruption can lead to instability, pain and arthrosis.1–3,14,15 Functionally, malreduced syndesmotic injuries have demonstrated worse outcomes on the Short Form Musculoskeletal Assessment, which looks at general health, and on the Olerud/Molander questionnaire, which is ankle-specific.15

Recent literature demonstrates that the validity and reliability of our classic diagnostic criteria is not optimal.4–11
diagnose syndesmosis injury have been useful, there remains no optimal tool for diagnosis.

It has been suggested that MRI, CT or arthroscopy should be used to ensure adequate diagnosis and treatment; however, if it is possible to diagnose syndesmotic disruption with plain film radiography, significant cost and morbidity could be spared. Stress examination is another method that has been used to diagnose syndesmotic disruption, however, use of the mortise and AP views have continued to be the foundation for diagnosis.

It has been demonstrated that we should be putting more emphasis in the sagittal plane, but ultimately, there is a need for new radiographic parameters to better delineate the syndesmosis.

Prior to analyzing the abnormal syndesmosis, however, it is essential to understand and document how a healthy syndesmosis is represented. We have therefore described the anterior tibiofibular ratio (ATFR), which characterizes the ATFI:TW ratio described previously. It has been documented in the literature on a number of occasions that sagittal movement of the fibula relative to the tibia can represent a syndesmotic injury however, to our knowledge only 2 studies have attempted to determine specific criteria for diagnosis on the lateral view. In 2013, Grenier and colleagues concluded that the tibiofibular joint can be accurately assessed on the lateral view when looking at the sagittal relationship of the fibula and the tibia. They described the anteroposterior tibiofibular ratio (APTF), which they calculated based on a line from the anterior tibial physesal scar to the intersection of the tibial cortex, anterior to the intersection of that line to the posterior tibial cortex. Although they were able to use the physesal scar as a radiographic marker for measurement, we believe it to be an indistinct landmark that could introduce inconsistency. In 2012, Dikos and colleagues determined that the interval of the anterior fibula to the anterior tibia is a reliable marker based on comparison with axial CT images. In addition, they determined that there are significant anatomic variations dependent and independent of sex. When the anterior interval was expressed as a ratio to the fibular width, those sex differences were controlled, and the independent variations were primarily seen with regards to fibular rotation, specifically in the AP plane. We believe that a ratio on the lateral radiograph would control for the sex and anatomic variations.

We evaluated 72 ankles free of disease and calculated a ratio that represents a normal positional relationship of the fibula relative to the tibia. Our results reveal that the ATFR should be equal to 39% ± 9% (i.e., approximately 40% of the tibia should be anterior to the anterior fibular cortex, 1 cm above the tibial plafond). Intrarater reliability was strong to very strong with a moderate interobserver reliability. When analyzing the ATFR, there was no significant difference shown with regard to age, sex or side.

**Limitations**

Limitations of our study include those inherent to a retrospective design; our radiographs were not randomly chosen and, therefore, there may be a selection bias. The quality of the radiographs may represent an issue with providing accurate measurements; however, this limitation is also present in the clinical setting. Ensuring appropriate and quality radiographs will facilitate the detection and treatment of correct pathology. In addition, there may be a discrepancy when determining the ratio in the sterile operating room setting without the ability to use digital rulers, and the amount of variance described from patient to patient may limit the effectiveness of the ratio. These are 2 areas that are outside the scope of the present study; however, a prospective analysis with an increased population size, including the ability to appropriately identify the ATFR and relate it to functional outcome, would be of great benefit moving forward.

**CONCLUSION**

The ATFR is a radiographic measure on the lateral view of the ankle that will add to the current diagnostic tools that delineate the ankle syndesmosis. The measure has to be validated on ankles with a disrupted syndesmosis; however, we have shown the ATFR to be an easily calculated and reproducible measure that is suitable for determining the normal relationship of the tibia and fibula. The ATFR provides an orthogonal measure for the syndesmosis that, in conjunction with those parameters previously documented, could clinically and economically improve the diagnosis of syndesmotic disruptions.

**Affiliations:** All authors are from the Department of Orthopaedic Surgery, Memorial University of Newfoundland, St. John’s, Nfld.

**Competing interests:** None declared.

**Contributors:** S. Croft, A. Furey and C. Moores designed the study. S. Croft, A. Furey, C. Stone and C. Moores acquired the data, which S. Croft, A. Furey, C. Stone and R. Wilson analyzed. S. Croft and A. Furey wrote the article, which all authors reviewed and approved for publication.

**References**


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Cherise Araujo
Corporate and Governance Services
Canadian Medical Association
1867 Alta Vista Drive, Ottawa ON K1G 5W8
Fax 613 526-7570, Tel 800 663-7336 x1949
cherise.araujo@cma.ca

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Laparoscopic right hemicolectomy with intracorporeal versus extracorporeal anastomosis: a comparison of short-term outcomes

**Background:** There is wide variation among laparoscopic colon resection techniques, including the approach for mobilization and the extent of intracorporeal vessel ligation, bowel division or anastamosis. We compared the short-term outcomes of laparoscopic right hemicolectomy (LRHC) with intracorporeal (IA) versus extracorporeal (EA) anastamosis.

**Methods:** We retrospectively reviewed all elective laparoscopic right hemicolectomies performed at St. Joseph’s Hospital between January 2008 and September 2009 and compared the demographic, pathologic, operative and outcome data.

