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Recently, an increasing number of reports have been warning physicians about the dangers of prescribing opioids. This is particularly relevant to our surgical community, given the traditional reliance on this category of medications as postoperative pain relievers. Unfortunately, there is growing evidence in both the formal scientific and popular mainstream literature that the risks of narcotic prescriptions may in fact be doing substantially more harm to our patients than we had ever understood.

Although details outlining the origins of the Sackler brothers’ (both psychiatrists) initial formulation of OxyContin have been locked away for decades in a shadowy, propaganda-laden box, more than 200,000 Americans have died of OxyContin overdoses since 1996. In 2016 alone, 53,000 Americans died from opioid overdoses, compared with 36,000 and 35,000 who died from motor vehicle crashes and gunshot wounds, respectively. For those of us who deal with injured patients on a daily basis, these numbers are comparatively staggering.

While American media dominate this discussion, there are recent data arguing that we may have an even larger opioid crisis in Canada. More specifically, within the first 6 months of 2018 alone, there were 2066 opioid-related deaths in Canada (11.2 deaths per 100,000 people).1 Across the country, Calgary consistently has the highest opioid-related death rate at 18.7 per 100,000 population (687 deaths in 2017) as well as the highest emergency department opioid-related visit rate (8%–10% of all visits over the past 3 years).1,2 Other provinces are not exempt from this public health issue either, given that Ontario leads the country in both total opioid prescriptions (9 million prescriptions per year) and total opioid-related deaths (1250 in 2017).3 Furthermore, Canada is the largest per capita consumer of prescription opioids and second largest prescriber of opioids (35,000 per year) in the developed world.4 One in 7 Canadians fills an opioid prescription each year. This is particularly problematic, considering that up to 75% of all heroin users are first introduced to narcotics through an initial physician- or surgeon-related opioid prescription.5

The dramatic rise in opioid-related deaths (350% increase between 2003 and 2017) mirrors a number of noncoincidental realities that have occurred over this time frame:

- Big Pharma, the American Pain Society, and the American Academy of Pain Medicine (among others) pressured governments and physicians alike to make pain “the fifth vital sign” (with a 10-point associated pain scale). By intensifying the more broad meaning of pain, internal Pharma documentation clearly aims at “attaching an emotional aspect to non-cancer pain” so that physicians feel the need to treat it more aggressively.
- A dizzying variety in opioid types and formulations became much more diverse and therefore challenging to manage.
- The increase in potency of newer narcotics has been significant (the oral morphine equivalent [OME] of hydromorphone [2 mg tablet] is 80, whereas that of codeine [30 mg tablet] is 45).
- Addicts have figured out how to manipulate opioid pills to be consumed in a wide variety of different delivery methods (e.g., ingestion, smoking, inhalation).
- Addicts who could not afford the street cost of many prescribed opioids switched to using more traditional narcotics, such as heroin.
- A strategic and persistent campaign to misinform physicians regarding the abuse potential of many of these opioids (which was successfully litigated by the United States government in 2007) was extremely potent.

Although as surgeons we often believe that our prescription patterns (and therefore patient usage) involve only short-term effects, it is clear that orthopedic surgeons, neurosurgeons and gastrointestinal surgeons consistently make up the top 3 physician prescriber groups.6 The US Centers for Disease Control and Prevention (CDC) stated that opioid use for longer than 5 days is a significant risk factor for subsequent narcotic misuse.4 Furthermore, more than 10% of opioid-naïve Canadians older than 65 years who were prescribed an opioid for a short-stay surgery were identified to be users 1 year after their surgery. A multitude of studies (both multicentre and registry-based) also identify the clear overprescription of opioids following surgical intervention. An audit of more than 7600 patients in the National Surgical

Surgeons as advocates for opioid control

The views expressed in this editorial are those of the author and do not necessarily reflect the position of the Canadian Medical Association or its subsidiaries.
Quality Improvement Program (NSQIP) reported a median of 375 OME prescribed (equivalent to over 70 tramadol tablets).\(^7\) This risk increased with advanced age, female sex, non-cancer diagnoses and obesity. It is also clear that prescribing habits vary widely among surgeons and cannot be explained by either patient or disease factors. To this end, overall prescribing patterns across Canada have shown an equally concerning variance. This reality is echoed by many patients, as only 28% of postsurgical patients use the entirety of their prescribed opioids (and only 9% formally dispose of their unused narcotics). It is also clear that prescription size (i.e., pill count) is directly associated with opioid consumption, and therefore abuse, after surgery.\(^8\)

It is interesting to contemplate the propagation and precise role of chronic pain services across Canada as well. Although these programs are typical for large Canadian cities, their patient inclusion, exclusion and program discharge criteria vary dramatically from site to site. For example, in some programs a mandatory discharge occurs at 1-year postenrolment. In others, discharge is much sooner. Regardless of funding, these programs can be challenging to access, care for a limited number of patients, and are often perceived (by both the patient and the referring physician) to be less than effective for our most complex patients. In 2016, the CDC stated that there was no solid evidence that opioids were an effective treatment for chronic pain beyond the 6-week mark.\(^9,10\)

This is strong food for thought not only as surgeons consider their own patient populations, but also the reality that up to 20% of the decline in the American labour force participation between 1999 and 2015 may be linked directly to chronic opioid use.

To address the opioid crisis, the Canadian government has constructed a formal interventional approach that mandates 4 key elements: prevention, treatment, harm reduction and enforcement. While this initiative is definitely commendable and worth contemplation, we also need to do more as physicians and surgeons. The first step in this endeavour is recognizing that prescription opioids play a major role in subsequent opioid misuse and that the risk of persistent opioid abuse following surgery is real.

We must also follow surgical leaders, such as Ken Leslie, Neil Parry, Daryl Gray and Kelly Vogt at the London Health Sciences Centre, who have created, implemented and studied a standardized, multimodal, opioid-sparing analgesic pathway to control postoperative pain while reducing postoperative opioid prescriptions among outpatients undergoing general surgical procedures (i.e., laparoscopic cholecystectomy, hernia repair, breast surgery, anorectal surgery).\(^11\) By triggering a formal program that included preoperative patient education, knowledge dissemination among surgeons, alternative intraoperative pain management (anti-inflammatories, antiemetics, steroids), and strict postoperative analgesia controls (opioid prescription for only rescue scenarios that expire after 7 days), they reduced their narcotic prescription rate by 90% (only 10% of patients filled the opioid prescription for additional pain control). When extrapolated to Ontario as a whole, the potential amount of narcotic reduction would be impressive (45 000 hernia and cholecystectomy procedures per year in Ontario would lead to 1 million narcotic tablets diverted from unintended usage).

Opioid misuse after surgery is clearly a current public health crisis. By using multimodality therapies, reducing our volume of opioid prescriptions (dose, duration and pill count), and educating patients in the preoperative setting, it is clear that surgeons have a central role and responsibility in decreasing patient risk. Now is the time to contemplate each of our own prescribing habits.

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Les chirurgiens pour le contrôle des opioïdes

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Des rapports de plus en plus nombreux ont récemment mis les médecins en garde contre les dangers des opioïdes prescrits. Cela concerne particulièrement la communauté chirurgicale compte tenu qu’elle a l’habitude de se fier à cette catégorie d’analgésiques pour le postopératoire. Malheureusement, selon les preuves qui s’accumulent dans la littérature, tant scientifique que grand public, les risques posés par la prescription de narcotiques pourraient en fait causer encore plus de tort à nos patients que nous l’avions imaginé.

Même si les détails concernant la recette originale du médicament OxyContin, conçu par les frères Sackler (tous deux psychiatres), sont protégés des regards depuis des décennies, ensevelis sous une lourde propagande, plus de 200 000 Américains sont décédés de surdoses d’OxyContin depuis 1996. En 2016 seulement, on a dénombré 35 000 décès aux États-Unis des suites de surdoses d’opioïdes, comparativement à 36 000 décès survenus sur les routes et 35 000 par arme à feu. Pour ceux d’entre nous qui soignons des blessés tous les jours, cette comparaison donne le vertige.

Tandis que les médias font largement écho de la situation chez nos voisins du Sud, selon certaines données, il se pourrait que la crise des opioïdes soit encore plus grave ici-même, au Canada. Plus spécifiquement, au cours des 6 premiers mois de 2018 seulement, on a enregistré 2066 décès liés aux opioïdes au Canada (11,2 décès par 100 000 habitants). Au pays, c’est Calgary qui détient le triste record du nombre le plus élevé de décès liés aux opioïdes, avec un taux de 18,7 par 100 000 habitants (687 décès en 2017), ainsi que du nombre le plus élevé de consultations aux urgences en lien avec les opioïdes (8 % à 10 % de toutes les consultations au cours des 3 dernières années). Les autres provinces ne sont pas en reste en ce qui concerne cette crise de santé publique car l’Ontario mène le bal pour ce qui est du nombre total d’ordonnances d’opioïdes (9 millions d’ordonnances par année) et du nombre total de décès liés aux opioïdes (1250 en 2017). Le Canada serait en outre le plus grand consommateur d’opioïdes prescrits per capita et le deuxième plus grand prescripteur d’opioïdes (35 000 ordonnances par année) parmi les pays industrialisés. Bon an, mal an, c’est 1 Canadien sur 7 qui se fait prescrire des opioïdes. Le phénomène est d’autant plus troublant que pour 75 % de tous les consommateurs d’héroïne, le premier contact avec les narcotiques est une ordonnance d’opioïdes remise par un médecin ou un chirurgien.

L’augmentation dramatique du nombre de décès liés aux opioïdes (en hausse de 350 % entre 2003 et 2017) est le reflet de plusieurs réalités émergentes qui ont joué un rôle non négligeable pendant cette période:
• Les géants de l’industrie pharmaceutique, l’American Pain Society et l’American Academy of Pain Medicine (entre autres) ont fait pression sur les gouvernements et les médecins pour faire de la douleur « le cinquième signe vital » (avec une échelle d’évaluation de la douleur en 10 points). Insistant sur une définition élargie de la douleur, les documents internes de l’industrie pharmaceutique soutiennent clairement « ajouter une charge émotive à la douleur non cancèreuse » pour que les médecins se sentent obligés de la traiter plus énergiquement.
• Les types et préparations d’opioïdes se sont diversifiés et multipliés à un point tel, que la question de l’analgésie est devenue très complexe à gérer.
• Les nouveaux narcotiques ont significativement gagné en puissance (l’équivalent en morphine orale [EMO] de l’hydromorphone [comprimé de 2 mg] est de 80, tandis que celui de la codeïne [comprimé de 30 mg] est de 45).
• Les personnes dépendantes ont appris comment jongler avec les comprimés d’opioïdes et les consomment sous diverses formes (p. ex., ils peuvent les ingérer, les fumer ou les inhaler).
• Les personnes dépendantes qui n’arrivaient pas à se procurer plusieurs opioïdes au prix où ils se vendent dans la rue, sont passées à des drogues plus de base, comme l’héroïne.
• Une campagne stratégique et persistante de désinformation des médecins au sujet du risque de mésusage de beaucoup de ces opioïdes (à l’origine d’un litige au terme duquel le gouvernement des États-Unis a eu gain de cause en 2007) a été extrêmement influente.

Même si, comme chirurgiens, nous croyons que nos habitudes de prescription des opioïdes (et l’utilisation qu’en font nos patients) n’ont que des effets à court terme, il est évident que l’orthopédie, la neurochirurgie et la gastroentérologie regroupent les 3 principales catégories de prescripteurs. Selon les US Centers for Disease Control and Prevention (CDC), l’utilisation d’opioïdes pendant plus de 5 jours est un facteur de risque significatif à l’égard d’un mésusage subéquent des narcotiques. On notera qu’au-delà de 10 % des Canadiens de 65 ans et plus à qui on a prescrit un opioïde suite à une chirurgie d’un jour les utilisent toujours au bout d’un an. Plusieurs études (multicentriques et liées à des registres) ont aussi clairement identifié la surprescription des opioïdes après une intervention chirurgicale. L’examen de plus de 7600 dossiers de patients du National Surgical Quality Improvement Program (NSQIP) a révélé qu’un nombre
métan de 375 EMO avaient été prescrits (équivalent à plus de 70 comprimés de tramadol)³. Ce risque était en lien avec un âge plus avancé, le fait d’être une femme, un diagnostic non cancéreux et l’obésité. Il est clair également que les habitudes de prescription varient grandement d’un chirurgien à l’autre et ne peuvent s’expliquer par des facteurs liés au patient ou à la maladie. À cet égard, la variabilité des habitudes de prescription globales au Canada est source d’inquiétude. Cette réalité trouve écho chez de nombreux patients, puisque seulement 28 % utilisent tous les opioïdes qui leur sont prescrits après une chirurgie (et seulement 9 % disposent des narcotiques inutilisés de manière appropriée). Il est également clair que le volume des ordonnances (c.-à-d., le nombre de comprimés servis) est en lien direct avec la consommation d’opioïdes et leur mésusage après une chirurgie⁴.

Il est intéressant d’analyser aussi la multiplication et le rôle précis des services axés sur la douleur chronique au Canada. Même si ces programmes sont reconnus dans les grandes villes canadiennes, leurs critères pour admettre et exclure les patients ou leur donner congé varient considérablement d’un endroit à l’autre. Par exemple, certains programmes prévoient un congé obligatoire des patients 1 an après leur inscription. Ailleurs, le congé est donné beaucoup plus tôt. Indépendamment de leur financement, ces programmes peuvent être difficiles d’accès, ils soignent un nombre limité de patients et sont souvent considérés (par les patients et les médecins traitants) moins efficaces pour les cas plus complexes. En 2016, le CDC a déclaré qu’il n’y avait pas de preuves solides que les opioïdes étaient un traitement efficace pour la douleur chronique au-delà de 6 semaines⁵,⁶,10. Il y a là ample matière à réflexion, non seulement en ce qui concerne les chirurgiens et leurs patients, mais aussi compte tenu qu’en réalité, jusqu’à 20 % de la diminution de la main-d’œuvre observée entre 1999 et 2015 pourrait être directement liée à l’utilisation prolongée d’opioïdes.

Pour s’attaquer à la crise des opioïdes, le gouvernement canadien a élaboré une approche interventionnelle qui repose sur 4 éléments clés : prévention, traitement, réduction des préjudices et contrôle d’application. Cette initiative est fort louable et digne d’être envisagée, mais nous devons aussi faire plus comme médecins et chirurgiens. La première étape consiste à reconnaître que les opioïdes sur ordonnance jouent un rôle majeur dans leur mésusage, et que le risque de dépendance aux opioïdes est bien réel après une chirurgie.