**Results:** Fifty LRHCs were completed during the study period: 21 IA and 29 EA. The groups were similar in age, sex, body mass index, American Society of Anesthesiologists score, previous laparotomy and preoperative invasive pathology. There was no difference between IA and EA in mean duration of surgery (170 v. 181 min, \( p = 0.78 \)), estimated blood loss (14 v. 42 mL, \( p = 0.15 \)), perioperative blood transfusions (5% v. 14%, \( p = 0.29 \)), in-hospital morbidity (33% v. 41%, \( p = 0.56 \)), out-of-hospital morbidity (19% v. 31%, \( p = 0.34 \)), emergency department visits (10% v. 17%, \( p = 0.16 \)) or 30-day readmissions (5% v. 7%, \( p = 0.75 \)). There was 1 anastomotic leak in each group and no perioperative deaths. Median length of stay was significantly shorter for IA (4 v. 5 d, \( p = 0.05 \)). There were 6 extraction site hernias with EA and none with IA (\( p = 0.026 \)).

**Conclusion:** Laparoscopic right hemicolectomy with IA has the advantage of a less hernia-prone Pfannenstiel extraction site, faster recovery and shorter stay in hospital EA.

Ashley S. Vergis, MD, MMed
Sarah N. Steigerwald, MD, MSc
Faizal D. Bhojani, MD
Paul A. Sullivan, MD
Krista M. Hardy, MD, MSc


Accepted for publication July 30, 2014

Correspondence to:
K.M. Hardy
Z3049-409 Tache Ave.
St. Boniface Hospital
Winnipeg MB R2H 2A6
krista.hardy@yahoo.ca

DOI: 10.1503/cjs.001914

Contexte : Il existe énormément de variations entre les techniques d’exérèse du côlon par laparoscopie, y compris en ce qui concerne l’approche adoptée pour la mobilisation et l’étendue de la ligature vasculaire intracorporelle, la séparation du côlon ou l’anastomose. Nous avons comparé les résultats à court terme de l’hémicolectomie droite laparascopique (HDL) avec anastomose intracorporelle (AI) aux résultats de l’HDL avec anastomose extracorporelle (AE).


Résultats : Cinquante HDL ont été pratiquées au cours de l’étude : 21 avec AI et 29 avec AE. Les groupes de patients étaient comparables pour ce qui était de l’âge, du sexe, de l’indice de masse corporelle, du score de l’American Society of Anesthesiologists, des antécédents de laparotomie et de la pathologie invasive préopératoire. Aucune différence n’a été observée entre l’AI et l’AE pour ce qui est de la durée moyenne de l’intervention chirurgicale (170 c. 181 min, \( p = 0.78 \)), de la perte de sang estimée (14 c. 42 mL, \( p = 0.15 \)), des transfusions sanguines péri-opératoires (5% c. 14%, \( p = 0.29 \)), de la morbidité hospitalière (33% c. à 41%, \( p = 0.56 \)), de la morbidité extra-hospitalière (19% c. 31%, \( p = 0.34 \)), des admissions à l’urgence (10% c. 17%, \( p = 0.16 \)) ou des réadmissions à l’hôpital dans les 30 jours (5% c. 7%, \( p = 0.75 \)). On a signalé 1 fuite anastomotique dans chaque groupe, mais aucun décès péri-opératoire. La durée médiane de l’hospitalisation était significativement plus courte pour les AE (4 v. 5 d, \( p = 0.05 \)). Il y a eu 6 hernies au point d’extraction pour les AE, mais aucune pour les AI (\( p = 0.026 \)).

Conclusion : L’hémicolectomie droite laparascopique avec AI a l’avantage de réduire le risque d’hernie au point d’extraction après incision de Pfannenstiel, d’accélérer le rétablissement de réduire la durée de l’hospitalisation.
Laparoscopic right hemicolectomy (LRHC) has gained acceptance in the treatment of a variety of benign and malignant conditions. Large randomized trials have demonstrated oncologically equivalent outcomes for laparoscopic and open colon resection.\textsuperscript{1-3} Laparoscopy has the additional benefits of improved postoperative recovery, reduced analgesia requirements and shorter length of hospital stay.\textsuperscript{2,4-6} There is also evolving evidence for long-term benefits, including reduced bowel obstructions and ventral hernias.\textsuperscript{4,7-9}

There is wide variation among laparoscopic colon resection techniques, including the approach for mobilization (medial-to-lateral v. lateral-to-medial) and the extent of intracorporeal vessel ligation, bowel division or anastomosis.\textsuperscript{1,5} Various terminology has been used to describe the different approaches. The term laparoscopic-assisted colectomy encompasses procedures in which a variable portion of the dissection and mobilization is performed intracorporeally followed by exteriorization of the bowel for the extracorporeal anastomosis (EA).\textsuperscript{3,4,10} Alternatively, a totally laparoscopic colectomy refers to a procedure in which the entire mobilization, resection and anastomosis is performed intracorporeally (IA) before specimen extraction.\textsuperscript{3,4,10} We sought to compare the short-term outcomes of LRHC using either an IA or EA technique.

Methods

Patients

We retrospectively reviewed the charts of all patients undergoing elective LRHC performed by 5 surgeons at St. Joseph’s Hospital, Toronto, Ont., between January 2008 and September 2009. This time frame was a sample of convenience with intermediate follow-up for hernias. Patients were identified from the operating room database by procedure codes. Patients undergoing extended right hemicolecctiony or ileocolic resection were included. Patients undergoing emergency procedures or those who had a conversion to open procedure were excluded from the analysis.

We collected patient demographic, preoperative and operative data, including age, sex, body mass index (BMI), American Society of Anesthesiologists (ASA) score, comorbidities, previous laparotomy, preoperative diagnosis, computed tomography (CT) findings, duration of surgery, extraction site, analgesia (epidural or spinal), number of stapler firings, use of alternate devices, estimated blood loss (EBL), intraoperative blood transfusions and complications. We also collected pathologic data, including tumour–node–metastasis (TNM) status, number of nodes examined, number of positive nodes and lymphovascular invasion. Outcome data included length of stay (LOS), in-hospital complications, intensive care unit (ICU) admissions, out-of-hospital complications, emergency department visits and 30-day readmissions. Patients were monitored for extraction and port site hernias with a median follow-up time of 32 months.

Surgical technique

All patients underwent colonoscopy. Patients also had CT imaging of the abdomen unless the indication for colectomy was a polyp not amenable to endoscopic removal, without documented dysplasia or malignancy.

Preoperative prophylaxis with unfractionated heparin and intravenous antibiotics was administered to all patients. Patients did not receive preoperative mechanical bowel preparation, routine nasogastric tubes or drains. The insertion of an epidural or spinal anesthetic was determined by the anesthesiologist.

Intraoperatively, mobilization was performed with the medial-to-lateral approach. Vascular pedicles were ligated with clips or vascular staple cartridges.

The EA involved a midline extraction or transverse rectus extraction site. The bowel division was performed with open staplers. A side-to-side staple anastomosis was performed and the enterotomy was closed with a linear stapler. The extraction sites were closed at the fascial level using running absorbable suture (0 Biosyn).

The IA required division of the ileum and transverse colon with endoscopic staplers, followed by a side-to-side endoscopic stapled anastomosis (3 staple cartridges). The enterocolotomy defect was then closed with a running absorbable 3–0 suture (Polysorb). The specimen extraction was usually performed through a traditional Pfannenstiel incision with a transverse incision of the skin, subcutaneous tissue and rectus sheath, followed by vertical spreading of the rectus muscles in the midline. However, 1 patient had a transverse rectus extraction site and 1 had a midline extraction. The Pfannenstiel incision was closed with absorbable interrupted muscular sutures (2–0 Polysorb) and a running fascial stitch (0 Biosyn).

Fascial incision length was not documented in the records for this review. However, in our practice, usual fascial incisions start at 4–5 cm for IA and 7–8 cm for EA. A longer initial incision is required for EA to accommodate the presence of both proximal and distal bowel lumens and staplers in the extraction site. Incisions are extended to accommodate body habitus, specimen size and bulky mesenteries as needed.

Statistical analysis

We performed our statistical analyses using SPSS software version 20.0. Quantitative variables were analyzed using a 2-tailed, unpaired Student \( t \) test. Categorial variables were analyzed using the Pearson \( \chi^2 \) or Fisher exact test. We considered results to be significant at \( p < 0.05 \).
Results

Demographics

Fifty patients underwent an elective laparoscopic right colon resection during our study period: 29 with EA and 21 with IA. The procedures included 45 right hemicolectomies, 4 extended right hemicolectomies and 1 ileocolic resection. Our sample comprised 26 men and 24 women. There was no difference in demographic and clinical characteristics, including mean age, sex, BMI, previous laparotomy, preoperative invasive pathology and mean ASA score, between the EA and IA groups (Table 1).

Intraoperative data

Most patients undergoing an EA procedure had a midline extraction site (93%). Alternatively, a Pfannenstiel incision was used for most IA procedures (90%). When comparing EA and IA procedures, there was no difference in mean duration of surgery, mean EBL, stapled ileocolic pedicle or use of a spinal versus an epidural anesthetic. The average number of Endo GIA stapler firings was 0.6 for the EA group and 4 for the IA group. The average number of open GIA and TA staplers for use for laparoscopically assisted procedures was 3 and 1, respectively. No patients required intraoperative blood transfusions (Table 2).

Final pathology revealed invasive adenocarcinoma in more EA than IA patients (24 v. 9, \( p = 0.003 \)). In those patients with invasive cancer, there was no difference between groups in terms of tumour size, number of nodes examined or number of positive nodes. There was no difference in use of postoperative patient-controlled analgesia or postoperative blood transfusion between the EA and IA groups (Table 3).

The median LOS was significantly shorter for the IA than the EA group (4 v. 5 d, \( p = 0.05 \)). The IA group also had an earlier resumption of solid oral intake (2.43 vs. 3.2 d, \( p = 0.023 \)). There was no difference in in-hospital morbidity or mortality, out-of-hospital morbidity, ICU admissions, emergency department visits and 30-day readmissions (Table 4). The most common morbidities were wound infections, ileus and cardiac arrhythmias.

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Table 1. Patient demographic and clinical characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>IA</th>
<th>EA</th>
<th>( p ) value</th>
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<tbody>
<tr>
<td>No. of patients</td>
<td>21</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>Age, mean yr</td>
<td>65</td>
<td>69</td>
<td>0.32</td>
</tr>
<tr>
<td>Male:female</td>
<td>13:8</td>
<td>13:16</td>
<td>0.23</td>
</tr>
<tr>
<td>BMI, mean</td>
<td>27.67</td>
<td>28.64</td>
<td>0.56</td>
</tr>
<tr>
<td>Previous laparotomy, yes:no</td>
<td>4:17</td>
<td>4:25</td>
<td>0.71</td>
</tr>
<tr>
<td>Preoperative colonoscopy yes:no</td>
<td>21:0</td>
<td>29:0</td>
<td>&gt; 0.99</td>
</tr>
<tr>
<td>Preoperative pathology invasive: all others</td>
<td>11:10</td>
<td>16:13</td>
<td>0.85</td>
</tr>
<tr>
<td>Preoperative CT yes:no</td>
<td>19:2</td>
<td>26:3</td>
<td>0.92</td>
</tr>
</tbody>
</table>

BMI = body mass index; CT = computed tomography; EA = extracorporeal anastomosis; IA = intracorporeal anastomosis.

*Indications for operation included invasive neoplasm (\( n = 27 \)), dysplastic polyp (\( n = 5 \)), adenoma (\( n = 9 \)), benign lesion (\( n = 2 \)), indeterminate lesion (\( n = 4 \)), appendiceal mass (\( n = 1 \)) and unknown (\( n = 2 \)).