Nous devons emboîter le pas à des chefs de file en chirurgie, comme Ken Leslie, Neil Parry, Daryl Gray et Kelly Vogt, du London Health Sciences Centre, qui ont créé, appliqué et étudié un parcours multimodal standardisé d’épargne des opioïdes pour maîtriser la douleur postopératoire tout en réduisant le nombre d’ordonnances d’opioïdes post-chirurgicales pour les chirurgies d’un jour (p. ex., cholécystectomie, cure de hernie, chirurgie ano-rectale laparoscopiques)⁷. En instaurant un programme officiel qui repose sur un enseignement préopératoire au patient, une sensibilisation des chirurgiens, une prise en charge différenante de la douleur peropératoire (anti-inflammatoires, antiémétiques, corticostéroïdes) et des protocoles d’analgesie postopératoire stricts (prescription d’opioïdes en dernier ressort et d’une durée maximale de 7 jours), ils ont réduit de 90 % leur taux d’ordonnances de narcotiques (seulement 10 % des patients se sont fait servir leur ordonnance d’opioïdes pour une meilleure maîtrise de la douleur). Si on extrapole pour l’Ontario, la réduction potentielle du volume de narcotiques prescrits serait impressionnante (pour les 45 000 cas annuels de cure de hernie et cholécystectomie en Ontario, ce sont 1 000 000 de comprimés de narcotiques en moins qui se trouveraient utilisés à mauvais escient.) Le mésusage des opioïdes en postopératoire est indéniablement une crise de santé publique. En recourant à des interventions multimodales, en réduisant le volume d’opioïdes que nous prescrivons (dose, durée et nombre de comprimés) et en faisan un enseignement préopératoire aux patients, les chirurgiens ont assurément un rôle et une responsabilité dans la prévention des risques chez les patients. Le temps est venu d’examiner notre façon de prescrire.

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Références

Determining the appropriateness of requests for outpatient magnetic resonance imaging of the hip

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Despite ongoing efforts and multiple government interventions, wait times for magnetic resonance imaging (MRI) continue to lag behind the provincial standard. Most recent reports suggest that the average Canadian in Ontario will wait 6 weeks for an MRI, despite the province setting a target of 28 days.¹ This lag calls into question both the appropriateness and the increasing volumes of referrals for MRI scans.

Magnetic resonance imaging has become a useful diagnostic tool for assessing a patient’s condition and determining the appropriate course of treatment owing to its high specificity and sensitivity to intra-articular cartilage pathologies and deformities.³ However, in many cases a less costly imaging technique, such as a plain radiograph imaging series, is sensitive enough to ascertain the same diagnosis. Additionally, MRI has become an important preoperative test when determining the indications for hip arthroscopy.³ Arthroscopy provides the ability to examine and surgically repair the cartilage of the hip joint. The minimal invasiveness and quicker estimated recovery period associated with this procedure has resulted in hip arthroscopy becoming the gold standard for the treatment of hip-related intra-articular pathologies, such as labral tears and femoroacetabular impingement (FAI).³

SUMMARY

In Ontario, Canada, wait times for magnetic resonance imaging (MRI) scans continue to exceed provincial targets. We sought to determine the incidence of inappropriate hip MRI scan referrals, based on accepted indications for hip MRI. We developed an algorithm to appraise each MRI referral based on a prescan patient questionnaire and the interpretation of the MRI by a musculoskeletal radiologist. After reviewing 84 patient questionnaires, we considered 32.1% of MRI referrals to be inappropriate; 25.9% of the inappropriate MRI referrals were ordered as a preoperative test for potential hip arthroscopy despite the patients showing severe osteoarthritis. Having no prior radiographic examination was the most common reason for inappropriate referrals, regardless of pathology (48.1%). With limited MRI scanner time available in Ontario, it is essential that guidelines and training be improved on the indications for hip MRI to reduce the wait times for these specialized tests.

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Hip arthroscopy is one of the fastest developing fields in orthopedic surgery, with a 600% increase in its utilization over a 5-year period. Proper patient selection is imperative at all stages to obtain the best possible results from this procedure. For example, it has been shown that hip arthroscopies performed in older patients, or even younger patients with joint space narrowing suggestive of osteoarthritis, have minimal benefit and a higher rate of subsequent total hip arthroplasty procedure than other types of patients.

We recently surveyed patients who were referred for MRI scans at a tertiary hospital in Ontario specializing in musculoskeletal radiology to identify the prevalence of inappropriate scan requests. Patients completed a questionnaire to collect information regarding clinical symptoms and the suspected diagnoses/reasons for referral. The subsequent interpretation of the MRI by a musculoskeletal radiologist was then used to determine an appropriateness classification. We cross-referenced patients’ questionnaire responses with each MRI scan interpretation from a musculoskeletal radiologist to verify the indication for the referral, elucidate the patients’ medical history and analyze the relevance from previous diagnostic test results. From there, we analyzed the referral through an appropriateness classification, categorizing the referrals as “appropriate MRI referral,” “may be an appropriate MRI referral,” or “not an appropriate MRI referral.”

The results of the MRI exams are shown in Figure 1. The 2 most common appropriate pre-MRI differential diagnoses of hip pathology were labral tears (n = 32) and/or FAI (n = 21). It is worth mentioning that 4 of the pathological conclusions (chondrosis, hip dysplasia, osteoarthritis and osteoid osteoma) are typically diagnosed with plain radiographs. These conditions accounted for 21.4% (18/84) of the ordered MRI scans. Only 2 scans diagnosed hip fractures, which aligned with current literature supporting the use of plain radiographs as the gold standard imaging modality to identify this pathology rather than MRI scans, which are used in cases of occult fractures. Based on the musculoskeletal radiologists’ interpretations, plain radiographs were recommended in 2 different cases following their respective MRI scans. Finally, of the 12 inconclusive/normal results, 7 MRI scans were done to rule out labral tears or FAI.

Based on the appropriateness criteria, we considered 32.1% (27/84) of referrals to be inappropriate. Having no prior radiographic examination was the most common reason for inappropriate referrals, regardless of pathology (48.1%; 13/27). Most MRI referrals came from primary care sports doctors (n = 40); 42.5% (17/40) of these referrals were deemed inappropriate. Additionally, 25.9% (7/27) of the inappropriate MRI referrals were ordered as a preoperative test for potential hip arthroscopy, despite those patients showing severe osteoarthritis. An inappropriate referral related to hip arthroscopy was defined as patients recommended for this procedure despite their preprocedural MRI showing evidence of severe osteoarthritis or hip dysplasia (the most commonly cited contraindications for hip arthroscopy).

We acknowledge that our chosen method of data collection is subject to recall bias; however, these data suggest that more work is needed to determine the appropriateness of MRI scan referrals. Future studies should aim to obtain the referral reasons directly from the requisition or referring physician. Furthermore, a blinded panel of experts in the field should assess the appropriateness of these referrals.

CONCLUSION

With the number of MRI exams performed in Canada doubling from 0.69 million in 2003–04 to 1.7 million in 2011–12, and a hip MRI costing approximately $900, the potential savings in health care costs from discovering which medical indications are inappropriate for MRI referral are substantial. Currently, it is estimated that there is 1 MRI machine for every 278 000 people. Despite plans to add more MRI machines, they will not be able to match the increasing demand, as the waiting list is expected to grow by 12 000 patients annually. In 2014, the Canadian Institute for Health Information reported that 61 patients...
per 1000 received an MRI in Ontario. Assuming the predicted growth of demand for these scans since then, removing approximately 30% of inappropriate requests would save around $750 million.

Educating physicians on identifying contraindications in pre-MRI radiographs and on patient selection for hip arthroscopy would eliminate the need to refer patients to specialists and decrease orders for unnecessary MRI examinations. With the volume of MRI referrals increasing, this emphasizes an area where reducing the proportion of inappropriate referrals will substantially reduce health care spending.

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Teaching simulated arthroscopic Bankart repair: residents’ assessment at the Annual Shoulder Course

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Background: This study’s aim was to evaluate the performance of senior orthopedic residents during simulated arthroscopic anterior stabilization (Bankart repair) before and after a national shoulder review course.

Methods: Participants were assessed before and after the Annual Shoulder Review Course over a 3-day period, using a multiple-choice examination and surgery performance assessment. The surgical evaluation was completed by fellowship-trained surgeons using a standardized procedure checklist and a global rating scale. All Canadian senior orthopedic residents were invited to participate in the course.

Results: The 57 participants showed improvement following the course. The written knowledge evaluation mean score increased, and all 3 surgical performance measurements improved: surgical task time improved from 4:40 min to 2:53 min ($p < 0.001$), surgical technique evaluation increased from 56% to 67% after the procedure checklist ($p < 0.001$), and anchor placement improved for all 3 aspects. Anchor entry point was the sole measure not to improve enough to reach statistical significance ($p = 0.37$).

Conclusion: Our data support the inclusion of dry model surgical simulation as part of a surgical skills course for both training and assessment of orthopedic surgery residents.

Learning surgical skills can be understood with Fitts and Posner’s 3-phase framework for acquiring motor skills.1,2 The initial cognitive phase is characterized by learners understanding the skills and watching demonstrations. In the associative phase, learners perform the tasks and associate the psychomotor steps with the knowledge acquired during the cognitive phase. The final autonomous phase focuses on repetition and the automatism of psychomotor movements.1,2

Effective and efficient surgical skills training strategies are needed to counter the impact of trainee work hour restrictions, increased pressures to enhance operating room efficiency and concerns regarding patient safety.3,4 Simulation
training with feedback and assessment of surgical skills is increasingly recognized as an education strategy that can assist in the integration of the phases of motor skill learning. Simulation training has been implemented and evaluated in a number of disciplines (e.g., aviation, military, medicine, surgery, business). The acquisition of minimally invasive techniques such as shoulder arthroscopic techniques, which are known to be challenging to learn and associated with a steep learning curve, requires many hours of practice. Previous studies have shown that shoulder simulation training improves both surgical performance in cadaveric and simulated models. Other studies have shown that surgical skills learned on physical or virtual-reality simulators are transferrable to the operating room.

Arthroscopy simulation is becoming more common in universities and surgical societies. One example is the Fundamentals of Arthroscopic Surgery Training (FAST) workstation that is currently used by the Arthroscopy Association of North America, the American Academy of Orthopaedic Surgeons and the American Board of Orthopaedic Surgery during courses offered to residents and practising surgeons.

The Canadian Shoulder and Elbow Society (CSES; formerly Joints Canada) Annual Shoulder Review Course committee chose to include a dedicated training session with a surgical simulator to assess the performance of senior orthopedic residents during simulated arthroscopic anterior stabilization (Bankart repair) before and after the CSES Annual Shoulder Review Course. The main purpose of this study was to evaluate the performance of senior orthopedic residents during simulated Bankart repair before and after a national shoulder review course. The primary objective of the study was to assess improvement in knowledge and surgical skills for arthroscopic Bankart procedures. The chosen outcomes were score on a 10-question multiple choice test, surgical performance based on a standardized procedure checklist, and precision of anchor placement. We hypothesized that course participants would show significant improvement in anchor placement precision and on Bankart repair knowledge after the course.

Methods

Course

The CSES Annual Shoulder Review Course is a 3-day course that covers all aspects of shoulder surgery, including sports medicine, open and arthroscopic techniques, trauma surgery and arthroplasty. The course received the ethics committee approval. Teaching related to the management of shoulder instability, including surgical techniques, consists of a 1-hour case-based small-group session, a 1-hour formal lecture and a 2-hour laboratory session using both Sawbones and cadaveric models.

Participants

All Canadian senior orthopedic residents (postgraduate year [PGY] 4 and 5) and fellows were invited to the CSES Annual Shoulder Review Course in Montreal, Québec. Experienced fellowship-trained shoulder surgeons provided the teaching throughout the review course. There were no exclusion criteria.

Written examination

All participants took a written examination before and after the review course. All participants were unaware of the research topic at the precourse test. The written examination included 10 multiple choice questions chosen according to relevant shoulder instability features and generated by an expert committee in accordance with the Delphi method. There was no time limit for this examination, and no reference material or communication was allowed.

Surgical performance assessment

All participants underwent a surgical performance assessment, using a rating instrument, before and after the review course. The instrument was created following expert consultation and consensus.

Several stations were available to allow the evaluation of multiple residents at the same time. Each station provided written instructions, and the required instruments were available on the station's worktable. Participants were instructed to insert the most inferior of the anteroinferior glenoid suture anchor, using 3 mm Bio-SutureTak anchors (Arthrex), into a synthetic right shoulder physical simulator model, which included synthetic skin and capsule (Sawbones), under arthroscopic guidance with a 30°, 3.5 mm arthroscope. The shoulder was in the beach chair position, but could be modified to the lateral decubitus position if requested. Anterosuperior and anteroinferior portal cannulae were inserted posteriorly before testing. Every resident had to choose the most appropriate cannulae for the procedure. A drill, drill guide, and anchor were available for each trainee.

Experienced, fellowship-trained shoulder surgeons assessed performance using an evaluation form created by a team of experts. The form included a task-specific checklist and an overall global rating scale, based on a 5-point Likert scale, to evaluate surgical technique, including anchor placement and insertion, use of appropriate portals, and camera manipulation. If a visual evaluation of the anchor placement was difficult intraoperatively, the expert assessors could manipulate the camera (once the procedure was completed) to determine the final anchor placement.

RECHERCHE

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Evaluation of anchor placement

The exact position of the anchor was analyzed using a 3D camera (Optotrack 302, NDI) and 3D reconstruction software (Catia V5R20, Dassault system). After each pre- and post-course test, all the glenoids were detached from the synthetic ligaments and tendons. The labrum was slightly elevated. In cases where the anchor was partially inserted through the labrum, the labrum was carefully elevated to expose the anchor.

Every glenoid was then placed against a Plexiglas sheet (Fig. 1). The position was controlled by a line drawn on the translucent sheet. The centre of the Plexiglas sheet and the centre of the glenoid were superimposed. The glenoid was maintained with a clamp. To create a 3D model, a recording of 6 points was made for each specimen with an optoelectronic pointer and a 3D camera (Optotrack 302, NDI). Points A to D were the extremes of a 6 cm × 8 cm rectangle drawn on the Plexiglas sheet (Fig. 1, Fig. 2). Point E was the projection of the entry point of the anchor on the Plexiglas sheet. We measured the distance between anchor and joint surface. Reconstruction of all 5 points was done using computer-aided design software (Catia V5R20, Dassault system). Measurement and calculation of these 5 points using the software extracted the anchor position, including the insertion angle (the angle between the long axis of the anchor and the glenoid joint surface), the glenoid clock face measurement (position of the entry point on the glenoid surface; depends on point E), and depth of insertion of the anchor from the glenoid surface.

Based on literature review, the course committee determined the ideal position: 5 o’clock (on a right shoulder), a 45° angle of insertion, and a final anchor position 2 mm below the articular surface of the glenoid. To determine the specific error of the anchor placement measures, 3 repeated measurements were taken per specimen. The error was calculated as the difference between the measure and the ideal position (e.g., if the entry point is at 4:45 on the clock face, the error will be 5:00 – 4:45 = 0:15). Paired t-tests were then performed to compare mean values of measurements before and after the review course.

Statistical analysis

Results are presented as means ± standard deviations (SDs) and 95% confidence intervals (CIs) for continuous variables and as percentages for categorical variables. We used paired t-tests to compare pre- and post-course continuous variables and $\chi^2$ tests to compare categorical variables. We considered results to be significant at $p < 0.05$, and we used SPSS software version 23 to perform all tests.