Table 2. Intraoperative data

<table>
<thead>
<tr>
<th>Intraoperative measure</th>
<th>Extraction site, no. (%)*</th>
<th>( p ) value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Midline</td>
<td>IA</td>
<td>EA</td>
</tr>
<tr>
<td>Pfannenstiel</td>
<td>19</td>
<td>0</td>
</tr>
<tr>
<td>Transverse rectus</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Duration of surgery, mean (range) min</td>
<td>170 (121–237)</td>
<td>181 (98–205)</td>
</tr>
<tr>
<td>IC pedicle (stapled other)</td>
<td>19.2</td>
<td>17.12</td>
</tr>
<tr>
<td>No. Endo GIA, mean</td>
<td>4.0</td>
<td>0.6</td>
</tr>
<tr>
<td>No. open GIA, mean</td>
<td>0.0</td>
<td>3.0</td>
</tr>
<tr>
<td>No. open TA, mean</td>
<td>0.1</td>
<td>1.0</td>
</tr>
<tr>
<td>Use of alternate devices, yes:no</td>
<td>4.17</td>
<td>4.25</td>
</tr>
<tr>
<td>ASA score, mean</td>
<td>2.65</td>
<td>3.04</td>
</tr>
<tr>
<td>EBL, mean mL</td>
<td>14</td>
<td>43</td>
</tr>
<tr>
<td>No. intraoperative transfusions</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Anesthesia, epidural:spinal</td>
<td>3.14</td>
<td>7.15</td>
</tr>
</tbody>
</table>

ASA = American Society of Anesthesiologists; EA = extracorporeal anastomosis; IA = intracorporeal anastomosis; IC = ileocolic.

*Unless otherwise indicated.
With a median follow-up of 32 months, there were significantly more extraction site hernias in the EA group than the IA group (6 v. 0, \( p = 0.026 \)). There was 1 asymptomatic port site hernia in the IA group.

There was 1 reoperation in the IA group for an anastomotic leak. The patient was a 51 year-old man with a preoperative diagnosis of tubulovillous adenoma with high-grade dysplasia. His postoperative course was complicated by an anastomotic leak requiring a laparotomy and end ileostomy. The patient also experienced a pulmonary embolism and a wound infection, and his total LOS was 28 days.

There was 1 contained anastomotic leak in the EA group requiring percutaneous drainage. The 54-year-old otherwise healthy man had a preoperative diagnosis of tubulovillous adenoma with high-grade dysplasia. The patient’s initial LOS was 4 days. A rectus sheath hematoma developed, and he was readmitted with an intra-abdominal abscess requiring percutaneous drainage. The drainage output was confirmed to be a controlled fistula from an abscess requiring percutaneous drainage. The drainage was managed on an outpatient basis and resolved with conservative management.

### Discussion

Laparoscopic colorectal surgery offers both short and long-term benefits compared with open colorectal surgery. These benefits include less postoperative pain, better pulmonary function, less postoperative ileus and shorter LOS. In addition, meta-analysis and randomized controlled trials with level-1 evidence have demonstrated that laparoscopic colorectal surgery achieves oncological outcomes that are no different from those achieved with the conventional open approach.\(^{11-13}\)

The results of our study show that LRHC with IA is associated with significantly shorter median LOS and fewer extraction site hernias than EA. The factors affecting LOS are difficult to determine from this retrospective review but are likely numerous. It has been established that lower abdominal incisions in both open and laparoscopic abdominal surgery have numerous advantages, including decreased pain, fewer pulmonary complications and earlier return to gastrointestinal function, compared with mid- or upper abdominal incisions.\(^{14-18}\) All of these factors are thought to influence LOS. We postulate that these advantages factor into the shorter median LOS in the IA group, who generally had their extractions at the low suprapubic Pfannenstiel site. Our findings are consistent with those reported in case–control studies and a systematic review comparing totally laparoscopic (with IA) and laparoscopically assisted (with EA) right hemicolectomy.\(^{10,12}\)

Incisional hernia is a complication of both open and laparoscopic colorectal surgery. The initial enthusiasm regarding potential decreases in incisional hernia owing to smaller incisions after laparoscopic colorectal surgery has been somewhat tempered. At least 2 prospective randomized trials have shown similar hernia rates after midline incision in both open and laparoscopic colonic surgery.\(^{19,20}\) The reported ranges were disparate between the investigations, with 1 trial reporting rates of 4.7% versus 8.9% and the other reporting rates of 24.3% versus 19.6% for laparoscopic versus open surgeries, respectively. The differences in absolute numbers between the 2 trials may be related to definitions used for incisional hernia. It should be noted that the literature is somewhat inconsistent, as these data contradict the results of other reviews.\(^{8,9}\) The reason for not realizing improved hernia rates after midline extraction sites compared with open laparotomy are not well described. It may relate to abdominal force distribution over a shorter incisional length. This relatively increased force per unit length may obviate the benefit of the smaller incision as it relates to hernia formation.

The benefit of transverse incisions on hernia occurrence for laparotomy and laparoscopic colorectal extractions are well described.\(^{7,17,21-24}\) Although not proven, the reason that muscle spreading, transverse fascial extraction incisions are less hernia prone is likely based on anatomic principles. First, spreading the rectus, transverse or oblique musculature in

### Table 3. Postoperative data

<table>
<thead>
<tr>
<th>Outcome measure</th>
<th>IA (n)</th>
<th>EA (n)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCA, yes:no</td>
<td>5:16</td>
<td>14:15</td>
<td>0.08</td>
</tr>
<tr>
<td>Postoperative transfusion, yes:no</td>
<td>1:20</td>
<td>4:25</td>
<td>0.29</td>
</tr>
<tr>
<td>Type, invasive:all others</td>
<td>9:12</td>
<td>24:5</td>
<td>0.003</td>
</tr>
<tr>
<td>Gross size (invasive only) cm</td>
<td>5.44</td>
<td>4.82</td>
<td>0.43</td>
</tr>
<tr>
<td>Node positive (invasive only), yes:no</td>
<td>5.4</td>
<td>14.10</td>
<td>0.89</td>
</tr>
<tr>
<td>No. positive nodes (invasive only)</td>
<td>2.78</td>
<td>2.54</td>
<td>0.86</td>
</tr>
<tr>
<td>No. nodes examined (invasive only)</td>
<td>19.1</td>
<td>17.2</td>
<td>0.50</td>
</tr>
</tbody>
</table>

EA = extracorporeal anastomosis; IA = intracorporeal anastomosis; PCA = patient-controlled analgesia.

### Table 4. Outcome data

<table>
<thead>
<tr>
<th>Outcome measure</th>
<th>IA (n)</th>
<th>EA (n)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median LOS, d</td>
<td>4.00</td>
<td>5.00</td>
<td>0.05</td>
</tr>
<tr>
<td>Mean LOS, d</td>
<td>5.33</td>
<td>5.86</td>
<td>0.67</td>
</tr>
<tr>
<td>Mean d to resumption of fluids</td>
<td>0.90</td>
<td>1.10</td>
<td>0.14</td>
</tr>
<tr>
<td>Mean d to resumption of solids</td>
<td>2.43</td>
<td>3.21</td>
<td>0.023</td>
</tr>
<tr>
<td>In-hospital complications, yes:no</td>
<td>7:14</td>
<td>12:17</td>
<td>0.56</td>
</tr>
<tr>
<td>Out-of-hospital complications, yes:no</td>
<td>4:17</td>
<td>9:20</td>
<td>0.34</td>
</tr>
<tr>
<td>Wound infection, yes:no</td>
<td>3:18</td>
<td>7:22</td>
<td>0.39</td>
</tr>
<tr>
<td>Hernia, yes:no</td>
<td>0:21</td>
<td>6:23</td>
<td>0.026</td>
</tr>
<tr>
<td>Total no. of reoperations required</td>
<td>1:20</td>
<td>6:23</td>
<td>0.11</td>
</tr>
<tr>
<td>No. of ICU admissions</td>
<td>1:0</td>
<td>0:0</td>
<td></td>
</tr>
<tr>
<td>Emergency department visits, yes:no</td>
<td>2:19</td>
<td>5:14</td>
<td>0.16</td>
</tr>
<tr>
<td>In-hospital mortality</td>
<td>0:0</td>
<td>0:0</td>
<td></td>
</tr>
<tr>
<td>30-d readmission, yes:no</td>
<td>1:20</td>
<td>2:27</td>
<td>0.75</td>
</tr>
</tbody>
</table>

EA = extracorporeal anastomosis; IA = intracorporeal anastomosis; ICU = intensive care unit; LOS = length of stay.
the direction of its fibres spares the blood supply as the incision runs parallel to the segmental arteries supplying them. Second, reapproximation of the muscle affords a type of 2-layer closure in that the muscle may buttress the fascial repair. Third, the defects created in the muscle and fascia lay perpendicular to each other, resulting in no significant full-thickness disruption of the abdominal wall at any given point along the incision when the layers are closed. The midline incision, however, results in a full-thickness injury through the relatively avascular linea alba, which is then susceptible to the lateral forces generated along its length.

Although there are substantial data supporting the association between laparoscopic colorectal resections with transverse extraction sites and less hernia formation, these studies usually examine all colonic segments of resection.22,23 With total colectomy, left-sided and rectal resections, the IA may be performed with a circular stapling device transanally to create an ileo- or colorectal anastomosis. In these cases, exteriorizing the bowel may be readily done through a transverse or Pfannenstiel incision. In LRHC, bowel exteriorization and EA is most easily and safely done through the midline as the incision can be extended without difficulty to accommodate bulky mesenteries or control bleeding if traction injuries occur. Anatomic constraints generally preclude EA through a low transverse incision.

In our study, there were 6 cases (21%) of extraction site hernias in the EA group and 1 case (5%) of port site hernia in the IA group at follow-up. All of the patients with extraction site hernias in the EA group were symptomatic and underwent definitive repair. The port site hernia was asymptomatic and smaller than 1 cm and was noted only by the examining surgeon. It has been included in this report as possible transparency. The patient did not proceed to surgical correction. These data support the use of IA with transverse extraction sites in relation to reduced hernia rates.

There are few other data addressing hernia formation specifically in LRHC with IA. Facy and colleagues24 reported a 2.4% hernia rate (2 of 82) in their series of patients who underwent LRHC with IA. There was no comparison group in their report.

Perceived disadvantages for LRHC with IA may include the necessity of intracorporeal suturing techniques and increased use of operating room resources, such as use of endoscopic staplers. Although intracorporeal laparoscopic suturing is a novel skill for many surgeons, it should be emphasized that this study occurred at an urban teaching hospital where the majority of procedures are completed by senior surgical residents under the supervision of laparoscopic surgeons with no need for conversion for intraoperative complications or for inability to complete the anastomosis. We contend that surgeons can use intracorporeal suturing techniques efficiently after a period of appropriate mentorship. There was no difference in duration of surgery or use of resources other than endoscopic staplers. Although our study did not involve a cost analysis, one can estimate an increased direct cost of endoscopic staplers of approximately $1064 per case based on current price structures. This cost is offset by shorter LOS based on previous investigation in our region ($1920/d). This savings would be compounded if reoperation for hernia repair were considered.

We believe that LRHC with IA has other advantages over EA that were not specifically assessed in this study; LRHC with IA allows the surgeon to have constant, direct vision of the entire surgical field. This may minimize potential bowel orientation errors while performing ileocolic anastomosis. In addition, IA may reduce the risk of microlacerations associated with increased manipulation and traction, thereby potentially increasing the success of the anastomosis25 and reducing postoperative ileus. This is particularly important in an ever-increasingly obese population, as these patients have larger specimens with heavy, fatty mesenteries and much thicker abdominal walls.