To perform the power calculation, we used duration of procedure, as this is a quantitative measure. We determined that a 25% improvement would be significant, and...
with a power of 80%, an $\alpha$ of 0.05 and an SD of 30% we needed a minimum of 24 participants per group.

**RESULTS**

**Participants**

Fifty-eight participants were recruited for the study: 16 PGY4 residents, 36 PGY5 residents and 6 clinical fellows. Thirty-six participants were men. All 58 residents completed the precourse test and 57 completed the post-course test.

**Written examination**

Questions and results of the written examination are shown in Table 1. The mean score on the written examination increased from 59% ± 15% (95% CI 48%–78%) to 68% ± 12% (95% CI 48%–88%) following the course.

**Surgical performance assessment**

The average total surgical task time decreased from the precourse test to the post-course test by 40%, from 4:40 min (95% CI 2:46–5:34) to 2:53 min (95% CI 2:30–3:16) ($p < 0.001$). Anchor placement, insertion angle and arthroscopic portal choices all improved. Thirty-five students (61%) increased their manipulation skills, 9 students (16%) had no change in their results, and 13 students (23%) decreased their manipulation skills. The mean score for manipulation skills decreased from 71% to 68%. The overall score for the surgical technique assessment improved from 56% before the course to 67% after the course ($p < 0.001$) (Table 2).

**Evaluation of anchor placement**

To evaluate anchor placement, 58 shoulder models were used for the precourse test. Seven were lost or stolen, and of the remaining 51 models, 8 had no anchor left inside (but the anchor tunnel was present), leaving 43 models with anchors present. For the post-course test 57 models were used, 2 were lost or stolen, and of the remaining 55 models, 11 had no anchor left inside (but the anchor tunnel was present), leaving 44 with anchors present. Results of the anchor placement evaluation are shown in Table 3 and Table 4. The depth of anchor placement was measured on a total of 87 synthetic glenoids with anchors present (pre- and post-course tests). Models without anchors were the result of technical errors.

The precision of the anchors’ insertion points improved following course completion ($p < 0.001$); however, no significant improvement was seen in the angle of insertion or the anchor depth. A clock was applied over the glenoid face to quantify entry points.

| Entry point before the review course ranged from 1:00 to 7:20 (mean ±1:5 ± 1:10); after the course it ranged from 3:05 to 6:00 (mean ±2:5 ± 0:35) ($p = 0.37$; Fig. 3). The precision improved, as shown by the significant decrease in deviation for the desired entrance point on the clock face, from 1.0 ± 0.8 hours to 0.6 ± 0.4 hours ($p < 0.001$).

| Angle of insertion before the review course ranged from 4° to 79° (mean 43° ± 16°); after the course it ranged from 20° to 76° (mean 44° ± 13°, $p = 0.25$; Fig. 4).

| The depth of anchor insertion ranged from –0.7 mm to 20.0 mm precourse (mean 5.7 mm ± 4.0 mm); after the course it ranged from –1.3 mm to 13.4 mm (mean 6.2 mm ± 3.8 mm, $p = 0.43$; Fig. 5). Figures 3, 4 and 5 represent individual matched performances.

**DISCUSSION**

Bankart repairs are commonly performed for recurrent instability of the shoulder, with the objective of restoring normal shoulder function and stability.¹⁴ This surgical technique commonly requires the insertion of suture anchors into the glenoid rim and reattachment of the torn labrum using sutures fixed on those anchors. The position and number of anchors have been shown to influence clinical outcomes, and mastering this skill contributes to treatment efficacy.¹⁴–¹⁹ Senior residents and shoulder clinical fellows improved their knowledge of arthroscopic Bankart lesion repair and their performance of a simulated repair on a dry surgical model. Residents may benefit from courses with curricula that include surgical simulation to both teach and assess surgical skill acquisition, in combination with didactic or small group sessions and cadaveric laboratories. Indeed, the relevance of simulation training as a part of orthopedic residency programs has been gaining in credibility with recent publications.⁸–²⁰ Moreover, Angelo and colleagues²¹ established the importance of defining specific benchmarks for evaluation in order to achieve progress. In terms of patient safety, this method has the advantage of furthering essential knowledge that is not appropriate for residents to learn in the operating room. Furthermore, residents should be formally assessed on their ability to perform these tasks to a minimal level of competence before performing them in the operating room. In the present study we saw a 40% improvement in the time to completion for the evaluated task, but we also evaluated the quality of the anchor placement; as pointed out in a recent editorial, “a task may be done quickly, but not necessarily well.”²² One of the strengths of this study is the inclusion of residents from all Canadian residency programs, providing a good national overview. Furthermore, it includes technical and theoretical knowledge assessments with a chosen model that closely resembles a real shoulder with synthetic skin and ligaments. This forced participants to look at the screen when performing the procedure and prevented them from seeing the bone insertion point.
### Table 1. Written examination questionnaire (part 1 of 2)

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>% Success test 1</th>
<th>% Success test 2</th>
<th>p value, paired t test</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. A 21-year-old male football player (linebacker) suffers a traumatic</td>
<td>D</td>
<td>90</td>
<td>89</td>
<td>&gt; 0.99</td>
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<tr>
<td>anterior dislocation of his nondominant shoulder for the first time. If</td>
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<td>he continues to play football, what is the likelihood of him having a</td>
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<tr>
<td>recurrent dislocation of his shoulder?</td>
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<tr>
<td>a) &lt; 20%</td>
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<tr>
<td>b) 20 to 40%</td>
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<tr>
<td>c) 41 to 60%</td>
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<tr>
<td>d) &gt; 60%</td>
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<tr>
<td>2. A 21-year-old male football player suffers a traumatic anterior</td>
<td>D</td>
<td>71</td>
<td>79</td>
<td>0.058</td>
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<tr>
<td>dislocation of his nondominant shoulder for the first time while</td>
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<td>making a tackle. The mechanism of injury is one of forced abduction</td>
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<td>external rotation. What is the likelihood of him having a disruption of</td>
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<tr>
<td>the antero-inferior glenoid labrum; i.e., a so-called Bankart lesion?</td>
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<tr>
<td>a) &lt; 25%</td>
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<tr>
<td>b) 25 to 50%</td>
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<tr>
<td>c) 51 to 75%</td>
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<tr>
<td>d) &gt; 75%</td>
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<tr>
<td>3. The same patient was treated in a sling for 2 weeks, then</td>
<td>C</td>
<td>62</td>
<td>68</td>
<td>0.252</td>
</tr>
<tr>
<td>rehabilitated his shoulder and tried to play, but his shoulder felt</td>
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<tr>
<td>unstable. He sees you at the end of the season. His x-rays are normal.</td>
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<tr>
<td>What is the evidence-based best treatment for this patient?</td>
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<tr>
<td>a) Advise him to use an external rotation brace for 4 weeks to allow</td>
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<tr>
<td>the shoulder to heal properly.</td>
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<tr>
<td>b) Continue with active rehabilitation and advise him to have surgery</td>
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<tr>
<td>only if he has a recurrent dislocation.</td>
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<tr>
<td>c) Advise him to have an arthroscopic surgical repair at the next</td>
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<tr>
<td>available time.</td>
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<tr>
<td>d) Advise him to have an open Latarjet procedure at the next available</td>
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<tr>
<td>time.</td>
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<tr>
<td>4. A 19-year-old Junior A hockey player sees you at the end of his</td>
<td>C</td>
<td>10</td>
<td>5</td>
<td>0.182</td>
</tr>
<tr>
<td>season wanting surgery to fix his unstable shoulder. He has had 3</td>
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<td>documented anterior dislocations, each requiring a physician reduction</td>
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<td>and several subluxation episodes. He has a small but perceptible Hill</td>
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<tr>
<td>Sachs lesion on his x-ray and the anterior contour of his glenoid is</td>
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<td>blunted, but there is no bony Bankart. What is the evidence-based, best</td>
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<tr>
<td>surgical treatment for this patient?</td>
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<tr>
<td>a) An arthroscopic Bankart repair.</td>
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<tr>
<td>b) An arthroscopic Bankart repair with remplissage.</td>
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<tr>
<td>c) An open Bankart repair.</td>
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<tr>
<td>d) An arthroscopic Latarjet procedure.</td>
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<tr>
<td>5. You decide to perform an arthroscopic Bankart repair of his right</td>
<td>C</td>
<td>34</td>
<td>61</td>
<td>&lt; 0.001</td>
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<td>shoulder. He has a typical Bankart lesion based on preoperative planning</td>
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<td>Which of the following portal positions would typically be considered</td>
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<td>the minimum to perform this procedure?</td>
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<tr>
<td>a) A posterior and anterosuperior portal.</td>
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<tr>
<td>b) A mid-anterior and an anterosuperior portal.</td>
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<tr>
<td>c) A posterior and mid-portal.</td>
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<tr>
<td>d) An anterosuperior and a trans-subscapularis portal.</td>
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<tr>
<td>6. You decide to perform an arthroscopic Bankart repair of his right</td>
<td>C</td>
<td>12</td>
<td>12</td>
<td>&gt; 0.99</td>
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<tr>
<td>shoulder. You perform a diagnostic arthroscopy through a standard</td>
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<td>posterior portal. You identify a labral tear that extends from the 7</td>
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<td>o’clock to the 3 o’clock position. What additional portals may be</td>
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<td>needed to perform an optimal arthroscopic repair?</td>
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<tr>
<td>a) A mid-anterior and an anterosuperior portal.</td>
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<tr>
<td>b) An anterosuperior and supplemental posterior portal.</td>
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<td>c) A supplemental posterior and trans-subscapularis portal.</td>
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<tr>
<td>d) An anterosuperior and a trans-subscapularis portal.</td>
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<tr>
<td>7. You decide to perform an arthroscopic Bankart repair of his right</td>
<td>B</td>
<td>64</td>
<td>95</td>
<td>&lt; 0.001</td>
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<tr>
<td>shoulder. You confirm a typical Bankart lesion. Where would you place</td>
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<td>your first anchor using the glenoid clock face description as the</td>
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<tr>
<td>reference point?</td>
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<tr>
<td>a) At the 7 o’clock position.</td>
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<td>b) At the 5 o’clock position.</td>
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<td>c) At the 3 o’clock position.</td>
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<tr>
<td>d) At the 1 o’clock position.</td>
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<tr>
<td>8. You place your first bio-absorbable anchor in the optimal position</td>
<td>C</td>
<td>88</td>
<td>93</td>
<td>0.182</td>
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<tr>
<td>with respect to the glenoid clock face. With respect to the patho-</td>
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<td>anatomy, where should the anchor hole be made?</td>
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<td>a) Through bleeding bone on the glenoid neck.</td>
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<td>b) On the face of the articular cartilage.</td>
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<td>c) At the junction of the articular cartilage and the glenoid bone.</td>
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<tr>
<td>d) At the position of the anterior labroligamentous periosteal sleeve</td>
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<tr>
<td>avulsion lesion.</td>
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</tbody>
</table>
directly. Entry point measurements were taken by a biomechanical engineering team with cutting-edge technology to ensure the greatest precision possible. Finally, this event was a fantastic opportunity to bring together shoulder surgeons from across the country and promote excellence in shoulder surgery.

**Limitations**

Limitations of the study include some discrepancies observed when comparing the examiners’ evaluations of surgical performance and the 3D camera evaluations. The 3D evaluations showed a reduction of the mean range and...
of the error and error range rather than the means themselves (Table 4). The assessments performed by the experts appear to have overestimated the amount of improvement from pre- to post-test in comparison to the 3D anchor evaluations. Possible explanations for this include examiner intra- and interobserver variation, or qualitative improvement of camera management by residents, which gives a more positive impression. Participants may also have improved in the manipulation of the specific anchor instrument through the standard learning curve. Other limitations include the lack of data on participants’ prior experience, the absence of a control group, and the absence of expert results for comparison. Future studies could include data from the evaluating surgeons to be used as the gold standard for comparison to establish validated metrics for assessment. 

Further investigation is required to better understand which methods are suitable for teaching and refining surgical procedures and techniques among senior residents and experienced surgeons, especially in terms of knowledge transfer with performance in the operating room. Many national and international courses offer cadaver training sessions, but these can be costly and difficult to organize compared with traditional didactic teaching methods. In a context of limited university budgets, partnerships with the industry remain the only avenue. Performance on arthroscopy simulators has been strongly correlated with performance on cadavers, and the use of simulators to supplement or replace certain parts of courses is appealing. Indeed, it would solve the problem of time lost during the surgical approach before performing the specific step that the course aims to improve. For more experienced surgeons, it is unnecessary to complete all the preparatory stages, especially in arthroscopic surgeries. Using simulators can get the surgeon directly to the specific step that needs to be practised, such as anchor placement in a difficult orientation or learning to use new materials. Recent studies have shown that surgical simulation training can improve performance, and longitudinal integration of skills training should continue throughout a training program.

CONCLUSION

Resident knowledge of shoulder instability and simulated performance of an arthroscopy-assisted stabilization improved following a structured intervention. Our data
support the inclusion of dry model surgical simulation as part of a surgical skills course both for training and assessment of orthopedic surgery residents.

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References
The impact of surgical modality on self-reported body image, quality of life and survivorship after anterior resection for colorectal cancer – a mixed methods study

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Background: There is growing enthusiasm for robotic and transanal surgery as an alternative to open or laparoscopic surgery for colorectal cancer (CRC). We examined the impact of surgical modality on body image and quality of life (QOL) in patients receiving anterior resection for CRC.

Methods: We used a mixed-methods approach, consisting of a chart review and semi-structured interviews with CRC patients, at least 8 months after surgery. We assessed cosmetic outcomes and QOL using validated questionnaires.

Results: Thirty patients were stratified into open (n = 8), laparoscopic (n = 12) and robotic (n = 10) groups. Mean body image scores were significantly higher (i.e., poorer body image) in patients receiving open surgery (mean difference [MD] +5.7 with laparoscopy, p < 0.001). Open surgery was more detrimental to physical function, including strenuous activities, prolonged ambulation and self-care (MD –11.6 with laparoscopy, p = 0.039). Patients receiving laparoscopic surgery reported superior role (MD +27.6 with open surgery, p = 0.002) and social function (MD +13.7 with open surgery, p = 0.042), including the ability to enjoy hobbies, family life and social activities. Surgical modality did not affect emotional and cognitive function or symptoms including genitourinary function, pain and defecation.

Conclusion: The negative impact of open surgery on body image and physical function warrants further educational interventions for patients. The protective effect of laparoscopy on role and function may be associated with “tumour factors” that are unaccounted for in the European Organization for Research and Treatment of Cancer questionnaires. Open surgery is detrimental to body image and physical function in patients receiving anterior resection for CRC. Prospective randomized studies are required to validate these findings.

Contexte : On observe un intérêt croissant pour la chirurgie transanale robotique comme solution de rechange à la chirurgie ouverte ou laparoscopique dans les cas de cancer colorectal (CCR). Nous avons analysé l’impact de la modalité chirurgicale sur l’image corporelle et la qualité de vie (QdV) chez les patients ayant subi une résection antérieure pour CCR.