**Limitations**

In this retrospective chart review we were unable to determine whether patients in whom hernias developed had significantly greater risk factors, such as obesity or wound complications, as this information was variably recorded. In addition, the groups were dissimilar in that there were substantially more invasive lesions removed from the EA than the IA group on final pathology (Table 3). Preoperatively there had been no significant difference between the groups (Table 1). This would not impact the surgeon’s preoperative decision to perform either an IA or an EA, as an invasive lesion is not a contraindication to either anastomosis technique. There were no conversions from IA to EA over the review period.

Finally this retrospective study was nonblinded and had a relatively small sample size. This could influence results, especially if there were changes in the perioperative management during the 21-month study period. Although the institution did not use a specific perioperative care map at the time, early ambulation, enteral feeding, aggressive pain management and judicious use of intravenous fluids have been embraced since before the period in question. We do not believe there were clinically important changes in patient care plans during this time.

**Conclusion**

We found that LRHC can be performed safely with either IA or EA. Whereas an IA requires advanced laparoscopic suturing skills, it is a feasible procedure that has the advantage of a less hernia-prone Pfannenstiel extraction site with faster recovery and reduced LOS. We believe that LRHC with IA offers substantial advantages to
patients and should be offered by surgeons who have been adequately mentored in this procedure.

Affiliations: From the Division of General Surgery, Department of Surgery, University of Manitoba, Winnipeg, Man. (Verbis, Steigerwald, Hardy), Department of Surgery, Guelph General Hospital, Guelph, Ont. (Bhojani), Division of General Surgery, Department of Surgery, University of Toronto, Toronto, Ont. (Sullivan).

Competing interests: None declared.

Contributors: A. Verbis and K. Hardy designed the study. A. Verbis, F. Bhojani, P. Sullivan and K. Hardy acquired the data, which A. Verbis, S. Steigerwald and K. Hardy analyzed. A. Verbis, S. Steigerwald and K. Hardy wrote the article, which all authors reviewed and approved for publication.

References

Safety of a no-fast protocol for tracheotomy in critical care

Trevor Hartl, MD
Donald Anderson, MD
Jasna Levi, MD, MSc

Accepted for publication
Feb. 24, 2014
Early-released Dec. 1, 2014

Correspondence to:
T. Hartl
103 — 34143 Marshall Rd.
Abbotsford BC V2S 1L8
trevor.hartl@gmail.com

DOI: 10.1503/cjs.027213

Tracheotomy remains one of the most commonly performed procedures in critically ill patients; as many as 12% of patients receiving mechanical ventilation in the intensive care unit (ICU) undergo tracheotomy for prolonged mechanical ventilation or airway support.

Minimizing gastric residuals before surgery with the patient under general anesthesia is considered standard practice to reduce the risk of pulmonary aspiration during surgery. To achieve this goal, a policy for preoperative fasting exists in many hospital ICUs, and the procedure is commonly implemented as nulla per os (NPO) from midnight the evening before surgery.

However, with modern anesthesia, aspiration is an exceedingly rare complication, and we have learned that a prolonged fast can result in serious adverse effects in critically ill patients. In the last decade, changes to the NPO from midnight policy have been suggested by various professional groups, including the American Society of Anesthesiologists, which has developed guidelines in support of more liberal preoperative fasting protocols in certain situations. Based on this guideline and on the rational judgment of intensivists and otolaryngologists at the Vancouver General Hospital (VGH), in 2007 the VGH ICU changed its policy for intubated, tube-fed adult patients who underwent elective open tracheotomy; for these patients, a “no-fast” protocol was implemented.

We evaluated the safety (relative to the traditional fasting protocol) of this new no-fast protocol. We compared the number of clinically significant aspiration events that occurred during an open tracheotomy procedure the year before and the year after the no-fast protocol was introduced in the VGH ICU. We defined “clinically significant aspiration” based on a landmark study conducted in 1993 of more than 120 000 procedures involving general anesthetic:

(...) The occurrence of objective aspiration of gastric contents during the procedure (as documented in the surgical postoperative note and/or anesthetic record) combined with 1 or more signs of respiratory deteriorations (new cough or wheeze, new pulmonary infiltrate reported on chest X-ray, a ≥ 10% increased required oxygen flow rate (FiO₂), or an alveolar-arterial oxygen tension ≥ 300 mm Hg) that occurred within the first 2 hours after the open tracheotomy procedure.

To evaluate the protocol, we conducted a retrospective, observational cohort study using data obtained from the target population of intubated, tube-fed, adult (> 16 yr) patients in the VGH ICU who underwent elective open tracheotomy between May 1, 2007, (date of protocol change) and Apr. 30, 2008. Our preprotocol control group underwent elective open tracheotomy between May 1, 2006, and Apr. 30, 2007.

SUMMARY

With modern anesthesia, aspiration is an exceedingly rare complication, and we have learned that a prolonged fast can result in serious adverse effects in critically ill patients. We discuss the no-fast protocol implemented at Vancouver General Hospital in 2007 for intubated, tube-fed adult patients who underwent elective open tracheotomy.
The protocol received ethical approval from the University of British Columbia Clinical Research Ethics Board.

A total of 318 patients were evaluated in the study. The characteristics of each study group were roughly the same; a summary is presented in Table 1.

In the no-fast group, no significant events occurred, whereas in our historical NPO after midnight control group, 1 event meeting our definition occurred. These results indicate that a no-fast protocol may be a safe alternative to a traditional fasting policy for these patients when undergoing this procedure. However, our relatively small sample size precludes us from making a statistically significant comparison; the incidence of pulmonary aspiration of gastric contents during general anesthesia for all patients undergoing elective procedures is reported to be approximately 1 in 3000 cases; therefore, aspiration is expected to be an exceedingly rare event.