Méthodes : Nous avons utilisé une approche à méthodologie mixte, composée d’une revue des dossiers et d’entrevues semi-structurées avec des patients atteints de CCR, au moins 8 mois après la chirurgie. Nous avons évalué les résultats cosmétiques et la QdV au moyen de questionnaires validés.

Résultats : Trente patients ont été stratifiés en 3 groupes : chirurgie ouverte (n = 8), laparoscopique (n = 12) et robotique (n = 10). Les scores moyens pour l’image corporelle ont été significativement plus élevés (c.-à-d., image corporelle plus négative) chez les patients ayant subi une chirurgie ouverte (différence moyenne [DM] +5,7 avec la laparoscopie, p < 0,001). La chirurgie ouverte a été plus nuisible au fonctionnement physique, y compris aux activités exigeantes, à la déambulation prolongée et à l’autosoin (DM –11,6 avec la laparoscopie, p = 0,039). Les patients soumis à une chirurgie laparoscopique ont fait état d’un rôle (DM +27,6 avec la chirurgie ouverte, p = 0,002) et d’un fonctionnement social meilleurs (DM +13,7 avec la chirurgie ouverte, p = 0,042), y compris la capacité d’apprécier les loisirs et les activités familiales et sociales. La modalité chirurgicale n’a pas exercé d’impact sur le fonctionnement émotionnel et cognitif ou sur les symptômes, y compris la fonction urogénitale, la douleur et la défécation.

Conclusion : L’impact négatif de la chirurgie ouverte sur l’image corporelle et le fonctionnement physique justifie que l’on renseigne plus adéquatement nos patients. L’effet protecteur de la laparoscopie aux plans du rôle et du fonctionnement serait associé à des “facteurs tumoraux” qui n’entrent pas en ligne de compte dans les questionnaires de l’Organisation européenne pour la recherche et le traitement du cancer. La chirurgie ouverte nuit à l’image corporelle et au fonctionnement physique chez les patients qui subissent une résection antérieure pour CCR. Des études prospectives randomisées sont nécessaires pour valider ces résultats.
Colorectal cancer (CRC) is the third most common cancer and the third leading cause of death from cancer in the world. In the past decade, extraordinary progress in prevention, diagnosis and management of CRC has led to a reduction in CRC incidence and mortality. This has allowed patients to live longer, but with treatment-related consequences, including postoperative pain, fatigue and impaired bowel, sexual and urinary function as well as the burden of invasive cancer surgery on body image and mental health. Rectal and sigmoid cancer surgery is particularly complex owing to technical and anatomical considerations. The natural barriers of the bony pelvis, in addition to the presence of critical organs and neurovascular structures, render pelvic dissection challenging, regardless of surgical modality. Anterior resections, therefore, may have a considerable long-term impact on patients’ postoperative function and quality of life (QOL). The impact of a permanent stoma after surgery as well as the longitudinal changes in QOL after surgery have been described previously.

Growing enthusiasm for robotic and transanal surgery as an alternative to open or laparoscopic surgery warrants further investigation into the impact of surgical modality on body image, survivorship and QOL. Previous studies, including a prospective comparison by Li and colleagues as well as the COLOR II trial have limited their discussion to open and laparoscopic approaches. A recent study of QOL in 36 patients who had laparoscopic versus robotic anterior resection found that patients in the robotic group reported lower pain, insomnia and male impotence scores than those in the laparoscopy group. Nonetheless, there remains a relative paucity of studies using qualitative interviews to explore the issue of survivorship from the patients’ perspective. There have also been limited data exploring the impact of rectal cancer surgery on body image and cosmesis in this vulnerable patient population. Therefore, the objective of this study was to examine the impact of surgical modality — open, laparoscopic or robotic surgery — on self-reported body image, function and QOL in patients receiving anterior resection for CRC.

Methods

Participants

Adult patients (>18 yr) who underwent surgical resection for pathologically confirmed rectal and/or sigmoid cancer and who were at least 8 months from surgery, had no signs of disease recurrence and were on no active treatment were eligible to participate. We limited selection to patients whose anastomosis was formed between 2 cm and 12 cm from the anal verge. We used convenience sampling, a form of nonprobability sampling, to identify patients for prospective recruitment from 2 surgeons’ (F.A.Q. and C.O.) clinical practices at 2 major academic hospitals (Toronto General Hospital and Toronto Western Hospital) in the University Health Network (UHN; Toronto, Ontario) between January 2015 and July 2016. The UHN is a multi-institution tertiary academic centre located in a large urban city, serving a culturally diverse and complex patient population. All patients approached to take part in the study were fully aware of their diagnosis and were considered physically and psychologically able to cope with the interview process. We obtained informed consent from all patients before their participation in the study. The protocol was approved by the University Health Network Research Ethics Board before study initiation.

Data collection

An interdisciplinary team, including a surgical oncologist and nurse navigator, developed a semistructured interview guide exploring the issue of body image, survivorship and QOL after surgery. The interview guide, consisting of both open-ended questions and question probes used to facilitate the discussion, allowed flexibility to elicit individual views and descriptions of experiences. All interviews were conducted by telephone. Patients were first asked to briefly recount their health care experiences since receiving the diagnosis of CRC. This provided an overview of preoperative and postoperative care, including therapies received, and enabled subsequent in-depth exploration of body image and survivorship.

These questions were followed by a series of closed-ended probing questions from previously validated and reliable questionnaires: the Body-Image Questionnaire (BIQ) and the European Organization for Research and Treatment of Cancer (EORTC) QLQ-C30 and QLQ-CR29 questionnaires. The BIQ consists of 8 items evaluating body image and cosmesis after surgery. The body image scale measures patients’ perception of and satisfaction with their own body and explores patients’ attitudes toward their bodily appearance (items 1–5). The cosmetic scale assesses the degree of satisfaction with respect to the physical appearance of the scar (items 6–8). A higher body image score signifies poorer body image, whereas a higher cosmesis score signifies a greater degree of satisfaction with cosmetic outcomes. The EORTC QLQ-30 questionnaire consists of 30 questions that combine to make 5 functional scales (physical, emotional, cognitive, social and role functioning); a global QOL measure; and symptom assessment, including pain, fatigue, diarrhea and constipation. The QLQ-CR29 has 29 questions divided into 4 functional scales (body image, anxiety, weight and sexual interest) and numerous symptoms scales exploring urinary, bowel and sexual outcomes. We used linear transformation of raw data to standardize the scores on a scale of 0–100, as described by the standard EORTC scoring system. Higher scores signified a better level of function and a greater severity of symptoms.
We collected demographic data from patients, and specific tumour staging information and surgical procedure type were obtained from electronic patient records.

**Statistical analysis**

Interviews were audio-recorded and transcribed verbatim by an independent transcriptionist. All identifying information was removed from transcripts before analysis to maintain anonymity. Transcripts were hand-coded following each interview to allow iterative data collection and analysis, whereby new and emerging concepts could be further explored in subsequent interviews. Descriptive coding was used to identify distinct concepts, which were later grouped into categories. The research team met consistently to discuss emerging ideas and categories. Upon achieving data saturation (the point at which no new information that was relevant to the research question emerged), these categories were further analyzed and refined to identify overarching themes in the attitudes, perceptions and experiences of patients.17–20

Sociodemographic and clinical data were summarized using descriptive statistics. We compared the 3 surgical modality cohorts with respect to aggregate body image and QOL scores. We used the Shapiro–Wilk test to assess data normality and the Levene test to assess for equality of variance. Parametric data were analyzed using 1-way analysis of variance (ANOVA). Nonparametric data were analyzed using the Kruskal–Wallis test. Data not meeting assumptions for equality of variance were assessed with the Welch ANOVA. Statistically significant outcome measures were subsequently assessed with pairwise comparisons to determine the association between surgical modalities and the outcome measure. To account for multiple comparisons, we performed a Bonferroni correction. The significance level for all group comparisons was maintained at \( p < 0.05 \).

Statistical analysis was conducted using IBM SPSS Statistics version 21.0 (IBM Corp.).

**RESULTS**

Thirty patients were stratified into open \( (n = 8) \), laparoscopic \( (n = 12) \) and robotic \( (n = 10) \) surgery groups. Group differences in sociodemographic characteristics, including sex \( (p = 0.117) \), age \( (p = 0.751) \), ethnicity \( (p = 0.532) \), education level \( (p = 0.299) \), employment status \( (p = 0.421) \) and net annual income \( (p = 0.456) \) are detailed in Table 1. Table 2 details the oncologic variables of our patient population. Notably, patients undergoing robotic surgery were significantly more likely to have their tumour localized to the rectum \( (90\%, \ p = 0.001) \), with a shorter distance to the anal verge \( (\text{mean } 6.5 \text{ cm}, \ p = 0.002) \), requiring neoadjuvant therapy \( (80\%, \ p = 0.037) \) and stoma creation \( (90\%, \ p = 0.008) \). Notably, 78% \( (n = 7) \) of patients in the robotic group who received a stoma ultimately underwent reversal to re-establish gastrointestinal continuity. The 3 groups were comparable with respect to other oncologic features, including preoperative American Joint Committee on Cancer (AJCC) stage \( (p = 0.253) \), median follow-up \( (p = 0.323) \), stoma reversal rates \( (p = 0.431) \), and need for adjuvant therapy \( (p = 0.163) \; \text{Table 2} \).

Descriptive thematic analysis yielded 3 overarching themes in the data that remained consistent with our quantitative findings.

**Perception of body image after surgery**

Patients undergoing open surgery for rectal and sigmoid cancer had differing perceptions of body image and cosmesis than those receiving laparoscopic or robotic operations. A majority of patients reported a high degree of dissatisfaction with the presence of midline laparotomy scars as well
as incisional hernias. Incisional hernias, for instance, were reported by 38% of patients in the open group, 17% in the laparoscopy group and 0% in the robotic surgery group. Many of these patients expressed concern with enlargement of their incisional hernias over time. Hypertrophic scars and keloid formation was also worrisome for patients treated with midline laparotomies. These patients expressed significantly less satisfaction with their body image and cosmetic outcome than those treated with minimally invasive surgery.

“The huge lump [incisional hernia] on my abdomen is disgusting and disfiguring...gone are the days when all my clothes used to fit me perfectly and I could take my shirt off without giving it a second thought.” — Patient 3

“The bottom of my belly hangs out and that’s what bothers me the most. This was not the case before the operation. Now I’m embarrassed when I know someone is judging the way my belly shows through some of my tops. The big scar right through it doesn’t help either.” — Patient 4

“The port sites healed really well. There were times where I couldn’t even count the number of cuts a few months after the [robotic] operation.” — Patient 12

This perception of body image and cosmetic was reflected in the body image and cosmesis questionnaires, where patients receiving open surgery had significantly higher (i.e., poorer) mean body image scores (12.0) and lower cosmesis scores (9.6) than those receiving laparoscopic (BIQ 6.3, cosmesis 16.4, \( p < 0.001 \)) and robotic surgery (BIQ 5.8, cosmesis 15.2, \( p < 0.001 \); Table 3). Comparison of body image and cosmesis scores between laparoscopic and robotic approaches identified no statistical difference between cohorts (both \( p > 0.99 \)).

**Surgical modality and physical function**

Patients undergoing open surgery also reported a significant impairment in physical function. This included deficits in basic actions (self-care required to maintain independence) and complex actions, such as strenuous activities and prolonged ambulation. This type of functional decline had a detrimental impact on self-perceived QOL and function scores.

“I used to love walking my dog on a daily basis. The pain, discomfort and general fatigue after the surgery prevents me from doing this...it’s impossible to carry anything moderately heavy and I have to continuously rely on others to help me do the things I used to do independently.” — Patient 1

“I am definitely slower and sloppier after the operation. I spend a lot more time in my chair or bed ‘resting.’ This is unusual for me but I really have no choice.” — Patient 2

Table 4 details the functional outcomes of patients among the 3 groups. Patients undergoing open surgery had lower mean physical function scores (83.3) than those

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**Table 2. Oncologic metrics of the patient cohort**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Group; no. (%) or mean ± SD</th>
<th>( p ) value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rectum</td>
<td>1 (12.5) 2 (16.7) 9 (90)</td>
<td>0.001</td>
</tr>
<tr>
<td>Rectosigmoid</td>
<td>1 (12.5) 5 (41.7) 1 (10)</td>
<td></td>
</tr>
<tr>
<td>Sigmoid</td>
<td>6 (75) 5 (41.7) 0 (0)</td>
<td></td>
</tr>
<tr>
<td>Stage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>3 (37.5) 5 (41.7) 2 (20)</td>
<td>0.253</td>
</tr>
<tr>
<td>II</td>
<td>3 (37.5) 1 (8.3) 6 (60)</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>1 (12.5) 4 (33.3) 2 (20)</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>1 (12.5) 2 (16.7) 0 (0)</td>
<td></td>
</tr>
<tr>
<td>Distance from anal verge, cm</td>
<td>25.6 ± 14.3 18.8 ± 11.3 6.5 ± 4.1</td>
<td>0.002</td>
</tr>
<tr>
<td>Neoadjuvant therapy</td>
<td></td>
<td>0.037</td>
</tr>
<tr>
<td>Yes</td>
<td>4 (50) 3 (25) 8 (80)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>4 (50) 9 (75) 2 (20)</td>
<td></td>
</tr>
<tr>
<td>Time since operation, mo</td>
<td>14.8 ± 3.7 16.3 ± 2.3 14.6 ± 2.5</td>
<td>0.323</td>
</tr>
<tr>
<td>Stoma creation</td>
<td></td>
<td>0.006</td>
</tr>
<tr>
<td>Yes</td>
<td>5 (62.5) 3 (25) 9 (90)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>3 (37.5) 9 (75) 1 (10)</td>
<td></td>
</tr>
<tr>
<td>Stoma reversed</td>
<td></td>
<td>0.431</td>
</tr>
<tr>
<td>Yes</td>
<td>3 (60) 3 (100) 7 (78)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>2 (40) 0 (0) 2 (22)</td>
<td></td>
</tr>
<tr>
<td>Adjuvant therapy</td>
<td></td>
<td>0.163</td>
</tr>
<tr>
<td>Yes</td>
<td>3 (37.5) 6 (50) 8 (80)</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>5 (62.5) 6 (50) 2 (20)</td>
<td></td>
</tr>
</tbody>
</table>

SD = standard deviation.
in the laparoscopic (94.9) and robotic groups (94.3). Pairwise comparisons showed that open surgery was associated with significantly lower physical function scores than laparoscopic surgery ($p = 0.026$) and robotic surgery ($p = 0.045$). There was no significant difference between robotic and laparoscopic surgery ($p > 0.99$).

**Effect of laparoscopy on role and social function**

Pairwise comparison of role function identified higher scores for the laparoscopic approach (98.6) than the open approach (71.0, $p = 0.019$) and the robotic approach (71.8, $p = 0.015$). Similarly, comparison of social function across cohorts showed higher scores for the laparoscopic approach (93.1) than the open approach (79.4, $p = 0.306$) or the robotic approach (73.4, $p = 0.046$). This included the ability to enjoy hobbies, activities and time with colleagues, family and friends (Table 4). The physical stress of undergoing open surgery also permeated into the personal and professional lives of many patients; they reported deficits in their ability to fulfill household chores and/or work proficiently at a job.

“The bag makes it impossible to do anything spontaneous. I’ve had poop running down my leg at restaurants… never mind the odor. Sometimes I also get depressed when my wife has to change my bag.” — Patient 11

“I’ve also had embarrassing leakage of gas, like while doing yoga with other people…all this has really taken a toll on my personal life and has robbed me of the opportunity to enjoy the things I loved doing.” — Patient 15

It is important to note that emotional and cognitive function did not seem to vary with surgical modality (Table 4). Surgical modality also did not have a considerable impact on fatigue ($p = 0.155$) and/or symptom scales.
assessing gastrointestinal (GI) function ($p = 0.105$), defecation ($p = 0.112$), psychological symptoms ($p = 0.793$) and pain ($p = 0.263$; Table 4).

There was a trend toward significance for global QOL ($p = 0.065$), sexual function ($p = 0.083$) and urinary function ($p = 0.061$). Pairwise comparisons were conducted to assess for significance across cohorts. With regards to sexual function, no association was found between open versus laparoscopic ($p = 0.197$), open versus robotic ($p > 0.99$) and laparoscopic versus robotic ($p = 0.418$) cohorts. Group comparisons for urinary function showed a trend toward significance between robotic and open surgery ($p = 0.053$). There were no group differences with respect to urinary function between robotic versus laparoscopic ($p = 0.281$) or open versus laparoscopic surgery ($p = 0.979$). Group comparisons for global QOL showed an association toward significance between open versus laparoscopic surgery ($p = 0.065$). There were no group differences with respect to global QOL scores between open versus robotic ($p = 0.511$) and laparoscopic versus robotic surgery ($p = 0.922$).

**DISCUSSION**

Using a mixed-methods design, we explored the impact of surgical modality on self-reported body image and QOL among patients undergoing anterior resection for CRC. Three major themes were identified through detailed semistructured interviews and validated questionnaires over a follow-up period of approximately 14 months. First, open surgery was found to be detrimental to body image and cosmesis scores. In particular, patients expressed dissatisfaction with the presence of midline laparotomy scars and incisional hernias. Second, open surgery was found to negatively affect physical function, including the ability to engage in arduous activities of daily living. Finally, while laparoscopy was found to be protective in preserving role and social function in comparison to open and robotic surgery, these findings require prospective validation. Global QOL and sexual, urinary and GI function remained unaffected by surgical modality.

A total of 30 patient interviews were completed, at which time data saturation was achieved. A recent study using 60 qualitative interviews found that saturation occurred within the first 12 interviews and that elements for meta-themes were present as early as the first 6 interviews. Therefore, we believe that our sample size was sufficient for thematic exploration of this topic.

Our study expands on the limited body of literature exploring the topic of cosmesis and functional outcomes of anterior resections from the patients' perspective. Self-reported body image and cosmetic outcomes have yet to be independently explored in this patient population. All previous reports, to our knowledge, have investigated the topic of body image using a limited set of 3 questions in the context of the EORTC QLQ-CR29 questionnaire. For instance, a recent study by Kamali and colleagues found no significant difference in mean body image scores between patients undergoing laparoscopic (96.3) or robotic surgery (92.9) for rectal cancer ($p = 0.85$). Similarly, in the COLOR II trial, 12 months after undergoing open surgery, patients had comparable mean body image scores (80.8) to those undergoing laparoscopic surgery (78.8, $p = 0.65$). While our study also did not find a meaningful difference in body image and cosmesis scores between patients undergoing laparoscopic and robotic surgery, patients undergoing open surgery had significantly poorer cosmetic outcomes than those receiving minimally invasive operations. This outcome was evident using a targeted BIQ as well as 3 probing questions about body image in the EORTC QLQ-CR29 questionnaire. This finding is important, given that, to our knowledge, ours is the first initiative exploring self-reported body image and cosmesis using a detailed, previously validated BIQ. Merit of the BIQ has been previously demonstrated among patients receiving surgery for Crohn disease, where body image and cosmesis was also rated more highly after laparoscopic than open surgery.

Our qualitative data provide further validation of our quantitative findings, where a significant proportion of patients in the open surgery cohort expressed concern over the presence of incisional hernias, wound infection and midline laparotomy scars. Poor wound healing (i.e., hypertrophy and keloid formation) and enlargement of hernias with time were added concerns for this subset of patients. It is therefore possible that their body image scores would diminish further over time with a more longitudinal analysis of cosmetic outcomes. It is important to note that ventral incisional hernia is a common and well-characterized complication of transabdominal surgery. The incidence ranges from 2% to 20% and varies greatly from one series to another as well as by surgical modality. Previous reviews of studies comparing laparotomy to minimally invasive surgery have reported a significantly higher incidence of incisional hernia after laparotomy, as seen in our series ($p = 0.001$).

That open surgery may significantly hinder perception of body image, cosmesis and physical function warrants further study. Future studies exploring this outcome may inform additional educational interventions for patients being considered for anterior resection. For instance, brochures, infographics and images of postoperative abdomens can be used to educate patients before surgery. Our previous study exploring decision-making preferences found that patients with CRC often perceived a lack of information in the decision-making process. Therefore, one must remain sensitive to the unique decision-making preferences of each patient to align their expectations with known or possible postoperative outcomes.

It is also important to note that while QOL after rectal cancer surgery has been a topic of numerous studies, specific comparisons of all 3 surgical modalities and their
impact on survivorship are yet to mature. In our study, surgical modality did not have a considerable impact on emotional and cognitive function, or symptom scales assessing GI function, defecation, psychological symptoms and pain. While there was a trend toward significance, differences in genitourinary function and global QOL did not achieve statistical significance. Several other studies, though limited to 2 of the 3 surgical modalities compared in the present study, have reported modality-related differences in sexual function. For instance, Kamali and colleagues'1 comparison of 34 patients revealed lower male impotence scores in patients who had robotic anterior resection than laparoscopic resection (7 ± 21 v. 33 ± 35, p = 0.03). Similarly, a systematic review and meta-analysis by Broholm and colleagues'30 reported a lower incidence of sexual dysfunction in patients undergoing robotic rectal cancer surgery than laparoscopy. While the CLASSIC trial found a higher rate of sexual dysfunction after laparoscopy than open surgery,10 the COLOR II trial did not report any significant modality-related differences in health-related QOL.10 Similarly, the recently published ROLARR trial did not reveal a statistically significant difference in bladder and sexual dysfunction between patients undergoing conventional laparoscopic versus robotic-assisted surgery for rectal cancer.31

Interestingly, our results also suggest that laparoscopy may be protective toward preserving role and social function in comparison to open and robotic surgery. This effect, however, is likely explained by “tumour factors,” which are unaccounted for in the EORTC questionnaires. Patients receiving robotic surgery were significantly more likely to have a diagnosis of low-lying rectal cancer, demanding stoma creation. This likely skewed the role and social functioning scores to favour those with a lower likelihood of stoma creation, namely patients with rectosigmoid or upper-to-mid rectal cancer amenable to laparoscopic resection. This protective effect of laparoscopy on social function, also reported by Kamali and colleagues,31 was not reflected in the COLOR II trial.10 It is possible that the relatively low role and social function scores reported by patients receiving robotic surgery would recover over time, as 78% of these patients ultimately underwent stoma reversal surgery to re-establish GI continuity. Robotic surgery, notwithstanding the cost, can help in overcoming the technical challenges associated with laparoscopy and has been shown to offer comparable short-term oncologic outcomes and anastomotic leak rates.14,11

Comprehensive longitudinal and randomized data comparing emerging (transanal total mesorectal excision) and current modalities (laparoscopy, robotic surgery) in CRC are yet to materialize. The ongoing COLRAR (NCT01423214) and COLOR III (NCT02736942) trials are expected to provide more information on the topic of QOL in this vulnerable patient population.

Limitations

Our study is limited by its nonrandomized design and accompanying selection bias. For instance, the use of convenience sampling may limit the generalizability of our results, as the findings represent the views of patients under the care of only 2 surgical oncologists at a tertiary academic centre. Future studies should aim to recruit a diverse cross-section of patients undergoing anterior resections with unique treatment experiences to further explore the themes presented in this study. As patients were at least 8 months from surgery at the time of the interviews, some of our results may also be limited by recall bias. Moreover, the relatively small sample size and heterogeneous nature of the patient cohort did not allow for the balancing of all potential confounders present within the sample. It also precluded a detailed multivariate analysis to independently assess the association between surgical modality and QOL. It is also possible that the cosmetic and QOL benefits described above may diminish over time; therefore, a longitudinal analysis would have provided a more thorough understanding of trends in self-reported body image, function and QOL after anterior resection for CRC. This underscores the importance of future prospective studies to further elucidate the intricacies of how surgical modality may impact survivorship among patients with CRC.

CONCLUSION

Quality of life is an important outcome measure to be considered when deciding on a treatment strategy for CRC. To our knowledge, this is the first study of its kind, which adds to the limited body of patient-centred qualitative data, on the impact of open, laparoscopic and robotic surgery on cosmetic and functional outcomes. In our series, patients selected for open surgery for rectal and/or sigmoid cancers had lower self-reported body image and physical function than those undergoing minimally invasive surgery. Additionally, patients chosen for laparoscopic surgery reported fewer deficits in role and social function than those undergoing open and robotic operations.

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Competing interests: None declared.

Contributors: D. Hirpara, A. Azin, V. Mulcahy, C. O’Brien and F. Quereshy designed the study. D. Hirpara, V. Mulcahy, E. Le Souder, C. O’Brien, S. Chadi and F. Quereshy acquired the data, which D. Hirpara, A. Azin and F. Quereshy analyzed. D. Hirpara, A. Azin, V. Mulcahy, E. Le Souder and F. Quereshy wrote the article, which all authors reviewed and approved for publication.
References


Crash testing the dummy: a review of in situ trauma simulation at a Canadian tertiary centre

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Background: In situ trauma simulations allow for the trauma team and emergency department to practise team dynamics, resuscitation and logistics in a safe environment. The goal of this investigation was to show the feasibility of an in situ trauma simulation program at a Canadian level I trauma centre.

Methods: We performed a retrospective review of in situ simulations (maximum 20 min, followed by a 10-min debriefing session) at a level I trauma centre from 2015 to 2017. Errors were categorized according to the National Patient Safety Agency risk assessment matrix by 3 independent raters and assigned consequence scores (assessing potential harm) and likelihood scores (assessing the likelihood of potential harm). A risk score was calculated as the product of the mean consequence and likelihood scores. Errors per simulation and the number of simulations required for error resolution were recorded.

Results: We reviewed 8 in situ simulations and identified 54 errors, of which 7 were related to medications, 20 to equipment, 21 to environment/staffing and 6 to training. The mean consequence score was 2.85/5 (standard deviation [SD] 0.75, intraclass correlation coefficient [ICC] 28%), indicating minor to moderate harm. The mean likelihood score was 2.82/5 (SD 0.55, ICC 41%), indicating unlikely to possible. The mean risk score was 8.42/25 (SD 3.19, ICC 43%). One error (2%) was low risk, 23 (43%) were moderate risk, 26 (48%) were high risk, and 4 (7%) were extreme risk.

Conclusion: In situ trauma simulations are feasible in a Canadian centre and provide a safe environment to identify and rectify errors.

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Contexte : Les simulations de catastrophes in situ permettent à l’équipe de traumatologie et au service d’urgence de tester la dynamique d’équipe, les techniques de réanimation et la logistique dans un environnement sécuritaire. L’objectif de cette étude était de montrer la faisabilité d’un programme de simulation in situ dans un centre canadien de traumatologie de niveau I.

Méthodes : Nous avons effectué une revue rétrospective des simulations in situ (maximum 20 min, suivies de séances de compte rendu) ayant eu lieu dans un centre de traumatologie de niveau 1 entre 2015 et 2017. Les erreurs ont été classées en catégories selon la grille d’évaluation des risques de la National Patient Safety Agency par 3 examinateurs indépendants, qui leur ont assigné des scores de conséquence (préjudices potentiels) et des scores de probabilité (probabilité de préjudices potentiels). Un score de risque a été calculé sous forme de produit des scores moyens de conséquence et de probabilité. Le nombre d’erreurs par simulation et le nombre des simulations requises pour les résoudre ont été enregistrés.

Résultats : Nous avons analysé 8 simulations in situ et relevé 54 erreurs, dont 7 concernaient les médicaments, 20, l’équipement, 21, l’environnement ou la dotation en personnel et 6, la formation. Le score de conséquence moyen était de 2,85/5 (écart-type 0,75; coefficient de corrélation intraclasse [CCI] 28%), indiquant des préjudices de mineurs à modérés. Le score de probabilité moyen était de 2,82/5 (écart-type 0,55; CCI 41%), soit d’improbable à possible. Le score de risque moyen était donc de 8,42/25 (écart-type 3,19; CCI 43%). Une seule erreur (2%) comportait un risque faible, 23 (43%) comportaient un risque modéré, 26 (48%), un risque élevé et 4 (7%), un risque extrême.

Conclusion : Les simulations de catastrophes in situ sont faisables dans un centre canadien et permettent d’identifier les erreurs et les rectifier dans un environnement sécuritaire.
Trauma resuscitation is complex, unpredictable and prone to medical error. The ability of trauma teams to safely manage rare events often depends on the frequency of exposure, which, in many Canadian centres, may be inadequate to maintain expertise. Simulation is an established tool in medical education and has been used to improve trauma team performance and patient safety.

Within a simulation laboratory that is removed from the actual environment in which care is performed, important system, equipment and environmental influences are challenging to fully evaluate. Furthermore, individual performance may be influenced by the artificial environment in which tasks are performed, and “suspension of disbelief” may be more difficult in the simulation laboratory.

In situ simulation, in which team-based training is conducted in the actual patient care area, and the resources and equipment available to the usual treating team are used, has been described as “crash testing the dummy.” In situ simulation has been used to proactively identify latent system errors in emergency medicine, pediatric anesthesia and trauma. Latent system errors are system-based conditions that do not appear to be creating active harm and may lie dormant for some time but, in certain circumstances, may materialize and result in serious morbidity. Multidisciplinary in situ simulation may inspire reflection from multiple clinical viewpoints and provide a better evaluation of latent safety errors. It may also provide an opportunity for team learning that may not be achievable within a traditional simulation laboratory.

The goal of this investigation was to show the feasibility of an in situ trauma simulation program at a Canadian level 1 trauma centre. We hypothesized that the introduction of in situ simulations would identify actual and latent safety errors that could be corrected by subsequent evaluations and provide unique learning opportunities for team members in a safe and supportive environment.

**Methods**

**Setting**

We evaluated in situ simulation involving the trauma team at the QEII Health Sciences Centre, a level 1 trauma centre in Halifax. It is a tertiary/quaternary referral centre for Atlantic Canada, serving a population of about 1 million. It performs over 400 major trauma activations each year. Trauma team activations follow established predefined mechanistic, physiologic and anatomic criteria and are standardized across the province of Nova Scotia.