The potential benefits of a change to the traditional fasting protocol in this setting deserve our attention. The ability to safely provide nutrition for the entire preoperative period has significant advantages in this patient population. Patients who are admitted to the ICU are much more likely to experience the adverse effects associated with malnutrition, such as a poorer ventilatory status; increased vulnerability to infection; and increased length of stay in the hospital, including poorer healing, complications related to nonhealing wounds and improved patient comfort. Furthermore, the hypercatabolic state of this patient population due to the known metabolic response to critical illness can lead to wasting of lean body mass, a decrease in immune function and impairment of visceral organ function.

The ability of the surgical team to have these patients in the OR without any interruption in nutrition is therefore a likely benefit to the overall well-being and recovery of the patient.

In addition to these potential patient benefits, it is important to note that shortened wait times for a tracheotomy (a noted side effect of the policy change at VGH) also benefit the medical system with regard to efficiency and cost. Decreasing recovery time and postoperative complications results in the ability to transfer ventilator-dependent patients from the ICU earlier and more safely to a ward bed and reduces the overall length of stay in hospital and hospital costs.

In the critical care setting, where patients are intubated and tube-fed and require an open tracheotomy, a preoperative no-fast protocol may be a safe alternative to traditional fasting, bringing significant potential health benefits to critically ill patients as well as real cost and system advantages. During our evaluation period, no aspiration events were recorded in the 160 tracheotomies performed. Given the rarity of the event, a multicentre analysis with requisite case volumes may be the next step to adequately power a conclusive comparison.

Affiliations: All authors are from the Department of Surgery, University of British Columbia, Vancouver, BC.

Competing interests: None declared.

Contributors: T. Hartl wrote the article. All authors contributed substantially to the conception and design of the manuscript and revised and approved the final version submitted for publication.

References
The Coeditors, on behalf of the Canadian Journal of Surgery Editorial Board, acknowledge with thanks the cooperation of the following reviewers over the past year.

Au nom du conseil de redaction du Journal canadien de chirurgie, les corédacteurs remercient les examinateurs suivants de leur collaboration au cours de l’année écoulée.

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N Wassif  
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Hamilton, Canada

D Zukor  
Montréal, Canada
THE ROLES OF EXPERIENCE, PARTICIPATION RATES AND JUDGMENT IN THE INJURY RATES OF WEEKEND WARRIORS

We challenge the conclusion in the article, “The ‘weekend warrior’: Fact or fiction for major trauma?” that adventure sport recreationists are at a higher risk of injury on weekends due to the compression of exercise, its resultant fatigue, and a lack of experience. It is submitted that the causes for the discrepancy in injury rates between weekdays and weekends can be attributed to increased participation rates on weekends and that incidents occur for a myriad of reasons, including risks inherent to the activities and errors in judgment, irrespective of experience level.

We welcomed the article for its interesting insight into the number of recreationists injured in various adventure sport activities on weekdays compared with weekends, but we were troubled by its neglect to account for errors in judgment and the role of participation rates in these skewed injury rates.

Notwithstanding its usage in the medical literature, the term “weekend warrior” is pejorative and is generally not complementary to those who are on its receiving end. It implies amateurishness, irresponsibility and recklessness, traits not necessarily associated with those who recreate on weekends. These stereotypes are unfortunately perpetuated by the speculation that weekend warriors’ higher rates of severe injury is caused by prolonged exercise beyond one’s inherent exercise tolerance or a lack of experience.

It is accepted that injury rates are affected by participant skill level, but it is not as simple as saying greater experience leads to fewer injuries. In its position statement on skiing and snowboarding injury prevention, the Canadian Pediatric Society properly noted that, “while injury rates have been shown to be lower for expert skiers and snowboarders compared with beginners, experts may be at risk for more severe injuries.” The American Orthopedic Society for Sports Medicine has similarly noted that beginner skiers have 3 times the injury rate of experts, but that their injuries are less severe than those of expert skiers, who sustain less frequent but more severe injuries.

While the above figures relate to skiing and snowboarding, which were excluded in the study, in light of the median injury severity score being 17 on weekdays and 19 on weekends, it ought to have been the other way around due to the weekend warriors’ apparent lack of experience.

Many of the activities cited involve significant environmental hazards. Within the data presented, many of the injuries could be the result of the inherent risks of the activity. An annual summary of data regarding accidents in North American mountaineering, rock climbing, and mountain hiking found the immediate causes of the compiled accidents to be (in order) falls/slips, falling objects (i.e., rock), exceeding abilities, illness, being stranded, avalanche and anchor failure. Several of these causes (i.e., falling objects, avalanche) are inherent risks of mountain travel and are unrelated to physical fitness. The remaining causes align with related work on human error in high risk sport, which finds behavioural factors, such as errors in judgment, excessive speed and lack of preparation, contribute to accidents.

Work on human factors identifies the complex social environment where one works or plays, with peer pressure, social proof and social identification all clouding one’s judgment of one’s ability. The human error field has long recognized that there are many contributing factors to any single event. Roberts and colleagues’ conclusion regarding physical fitness is overly simplistic. We are also concerned that the conclusion that weekend warriors may be at an increased risk of injury due to the compression of weekly exercise volume into a weekend is not supported by the evidence.

The weekend warrior study did not take into account the differences in activity usage on weekdays versus weekends. While it showed that 54.8% of injuries were sustained on the weekend, it is problematic to frame the extent to which this figure is actually significant. For example, in Canada’s climbing mecca of Squamish, BC, there are 53% more climbers on each day of the weekend than on any given weekday. It may simply be that the reason there are more weekend warriors injured on weekends is that there are more weekend warriors recreating on weekends.

While we agree with the conclusion that weekend warriors should be aware of the risk of severe injury associated with intense and sustained weekend recreation, we believe that the reason for the increased incidence of injuries on weekends has less to do with the compression of exercise and more to do with there being more recreationists on the weekends. There should be more research into the root causes, including skill level, decision-making in uncertainty and the proper accounting of participation rates on different days of the week, before conclusions are made about weekend warriors being at a higher risk of injury.