**Participants**

The trauma team includes an attending trauma team leader, resident trauma team leader, general surgery resident, orthopedic surgery resident, anesthesia resident, paramedic, respiratory therapist, radiology resident, radiology technologist and 3 emergency nurses. Three evaluators (the QEII Health Sciences Centre medical director of trauma [general surgery/critical care and trauma team leader attending], a simulation specialist [paramedic] and the Trauma Nova Scotia Program education nurse) were physically present for each of the in situ simulations. The evaluators developed test scenarios, provided feedback and led a focused team debriefing session.

**Design**

Initiation of in situ simulations in the emergency department were vetted through the QEII Health Sciences Centre trauma services committee, surgery executive committee and department head of Emergency Medicine, and the Nova Scotia provincial trauma committee. Concern regarding any potential impact on patient care was discussed, and all committees were in agreement that the benefits of the exercise exceeded the risks.

Starting in November 2015, in situ simulations were planned at monthly intervals and ran from November 2015 to May 2017. To evaluate the trauma system with various staff and variables that may be temporally related, the simulations were performed at a variety of times during weekdays, including evenings. One hour before activation, the intent to activate the trauma team was discussed in confidence with the emergency charge physician and charge nurse to determine whether there were any barriers to running the simulation. A “no-go” criterion was established whereby the simulation would be cancelled if the charge nurse or physician felt that the simulation would result in definite patient harm. Examples of no-go situations included a trauma activation already in progress or all monitored emergency department beds’ being occupied with critically ill patients in unstable condition who could not be transferred to lower-acuity beds. The trauma team was activated in the usual manner via the standard provincial trauma communication system and was not informed that the activation was a simulation.

A SimMan 3G simulator (Laerdal Medical) was brought into the trauma bay from the ambulance bay, and handover to the trauma team was conducted by paramedics as per standard protocol. The trauma team used equipment, medications and supplies from the trauma room in a manner similar to that with a real patient with trauma. This included using regular monitors, drugs and procedural equipment as well as transport to the computed tomography scanner and operating room when appropriate. To limit time away from other clinical activities, scenarios were limited to 20 minutes in length, following by a 10-minute debriefing session.

Test scenarios were developed to investigate team behaviours, communication issues or equipment readiness. Most scenarios were developed with the use of real cases...
from the trauma database appropriate to meet predetermined educational goals. If an actual or latent error was identified during the simulation, it was added as an educational goal to the next simulation to test whether the efforts to correct it had been successful. During the debriefing session, observations regarding actual and latent safety errors as well as possible solutions were solicited from members of the trauma team. After each simulation, the medical director of trauma documented the identified safety issues and proposed solutions.

**Data analysis**

The primary data source for our study was the debriefing reports created by the medical director of trauma between November 2015 and May 2017. Each error was noted and presented to 3 independent reviewers (S.M., R.G. and S.J.) for framework analysis. An error was defined as a deviation in best care, and a latent error was defined as a potential set-up for patient harm. Best care was defined as care consistent with evidence-based practice guidelines, such as use of tranexamic acid, or with institutional trauma protocols that were not necessarily based on evidence-based guidelines. Errors were identified by the 3 evaluators during the simulation or by the participants during the debriefing session.

Framework analysis uses a matrix format to systematically reduce qualitative data to be uniformly analyzed.25 The framework used was the National Patient Safety Agency risk assessment matrix26 (Fig. 1). Errors were categorized into medication-related, equipment-related, environment-related or training-related. Each error was attributed a consequence score, a likelihood score and a risk score. Consequence scores ranged from 1 (negligible) to 5 (catastrophic) and were based on the severity of the outcome or potential outcome that would have resulted from the error. Likelihood scores ranged from 1 (rare) to 5 (almost certain) and were based on the probability of the outcome’s occurring. A risk score was then computed as the product of the consequence and likelihood scores, with a range from 1–3 (low risk) to 15–25 (extreme risk), reflecting the impact of the identified error. We summarized consequence, likelihood and risk scores of each reviewer as means and standard deviations (SDs) and assessed agreement among reviewers using intraclass correlation (ICC), through a 2-way mixed-effects methodology. The final presented scores are the mean scores across all 3 raters, thus adjusting for rater bias. For example, failure to give tranexamic acid in the setting of massive bleeding was allocated an average consequence score of 5 (death from exsanguination) and an average likelihood score of 4 (based on strong evidence for its use in this setting), for a risk score of 20 (extreme risk). In contrast, failing to use the mobile recording desk (institutional standard operating procedure because the recording nurse can hear better) had an average consequence score of 1 and an average likelihood score of 3 (whenever not used, our personal experience was that the nurses frequently complained they could not hear), for a risk score of 3 (low risk).

**RESULTS**

Over the study period, 8 in situ simulations were reviewed. The overall rate of cancellation of simulations was 27%, with a higher rate observed after simulations were introduced, relative to later in the study period. The most common reason for cancellation was Emergency Medicine staff overburden.

A total of 54 errors were identified, of which 7 were medication-related, 20 were equipment-related, 21 were environment-related, and 6 were training-related. Examples of identified errors included failure to administer tranexamic acid (medication), inability to locate a Thomas splint (equipment), inability of recording nurse to hear
trauma team leader (environment) and no person able to perform focused assessment with sonography in trauma (FAST) (Table 1). A mean of 6 errors (SD 3.35) were identified per simulation.

The overall mean consequence score was 2.85/5 (SD 0.75, ICC 28%), the mean likelihood score was 2.82/5 (SD 0.55, ICC 41%), and the mean risk score was 8.42/25 (SD 3.19, ICC 43%). Mean consequence, likelihood and risk scores by category are summarized in Table 2. Most errors identified were moderate or high risk (Fig. 2). A median of 2 simulations (interquartile range 1–5) were required to satisfactorily resolve the error.

**DISCUSSION**

Our study shows the feasibility of introducing training based on in situ simulation into a Canadian trauma centre with a goal of identifying latent safety issues. Each simulation identified a broad array of errors, with the most common categories being equipment and environmental. Once an error was identified, potential solutions were devised by the trauma team and implemented over the following month. Whether a solution was effective was specifically evaluated with the use of scenarios designed to test the solution until it was clear that the issue had been resolved. It took a median of 2 further simulations to solve the identified problem.

Our overall simulation cancellation rate was 27%, which is similar to that in other in situ programs. However, this rate was much higher when the simulations were first introduced. We subsequently met with the QEII Health Sciences Centre trauma services committee and chief of the emergency department to discuss the high rate of cancellation. It was felt that, although in situ simulation had some potential to negatively affect or delay patient care, the potential positive outcomes of running the simulations outweighed those risks. We subsequently agreed that the only criterion for cancelling the simulation was causing definite patient harm. This varies from other no-go criteria described in the literature but was successful in increasing the number of simulations performed and may be helpful to understand potential errors that are the result of high workload strain. Monitoring the frequency of cancelled simulations was also informative as a marker of the potential impact that the trauma program might have been having on the rest of the emergency patient population.

Other investigators have detailed the successful implementation of in situ simulation programs in the emergency department. Patterson and colleagues introduced 90 in situ simulations over 1 year at a large centre with about 3000 resuscitation activations per year and were able to identify a latent safety error for every 1.2 simulations performed (rate of 3.5/simulation). Geis and colleagues used in situ simulations to identify 37 latent safety errors and 46 errors in clinical proficiency over 24 in situ simulations in a new satellite emergency department. Similar to our study, most of the identified errors involved equipment and medication.

### Table 1. Identified errors by category

<table>
<thead>
<tr>
<th>Category</th>
<th>Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medication</td>
<td>Tranexamic acid incorrectly or not administered</td>
</tr>
<tr>
<td></td>
<td>Tetanus not administered</td>
</tr>
<tr>
<td></td>
<td>Mannitol not available or not administered</td>
</tr>
<tr>
<td>Equipment</td>
<td>Communication system malfunction</td>
</tr>
<tr>
<td></td>
<td>Raney clips not available</td>
</tr>
<tr>
<td></td>
<td>Nursing mobile desk not used</td>
</tr>
<tr>
<td></td>
<td>Nursing recording sheet used improperly</td>
</tr>
<tr>
<td></td>
<td>HoverMatt not used</td>
</tr>
<tr>
<td></td>
<td>Thomas splint not available</td>
</tr>
<tr>
<td></td>
<td>Level 1 infuser used incorrectly</td>
</tr>
<tr>
<td></td>
<td>Glucometer not used</td>
</tr>
<tr>
<td>Environment</td>
<td>Recording nurse could not hear</td>
</tr>
<tr>
<td></td>
<td>Imaging not available</td>
</tr>
<tr>
<td></td>
<td>Neurosurgery unavailable</td>
</tr>
<tr>
<td></td>
<td>Orthopedic surgery unavailable</td>
</tr>
<tr>
<td></td>
<td>Radiology unavailable</td>
</tr>
<tr>
<td></td>
<td>Paramedic overwhelmed with too many tasks</td>
</tr>
<tr>
<td></td>
<td>Room not warmed</td>
</tr>
<tr>
<td></td>
<td>Sign-in board not used</td>
</tr>
<tr>
<td></td>
<td>Identification stickers not used</td>
</tr>
<tr>
<td>Training</td>
<td>Improper technique for spinal precautions</td>
</tr>
<tr>
<td></td>
<td>Universal precautions not used</td>
</tr>
<tr>
<td></td>
<td>No one trained in focused assessment with sonography in trauma (FAST)</td>
</tr>
</tbody>
</table>

### Table 2. Mean consequence, likelihood and risk scores* by error category

<table>
<thead>
<tr>
<th>Error category</th>
<th>Mean consequence score ± SD</th>
<th>Mean likelihood score ± SD</th>
<th>Mean risk score ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medication (n = 7)</td>
<td>3.00 ± 0.27</td>
<td>2.57 ± 0.32</td>
<td>8.05 ± 1.37</td>
</tr>
<tr>
<td>Equipment (n = 20)</td>
<td>2.77 ± 0.83</td>
<td>2.85 ± 0.54</td>
<td>8.18 ± 3.12</td>
</tr>
<tr>
<td>Environment (n = 21)</td>
<td>2.83 ± 0.78</td>
<td>2.90 ± 0.63</td>
<td>8.80 ± 3.82</td>
</tr>
<tr>
<td>Training (n = 6)</td>
<td>3.06 ± 0.80</td>
<td>2.66 ± 0.41</td>
<td>8.27 ± 2.84</td>
</tr>
</tbody>
</table>

SD = standard deviation.

*Consequence errors were rated on a scale of 1 (negligible) to 5 (catastrophic). Likelihood errors were rated on a scale of 1 (rare) to 5 (almost certain). Risk score was computed as the product of the mean consequence and likelihood scores, with a range from 1–3 (low risk) to 15–25 (extreme risk), reflecting the impact of the identified error.

![Fig. 2. Distribution of risk scores.](image-url)
resource issues, and 86% were corrected by the time the facility opened. The ability of in situ simulation to identify a high rate of latent safety errors was validated by video analysis of actual trauma resuscitations, which also showed a high error detection rate, 2.4 errors/case. However, for many centres, video analysis may be impractical owing to privacy issues and the logistics of having a delay between obtaining the video footage and being able to view it. In a comparison of in situ simulation versus traditional simulation, in situ simulation was able to identify more latent safety errors per simulation than traditional simulation.30 We had a high rate of safety errors identified (mean 6 per simulation), with half of the errors identified as high risk. Our high rate of error detection may have been secondary to having 3 trained evaluators for each simulation or because we invited feedback from the entire trauma team. The high rate may also reflect a system that was in need of substantial improvement.

We found in situ simulation to be an excellent method to identify irregularities in care and to provide practical solutions. The errors, which likely would not have been identified through traditional means of error reporting, were resolved without any patient harm.31 During an actual trauma there are practical barriers to providing feedback, as some of the team members depart with the patient while others return to their regular clinical duties.28 The use of in situ simulation accomplishes the dual goals of identifying andremedying latent safety errors as well as providing continuous opportunities to deliberately practise technical and nontechnical skills. This provides immediate benefit to the individual health care provider, the health care team and the next patient with trauma. On a strategic level, it also contributes to the evolution of the culture of safety.32 The realism and actual clinical environment of in situ simulation engages participants to improve the system and thereby patient safety as few other training methods can.13–35

Although we feel that performing in situ simulations has improved patient safety at our centre, future studies could investigate whether identification and resolution of latent safety errors through this training activity actually translates into important patient outcomes, which is the ultimate goal of any quality-improvement program.

Limitations

The single-centre design of our study is a limitation, and the observations and utility of the in situ simulation program we have described may not be generalizable to other centres. However, in light of the success of the other in situ simulation interventions described,10–28 we feel that this study adds to the understanding of the opportunities with and barriers to in situ simulation. Furthermore, our study is limited by a relatively small number of simulations reviewed (8 in total). There was also considerable subjectivity in our analysis. The classification of events as errors, which were not predetermined, depended on the evaluators’ and participants’ input for identification. In addition, although the National Patient Safety Agency risk assessment matrix is validated, it remains subjective, as evidenced by our relatively high ICC. To combat potential rater bias, we used the mean scores across 3 raters; however, should the raters have the same biases, bias would persist.

CONCLUSION

This project shows that an in situ simulation program is feasible in a Canadian trauma centre and provides a strategy that simultaneously allows for the identification of latent safety errors, deliberate practice of teamwork and communication skills, and multiple opportunities to improve patient safety.

References


Long-term outcomes of total hip arthroplasty in patients younger than 55 years: a systematic review of the contemporary literature

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Background: Total hip arthroplasty (THA) is increasingly performed in younger patients despite the lack of comprehensive assessment of long-term outcomes. We systematically reviewed the contemporary literature to assess the 1) indications, 2) implant selection and long-term survivorship, 3) complication and reoperation rates and 4) radiographic and functional outcomes of primary THA in patients younger than 55 years.

Methods: We searched the Embase and MEDLINE databases for English-language articles published between 2000 and 2018 that reported outcomes of primary THA in patients younger than 55 years with a minimum follow-up duration of 10 years.

Results: Thirty-two studies reporting on 3219 THA procedures performed in 2434 patients met our inclusion criteria. The most common preoperative diagnoses were avascular necrosis (1044 [32.4%]), osteoarthritis (870 [27.0%]) and developmental dysplasia of the hip (627 [19.5%]). Modular implants (3001 [93.2%]), cementless fixation (2214 [68.8%]) and metal-on-polyethylene bearings (1792 [55.7%]) were frequently used. The mean 5- and 10-year survival rates were 98.7% and 94.6%, respectively. Data on survival beyond 10 years were heterogeneous, with values of 27%–99.5% at 10–14 years, 59%–84% at 15–19 years, 70%–77% at 20–24 years and 60% at 25–30 years. Rates of dislocation, deep infection and reoperation for any reason were 2.4%, 1.2% and 16.3%, respectively. The mean Harris Hip Score improved from 43.6/100 to 91.0/100.