Jon Heshka, BSc, BA, BEd, MEd, LLM
Jeff Jackson, BBA, MEd, PhD
Faculty of Law, Thompson Rivers University Outdoor Adventure Program, Algonquin College

DOI: 10.1503/cjs.011114
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Author response

We thank the authors for their interest in this preliminary weekend warrior study. While we agree with many of their comments, their reference to a negative assertion associated within the term “weekend warrior” is unclear to us. We have not witnessed any particular negativity associated with this term. More specifically, many of our patients use it as a badge of honour to indicate a continued attempt at maintaining a healthy and active lifestyle in the era of long work weeks and sustained commitment to family and occupation. In fact, the term is used in a friendly supportive manner among some of our most accomplished athletes injured on the weekend (i.e., ex-Olympians).

We do agree that this work is preliminary. As previously documented in our centre’s equestrian injury publications, the only way to truly determine root cause factors remains prolonged individual patient follow-up. This is currently underway among our weekend warriors and will hopefully provide us with definitive data on skill level and decision making analyses. We look forward to presenting this data in the near future.

Chad G. Ball
Associate Professor of Surgery and Oncology
Hepatobiliary and Pancreatic Surgery
Trauma and Acute Care Surgery

DOI: 10.1503/cjs.015114

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Humble correspondence: gaining a foothold in the surgical literature

We enjoyed Farooq and White’s essay that paints a wonderfully accurate picture of our educational world, where “rapid communications technology” rules the roost. They intelligently describe the myriad benefits of our technological age, while balancing these against drawbacks, including potential distractions. However, they neglect online journals, which are now ubiquitous. Through online content, students and surgeons can instantly access and learn from articles that previously took weeks to obtain, thus hugely progressing our profession.

Telecommunication has utterly revolutionized the process of publishing research, making this established and fundamentally required practice even easier. Nonetheless, we still perceive another barrier to publication for our future surgeons, the medical students and junior doctors of today.

The blockade is rudimentary: tomorrow’s surgeons simply do not know how to begin publishing. Unfortunately, universities provide inadequate guidance for writing papers, probably due to already swollen curricula, and while seniors may have confidence in our surgical future, concerns exist regarding the need to instill the significance of publishing to the next generation. A thorough discourse is beyond the scope of this piece, but we wish to make some suggestions for surgeons-to-be.

An apropos place to start for first-time writers is correspondence or letters to the editor. These articles are concise opinions in response to published research or stand-alone pieces discussing topical issues or presenting research not substantial enough to warrant a full article. They may not garner as much respect as a review or an original research paper, but they are easier for juniors to write and often data-based. Going through the motions of letter publication provides juniors with important skills, such as cover letter writing, debating authorship and maintaining good academic conduct. Furthermore, they can enjoy seeing their names in print postpublication and gain the satisfaction having generated valuable debate. It is pertinent to remember that letters are opinions and thus the lowest form of evidence on the Oxford Hierarchy of Evidence; as such, juniors must aim to publish more substantial articles. However, naive academic surgeons would be in a stronger position to publish more meaningful papers having gained a foothold in the literature with a humble letter and having acquired the associated skills and confidence.

It can be tricky for the inexperienced to generate appropriate material. This mnemonic might light a
SPARK of an idea:

S — Stay alert for grey areas, changing practice and controversial opinions.
P — Published papers are easily mined, critiqued or added to. Authors deeply value feedback.
A — Attempt submission. Responses are quick and constructive.
R — Revise a rejection. Tweaking is painless.
K — Keep going. If your idea is original or stimulating, it should get accepted for publication.

It is crucial that the surgical community cooperates to bolster the publishing prowess of students and juniors. This will enable a secure surgical future and potentially expand the quality of surgical research: tomorrow’s surgeons will possess greater abilities having started at a foundational juncture. In the meantime, we hope fledgling surgeons take something practical from our suggestions and share our opinion of the great potential of humble correspondence.

Joseph M Norris
Meher Lad
David R McGowan

Department of Surgery, University of Cambridge, Addenbrooke’s Hospital, Cambridge University Hospitals NHS Foundation Trust, Cambridge, Cambridgeshire, UK; Department of Neurology, Newcastle University, Royal Victoria Infirmary, The Newcastle upon Tyne Hospitals NHS Foundation Trust, Newcastle upon Tyne, Tyne and Wear, UK; and Department of Surgery, Northern General Hospital, Sheffield Teaching Hospitals NHS Foundation Trust, Sheffield, South Yorkshire, UK

DOI: 10.1503/cjs.015214

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CMA committees advise the Board of Directors and make recommendations on specific issues of concern to physicians and the public. Five core committees mainly consist of regional, resident and student representation while other statutory and special committees and task forces consist of individuals with interest and expertise in subject-specific fields. Positions on one or more of these committees may become available in the coming year.

For further information on how you can get involved please go to https://www.cma.ca/en/Pages/get-involved-in-cma.aspx, or contact

Cherise Araujo, Corporate and Governance Services
Canadian Medical Association
1867 Alta Vista Drive, Ottawa ON K1G 5W8
Fax 613 526-7570, Tel 800 663-7336 x1949
cherise.araujo@cma.ca

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Pour obtenir plus d’information au sujet des façons de participer, veuillez consulter https://www.cma.ca/fr/Pages/get-involved-in-cma.aspx ou communiquer avec

Cherise Araujo, Services généraux et de gouvernance
Association médicale canadienne
1867, promenade Alta Vista, Ottawa (Ontario) K1G 5W8
Télécopieur : 613 526-7570, Téléphone : 800 663-7336, poste 1949
cherise.araujo@cma.ca

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Dr. Javed Alloo  
Family physician  
Toronto, Ont

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