Conclusion: Total hip arthroplasty in patients younger than 55 years provides reliable outcomes at up to 10 years. Future studies should evaluate the outcomes of THA in this population at 15–20 years' follow-up.
Total hip arthroplasty (THA) reliably decreases pain and improves function and quality of life in patients with advanced hip disease at up to 25–30 years of follow-up. Despite early concerns over prosthetic longevity in patients with higher activity levels, improvements in implant design and surgical technique have led to increased demand for THA in younger, active patients. Kurtz and colleagues reviewed the American National Inpatient Sample database from 2006 and reported the proportion of primary THA procedures performed annually in patients younger than 55 years to be about 21%, with a projected rise to 28% by 2030. This proportion is slightly lower outside the United States, with rates of 11.9%, 6.4% and 13.2% reported by the Canadian, United Kingdom and Australian joint replacement registries, respectively.

Earlier studies showed high revision rates following Charnley low-friction arthroplasty in younger patients compared to older cohorts, with the main modes of failure being aseptic loosening and wear-induced osteolysis. Inferior implant survival in younger patients has been attributed to higher activity levels as well as a higher proportion of patients with inflammatory arthritis and congenital hip disease as their preoperative diagnosis. Despite these challenges, recent innovations including cementless fixation and alternative bearing surfaces have shown considerable promise in addressing many previous limitations of THA in younger patients.

Given these technological advances, we performed a systematic review of the contemporary literature with the aim of assessing the indications, implant selection and long-term survivorship, rates of complication and reoperation and radiographic and functional outcomes of primary THA in patients younger than 55 years of age.

Methods

Literature search and study selection

We performed a literature search according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Eligible studies were identified through a systematic search of MEDLINE and Embase databases from inception to April 2018. Database search terms included “total hip arthroplasty,” “total hip replacement,” “younger than 55,” “younger than 50,” “younger than 40,” “younger than 30,” “less than 55,” “less than 50,” “less than 40,” “less than 30” and “young patient.” We reviewed the bibliographies of all retrieved studies for relevant articles.

Two authors (X.Y.M. and Y.J.G.) independently screened the titles and abstracts of articles identified through the search strategy for eligibility. The predetermined inclusion criteria were 1) reporting of primary THA outcomes, 2) series of at least 20 patients, 3) mean follow-up of at least 10 years, 4) all patients younger than 55 years at the time of surgery and 5) reporting of implant selection and survivorship, complications and functional outcomes. Articles were restricted to those that were published in full and written in English. Studies were excluded if they 1) were published before 2000, 2) were conference abstracts, case reports, reviews or surgical technique articles, 3) did not adequately report implant selection and survivorship or 4) reported outcomes of hemiarthroplasty, hip resurfacing, metal-on-metal bearings or revision THA. When multiple studies reported on the same study population, the article with the longest follow-up duration was selected, and the other studies were removed. Studies that passed the initial title and abstract screening were reviewed in full with the use of the same eligibility criteria. Any disagreement between authors was resolved by consensus.

Data extraction and quality assessment

Two authors (X.Y.M. and Y.J.G.) independently extracted the relevant data from each study and recorded them in an Excel document. Data collected included study design and period; patient age, sex and body mass index; mean follow-up duration and proportion of patients lost to follow-up; preoperative diagnosis and surgical approach; and implant selection, type of fixation and bearing surface. Outcome measures included implant survivorship at 5 years, 10 years and final follow-up; rates of dislocation, deep infection, other complications and reoperation; radiographic assessment; and functional outcome scores. Disagreements between reviewers were resolved by consensus.

Two authors (X.Y.M. and Y.J.G.) independently assessed the methodological quality of eligible studies. The Cochrane Collaboration’s tool for assessing risk of bias in randomized trials was used for randomized controlled trials, and the Methodological Index for Non-Randomized Studies (MINORS) was used for nonrandomized studies. Review Manager (RevMan) version 5.3 (Cochrane Collaboration) was used to construct the risk of bias summary. Any disagreement between reviewers was resolved by consensus. Agreement between reviewers on individual MINORS items was measured with the Cohen k.

Statistical analysis

We used descriptive statistics to summarize patient demographic characteristics, implant selection and outcome measures. We calculated weighted means for all interval and ratio data. Stratification by implant fixation was not performed owing to inconsistent reporting of outcomes and the small number of studies using cemented and hybrid fixation. A p value < 0.05 was considered statistically significant. We performed all statistical analysis using SPSS version 24.0 software (IBM Corp.).
RESULTS

The initial search yielded 435 potentially relevant articles after exclusion of duplicates (Fig. 1). After review of the titles and abstracts, 384 articles were excluded. Twenty-three additional articles were excluded after full-text review, leaving 32 articles eligible for inclusion in the systematic review.

Patient demographic characteristics

A total of 3219 primary THA procedures performed in 2434 patients between 1969 and 2006 were included. The year of surgery was 1970–1980 for 171 hips (5.3%), 1980–1990 for 650 (20.2%), 1990–2000 for 1044 (32.4%) and after 2000 for 495 (15.4%); 9 studies reporting on 859 procedures (26.7%) had dates of surgery spanning more than 1 decade and thus could not be sorted into these intervals. A total of 777 procedures (24.1%) were performed after 1985. Of the 2434 patients, 1144 (47.0%) (standard deviation [SD] 17.2, range 20.5–85.7) were women. The mean age was 42.0 years (SD 7.4 yr, range 17.9–52.5 yr), and the mean body mass index was 26.6 (SD 2.7, range 22–29.6). The mean follow-up duration was 15.5 years (SD 5.9 yr, range 10–28.4 yr); 185 patients (7.6% [SD 8.1, range 0–39.1]) were lost to follow-up. The most common preoperative diagnoses were avascular necrosis (1044 cases

Fig. 1. Flow diagram showing study selection.
[32.4%]), primary/secondary osteoarthritis (870 [27.0%]) and developmental dysplasia of the hip (627 [19.5%]) (Table 1). A summary of the patient demographic characteristics is presented in Table 2, with full details available in Appendix 1 (available at canjsurg.ca/013118-a1).

Surgical technique and implant selection

A variety of surgical approaches including anterolateral, posterolateral, posterior and transtrochanteric were used. Modular implants were used in 3001 hips (93.2%) and monoblock implants in 218 (6.8%). Implant fixation was cementless in 2214 hips (68.8%), hybrid in 540 (16.8%) and cemented in 465 (14.4%). Among the 2399 cementless femoral stems described, the fixation design was metaphyseal-fitting in 1544 cases (64.4%), metaphyseal–diaphyseal-junction-fitting in 366 (15.3%), diaphyseal-fitting in 223 (9.3%) and screwed into the femoral canal in 137 (5.7%); the fixation design was not reported in 129 cases (5.4%). The bearing surface used was metal-on-conventional-polyethylene in 1792 hips (55.7%), ceramic-on-ceramic in 748 (23.2%), ceramic-on-conventional-polyethylene in 530 (16.5%), metal-on-highly-cross-linked polyethylene in 147 (4.6%) and ceramic-on-highly-cross-linked polyethylene in 2 (0.1%). The femoral head diameter ranged from 22 to 36 mm. Two studies reported use of acetabular autografts.40,43 Full surgical and implant details are presented in Appendix 1.

Implant survivorship, complications and reoperation

The 5- and 10-year revision-free implant survival rates were 98.7% (SD 1.5%, range 95.4–100%) and 94.6% (SD 3.5%, range 78.1–100%), respectively. In studies with mean follow-up beyond 10 years, reported revision-free survival rates were 27%–99.5% (16 studies) at 10–14 years, 59%–84% (2 studies) at 15–19 years, 70%–77% (2 studies) at 20–24 years and 60% (1 study) at 25–30 years. Rates of dislocation, deep infection and reoperation for any reason were 2.4% (SD 2.5%, range 0%–10.9%), 1.2% (SD 1.5%, range 0%–7%) and 16.3% (SD 13.6%, range 0%–63.8%), respectively. Aseptic loosening was the most common reason for reoperation. A summary of implant survivorship and complications is presented in Table 2, with full details available in Appendix 1.

Radiographic assessment and functional outcome

Nonprogressive acetabular and femoral radiolucent lines were observed in 418 (13.0%) (SD 18.4%, range 0%–85.2%) and 225 (7.0%) (SD 13.8%, range 0%–90.9%) components, respectively. Progressive radiolucency was not commonly reported. Functional outcome at final follow-up was reported with the use of the Harris Hip Score or the Merle d’Aubigné Score in all but 1 study, which used the Western Ontario and McMaster Universities Osteoarthritis Index.34 The Harris Hip Score was reported in 26 studies, with a mean postoperative score of 91.0/100 (SD 4.8, range 81–98) and a mean improvement of 47.4 points (SD 4.6, range 32.5–53). The Merle d’Aubigné Score was reported in 7 studies, with a mean postoperative score of 16.0/18 (SD 1.6, range 10.5–17.1) and a mean improvement of 7.1 points (SD 1.5, range 5.6–8.7). Other reported outcome scores included the Hip Disability and Osteoarthritis Outcome Score, Oxford Hip Score and modified UCLA Activity Score.

Study quality

The level of evidence was I in 3 studies37–39 and IV in 29 studies.20–48 The risk of bias summary for each included randomized trial and the interrater agreement for each MINORS item are presented in Table 3 and Table 4, respectively. The overall risk of bias of the randomized trials was low. The majority of included case series were of low methodological quality. Agreement between the reviewers was considered satisfactory for all items. The mean MINORS global score was 11.0/16 (range 7–14).

DISCUSSION

We found that a large proportion of younger patients underwent THA for avascular necrosis and osteoarthritis secondary to congenital, developmental or traumatic anatomic abnormalities. This result is in keeping with the current literature.49 These patients often present with major structural abnormalities such as proximal femoral deformity and femoral head collapse that increase the complexity of THA. Furthermore, patients who have undergone
## Table 2 (part 1 of 2). Summary of patient demographic characteristics, implant selection, survivorship outcomes and complications

<table>
<thead>
<tr>
<th>Study</th>
<th>No. of</th>
<th>No. of</th>
<th>Age, yr. mean (range)</th>
<th>Length of follow-up, yr. mean (range)</th>
<th>Implant fixation</th>
<th>Bearing surface</th>
<th>Implanted survival, %</th>
<th>Outcome, no. (%) of hips</th>
<th>Dislocation</th>
<th>Deep infection</th>
<th>Reoperation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cho et al., 27 2017</td>
<td>17</td>
<td>20</td>
<td>36.2 (21–40)</td>
<td>11 (10–13.5)</td>
<td>Cementless, hybrid</td>
<td>Metal-on-HXLPE</td>
<td>95</td>
<td>95 (11 yr)</td>
<td>1 (5.0)</td>
<td>0 (0.0)</td>
<td>1 (5.0)</td>
</tr>
<tr>
<td>Philippot et al., 25 2017</td>
<td>114</td>
<td>137</td>
<td>41 (18–50)</td>
<td>21.9 (3–30.9)</td>
<td>Cementless</td>
<td>MoP</td>
<td>NR</td>
<td>NR</td>
<td>77 (21.9 yr)</td>
<td>15 (10.9)</td>
<td>1 (0.7)</td>
</tr>
<tr>
<td>Schmoulders et al., 27 2017</td>
<td>77</td>
<td>81</td>
<td>48 (30–50)</td>
<td>13.5 (9.7–16.9)</td>
<td>Cementless</td>
<td>CoP</td>
<td>NR</td>
<td>96.8</td>
<td>93 (13.5 yr)</td>
<td>1 (1.2)</td>
<td>0 (0.0)</td>
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<tr>
<td>Starnsough et al., 25 2016</td>
<td>72</td>
<td>75</td>
<td>41.2 (17–50)</td>
<td>10 (8.2–11.9)</td>
<td>Cementless</td>
<td>Metal-on-HXLPE</td>
<td>96</td>
<td>92 (10 yr)</td>
<td>1 (1.3)</td>
<td>1 (1.3)</td>
<td>5 (6.7)</td>
</tr>
<tr>
<td>Kim et al., 25 2010</td>
<td>200</td>
<td>400</td>
<td>52.5 (20–54)</td>
<td>11.8 (10–13)</td>
<td>Cementless</td>
<td>CoC</td>
<td>99.5</td>
<td>99.5</td>
<td>99.5 (11.8 yr)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Kim et al., 25 2016</td>
<td>171</td>
<td>342</td>
<td>48 (21–50)</td>
<td>26.1 (21–27)</td>
<td>Hybrid, cementless</td>
<td>MoP</td>
<td>NR</td>
<td>NR</td>
<td>78.5 (26.1 yr)</td>
<td>5 (1.5)</td>
<td>1 (0.3)</td>
</tr>
<tr>
<td>McLaughlin et al., 25 2015</td>
<td>67</td>
<td>82</td>
<td>38.4 (20–49)</td>
<td>25 (20–29)</td>
<td>Cementless</td>
<td>MoP</td>
<td>NR</td>
<td>NR</td>
<td>90 (27 yr)</td>
<td>0 (0.0)</td>
<td>3 (3.7)</td>
</tr>
<tr>
<td>Kim et al., 25 2014</td>
<td>70</td>
<td>88</td>
<td>45.6 (19–49)</td>
<td>28.4 (27–29)</td>
<td>Cementless</td>
<td>MoP</td>
<td>NR</td>
<td>66</td>
<td>90 (28.4 yr)</td>
<td>2 (2.3)</td>
<td>0 (0.0)</td>
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<tr>
<td>Babovic et al., 25 2013</td>
<td>50</td>
<td>54</td>
<td>38.9 (15–50)</td>
<td>10.4 (10–13.4)</td>
<td>Cementless</td>
<td>MoP</td>
<td>NR</td>
<td>NR</td>
<td>98.1 (10.4 yr)</td>
<td>1 (1.9)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Chana et al., 25 2013</td>
<td>100</td>
<td>110</td>
<td>45.8 (20–55)</td>
<td>11.5 (10–13.5)</td>
<td>Cementless</td>
<td>CoC</td>
<td>96.5</td>
<td>96.5</td>
<td>(11.5 yr)</td>
<td>1 (0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Schmitz et al., 25 2013</td>
<td>48</td>
<td>69</td>
<td>25 (16–29)</td>
<td>11.5 (12–23)</td>
<td>Cemented</td>
<td>MoP</td>
<td>NR</td>
<td>86</td>
<td>75 (15 yr)</td>
<td>2 (2.9)</td>
<td>4 (5.8)</td>
</tr>
<tr>
<td>Yoon et al., 25 2012</td>
<td>62</td>
<td>75</td>
<td>24 (18–30)</td>
<td>11.4 (10–13.4)</td>
<td>Cementless</td>
<td>CoC</td>
<td>NR</td>
<td>99.9</td>
<td>96.9 (10 yr)</td>
<td>1 (1.3)</td>
<td>0 (0.0)</td>
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<tr>
<td>Biemond et al., 25 2011</td>
<td>80</td>
<td>93</td>
<td>44 (16–50)</td>
<td>12.3 (9.8–15.5)</td>
<td>Cementless</td>
<td>MoP</td>
<td>NR</td>
<td>94</td>
<td>94 (12.3 yr)</td>
<td>6 (6.5)</td>
<td>0 (0.0)</td>
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<tr>
<td>Faldini et al., 25 2011</td>
<td>28</td>
<td>34</td>
<td>47 (44–50)</td>
<td>12 (10–14)</td>
<td>Cementless</td>
<td>MoP 27, CoC 7</td>
<td>100</td>
<td>100</td>
<td>100 (12 yr)</td>
<td>1 (2.9)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Hsu et al., 25 2011</td>
<td>62</td>
<td>80</td>
<td>38.6 (16–49)</td>
<td>10.1 (10–12.3)</td>
<td>Hybrid</td>
<td>CoC</td>
<td>NR</td>
<td>96.3</td>
<td>96.3 (10 yr)</td>
<td>0 (0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Kim et al., 25 2011</td>
<td>78</td>
<td>109</td>
<td>43.4 (21–50)</td>
<td>18.4 (17–19)</td>
<td>Hybrid, cementless</td>
<td>MoP</td>
<td>NR</td>
<td>93.6</td>
<td>85.5 (20 yr)</td>
<td>3 (1.4)</td>
<td>3 (1.4)</td>
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<tr>
<td>Pakvis et al., 25 2011</td>
<td>131</td>
<td>158</td>
<td>42 (18–50)</td>
<td>13.2 (10–18)</td>
<td>Cementless</td>
<td>CoP 100, MoP 58</td>
<td>NR</td>
<td>98</td>
<td>90 (14 yr)</td>
<td>7 (4.4)</td>
<td>3 (1.9)</td>
</tr>
<tr>
<td>Boyer et al., 25 2010</td>
<td>69</td>
<td>76</td>
<td>39 (NR)</td>
<td>10 (7–15)</td>
<td>Hybrid, cementless</td>
<td>CoP</td>
<td>NR</td>
<td>92</td>
<td>92 (10 yr)</td>
<td>3 (3.9)</td>
<td>1 (1.3)</td>
</tr>
<tr>
<td>Burston et al., 25 2010</td>
<td>44</td>
<td>54</td>
<td>39.5 (18–50)</td>
<td>12.5 (10–17)</td>
<td>Cemented, hybrid</td>
<td>MoP</td>
<td>NR</td>
<td>NR</td>
<td>79.2 (12.5 yr)</td>
<td>4 (7.1)</td>
<td>2 (2.8)</td>
</tr>
<tr>
<td>Fletcher et al., 25 2011</td>
<td>212</td>
<td>233</td>
<td>42.6 (20–50)</td>
<td>10 (5–16)</td>
<td>Cementless</td>
<td>CoP</td>
<td>NR</td>
<td>96.7</td>
<td>87 (15 yr)</td>
<td>6 (2.6)</td>
<td>4 (1.7)</td>
</tr>
<tr>
<td>Wroblewski et al., 25 2010</td>
<td>26</td>
<td>35</td>
<td>17.9 (12–19)</td>
<td>15.6 (2.3–34)</td>
<td>Cemented</td>
<td>MoP 25, CoP 10</td>
<td>NR</td>
<td>NR</td>
<td>59 (15.6 yr)</td>
<td>0 (0)</td>
<td>1 (2.9)</td>
</tr>
<tr>
<td>Akbar et al., 25 2009</td>
<td>59</td>
<td>70</td>
<td>35 (22–40)</td>
<td>14 (10–16)</td>
<td>Cementless</td>
<td>CoP</td>
<td>100</td>
<td>100</td>
<td>86 (14 yr)</td>
<td>0 (0)</td>
<td>0 (0.0)</td>
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<tr>
<td>Lewthwaite et al., 25 2008</td>
<td>101</td>
<td>123</td>
<td>42 (NR)</td>
<td>12.5 (10–17)</td>
<td>Cemented</td>
<td>MoP</td>
<td>NR</td>
<td>94.4</td>
<td>92.6 (12.5 yr)</td>
<td>1 (0.8)</td>
<td>1 (0.8)</td>
</tr>
<tr>
<td>Utting et al., 25 2008</td>
<td>53</td>
<td>70</td>
<td>40 (19–49)</td>
<td>13.6 (12–16)</td>
<td>Hybrid</td>
<td>MoP</td>
<td>NR</td>
<td>NR</td>
<td>84 cup/liner (stem NFI)</td>
<td>2 (2.9)</td>
<td>1 (1.4)</td>
</tr>
<tr>
<td>Wangen et al., 25 2008</td>
<td>42</td>
<td>47</td>
<td>25 (15–30)</td>
<td>13 (10–16)</td>
<td>Cementless</td>
<td>MoP</td>
<td>NR</td>
<td>NR</td>
<td>51 (13 yr)</td>
<td>3 (6.4)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Singh et al., 25 2004</td>
<td>33</td>
<td>38</td>
<td>42 (22–49)</td>
<td>10 (5.3–14.2)</td>
<td>Hybrid, cementless</td>
<td>CoP 36, MoP 2</td>
<td>NR</td>
<td>NR</td>
<td>90.5 cemented cup, 96 cementless cup, 100 stem (12 yr)</td>
<td>0 (0)</td>
<td>0 (0.0)</td>
</tr>
</tbody>
</table>

previous surgery may have retained hardware, extensive scar tissue, heterotopic ossification or limb length discrepancy that require a greater degree of preoperative planning than routine THA in older patients with osteoarthritis. Although THA had historically been performed in younger patients for rheumatoid arthritis, only 8.3% of hips in our review had inflammatory arthritis of any kind as in younger patients for rheumatoid arthritis, only 8.3% of implants after a mean follow-up duration of 10.8 years.

Table 2 (part 2 of 2). Summary of patient demographic characteristics, implant selection, survivorship and outcomes

<table>
<thead>
<tr>
<th>Study</th>
<th>No. of patients</th>
<th>No. of hips</th>
<th>Age, yr, mean (range)</th>
<th>Length of follow-up, yr, mean (range)</th>
<th>Implant fixation</th>
<th>Bearing surface</th>
<th>Implant survival, %</th>
<th>Outcome, no. (%) of hips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keener et al.,24 2003</td>
<td>42</td>
<td>57</td>
<td>42 (18–59)</td>
<td>25.7 (25–30)</td>
<td>Cemented</td>
<td>MoP</td>
<td>NR</td>
<td>60 (30 yr)</td>
</tr>
<tr>
<td>Crowther et al.,25 2002</td>
<td>44</td>
<td>56</td>
<td>37 (22–49)</td>
<td>11 (9–14)</td>
<td>Cementless</td>
<td>MoP</td>
<td>NR</td>
<td>87.5 (11 yr)</td>
</tr>
<tr>
<td>Chiu et al.,26 2001</td>
<td>33</td>
<td>47</td>
<td>28.6 (17–39)</td>
<td>14.9 (6.9–21.1)</td>
<td>Cemented</td>
<td>MoP</td>
<td>97.8</td>
<td>27 (15 yr)</td>
</tr>
<tr>
<td>Duffy et al.,27 2001</td>
<td>72</td>
<td>82</td>
<td>32 (17–39)</td>
<td>10.3 (10–14)</td>
<td>Cementless</td>
<td>MoP</td>
<td>96.3</td>
<td>78.1 (10 yr)</td>
</tr>
<tr>
<td>Garcia-Cimbrelo et al.,28 2000</td>
<td>58</td>
<td>67</td>
<td>32.4 (18–39)</td>
<td>21.7 (5–25)</td>
<td>Cementless</td>
<td>MoP</td>
<td>98.5</td>
<td>88 (24 yr)</td>
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<tr>
<td>Smith et al.,29 2000</td>
<td>40</td>
<td>47</td>
<td>41 (21–50)</td>
<td>18.2 (17–20)</td>
<td>Cemented</td>
<td>MoP</td>
<td>96.8</td>
<td>96.8 (10 yr)</td>
</tr>
</tbody>
</table>

Table 3. Risk of bias for each included randomized trial14

<table>
<thead>
<tr>
<th>Study</th>
<th>Random sequence generation (selection bias)</th>
<th>Allocation concealment (selection bias)</th>
<th>Blinding of participants and personnel (performance bias)</th>
<th>Blinding of outcome assessment (detection bias)</th>
<th>Incomplete outcome data (attrition bias)</th>
<th>Selective reporting (reporting bias)</th>
<th>Other bias</th>
</tr>
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<tbody>
<tr>
<td>Kim et al.17</td>
<td>+</td>
<td>+</td>
<td>?</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Kim et al.18</td>
<td>+</td>
<td>+</td>
<td>?</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
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<tr>
<td>Kim et al.19</td>
<td>+</td>
<td>+</td>
<td>?</td>
<td>+</td>
<td>+</td>
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<td>+</td>
</tr>
</tbody>
</table>

+ = low risk of bias; ? = unclear risk of bias.

preoperatively and intraoperatively. In addition, modular head and liner exchange can be a less invasive revision option in cases of instability and eccentric polyethylene wear with well-fixed femoral and acetabular components. Although modularity is associated with risk of trunnion corrosion, adverse local tissue reactions and component fracture, the only modularity-related complications in our review were 4 cases of fractured ceramic liner.

The inconsistent survivorship of cemented implants in younger patients has led to a preference for cementless fixation in this population. We found that a variety of cementless femoral component designs were used, with metaphyseal-fitting stems being the most common. Metaphyseal-fitting stems are thought to not only increase proximal load transfer to reduce stress shielding and thigh pain, but also preserve diaphyseal bone for future revision, thus making them a popular choice in younger patients, who are expected to outlive their implants. Success with metaphyseal-fitting stems has furthered interest in shorter stem designs for additional bone preservation. In a within-patient randomized trial, Kim and colleagues reported the outcomes of 200 patients who underwent bilateral THA and were randomly allocated to receive conventional cementless stems in one hip and short cementless stems in the contralateral hip. Those authors found decreased stress shielding in the short stems but no difference in survivorship or functional outcome between the implants after a mean follow-up duration of 10.8 years.

The most commonly reported bearings in our review were metal-on-conventional-polyethylene, ceramic-on-
ceramic and ceramic-on-conventional-polyethylene. This may be related to our inclusion of only studies with long-term follow-up. Although highly cross-linked polyethylene has been shown to improve wear rates compared to conventional polyethylene, long-term data showing a clear increase in clinical survivorship are not yet available. The superior wear resistance of ceramic-on-ceramic bearings offers potential reduction of wear-induced osteolysis in comparison to metal-on-conventional-polyethylene bearings, although no study to date has shown a significant difference in reoperation rates. There have also been concerns over the risk of ceramic component fracture, chipping on insertion and squeaking. The incidence of ceramic-related complications in our review was relatively low, with 4 cases (0.3%) of fractured ceramic liners and 5 cases (0.4%) of squeaking. Ceramic-on-conventional-polyethylene bearings have also shown excellent wear resistance in the long term, although studies comparing these bearings with metal-on-conventional-polyethylene bearings have shown mixed results. We excluded metal-on-metal bearings from our review owing to widespread concerns over increased metal ion levels and adverse local tissue reactions to metallic wear debris.

The overall revision-free survival rate was 98.7% at 5 years and 94.6% at 10 years. These values are similar to those reported for THA in older patients. Mäkelä and colleagues reviewed the Nordic Arthroplasty Registry for all primary THA procedures performed in patients older than 55 years between 1995 and 2011. Using the outcome of revision for any reason, they reported 10-year survivorship rates of 91.8%, 90.0% and 92.2% for cementless, hybrid and cemented components, respectively, in patients aged 55–64 years. Similarly, Hailer and colleagues reviewed the Swedish Hip Arthroplasty Register from 1992 to 2007 and reported 10-year survivorship rates of 85% and 94% for cementless and cemented THA components, respectively. Survivorship beyond 10 years was inconsistently reported because the final follow-up periods varied greatly between studies. Therefore, we were able to present only the range of final survivorship rates reported in the included studies. This reflects the current paucity of studies with more than 15 years’ follow-up, which is an inherent limitation of newer technology. Only 2 studies showed implant survivorship rates less than 75% at 10–15 years. Chiu and colleagues reported acetabular component survivorship of 27% at 15 years in 47 Charnley low-friction arthroplasty procedures performed using early cementing techniques. They found inadequate cement mantle around 27 components (57%) that correlated strongly with subsequent aseptic loosening and emphasized the importance of good cementing technique. Wangen and colleagues reported acetabular component survivorship of 51% at 13 years in 47 cementless THA procedures using hydroxyapatite-coated hemispherical cups in patients younger than 30 years. They attributed the high rates of cup loosening to the tendency for dissolution and resorption of the hydroxyapatite coating on the acetabular side, which had been observed in previous studies.

Rates of dislocation (2.4%) and deep infection (1.2%) in our review are comparable to values reported in large registry studies (1.9% and 1.3%, respectively). Rates of periprosthetic fracture were also relatively low in comparison to those in the literature (0.3% v. 1%), likely secondary to superior bone quality in younger patients. The overall reoperation rate was high, at 16.3%, although many operations were late revisions for aseptic loosening more than 10 years after THA.

Radiographic evaluation of implant stability was performed with the DeLee and Charnley and Gruen systems for acetabular and femoral components, respectively. Progressive radiolucency was rarely reported, which minimized the risk of a large number of impending aseptic failures. Substantial improvements and high postoperative Harris Hip and Merle d’Aubigné scores suggest that most patients achieved satisfactory functional outcome.

**Limitations**

This study has several limitations. First, our review was restricted to English-language studies published after 1999 that had a mean follow-up duration of 10 years or more. Although having these strict inclusion criteria allowed us to focus on contemporary, long-term outcomes that are critical to counselling patients preoperatively, they may have resulted in exclusion of studies that contributed substantially to the literature on THA in younger patients. For instance, our minimum follow-up cut-off may have led to underrepresentation of highly cross-linked polyethylene in our study owing to its relative newness. Second, most of the included studies were small, retrospective case series of low methodological quality and were heterogeneous with respect to preoperative demographics, surgical technique and implant selection. This limited our ability to perform a meta-analysis and reflects the current lack of prospective, standardized, multicentre data in the orthopedic literature. Third, the paucity of studies with 15 years’ follow-up limited our ability to draw conclusions about implant survivorship beyond 10 years. Finally, there was considerable variability in outcome reporting between studies. For instance, many studies did not differentiate between primary and secondary osteoarthritis. Moreover, 6 different clinical outcome scores were used among the included studies, with 11 studies reporting only postoperative scores. These inconsistencies not only limited statistical analysis but may also have led to misclassification bias.
CONCLUSION

Our study provides important trends and data that should help surgeons counsel younger patients undergoing THA. The most common preoperative diagnoses appear to be avascular necrosis, osteoarthritis and developmental dysplasia of the hip. Modular, cementless implants with metal-on-conventional-polyethylene bearings were used in most cases, with high survivorship seen at up to 10 years. Rates of dislocation and infection were comparable to those with THA in older patients, and good functional outcomes were routinely achieved. Future studies should aim to evaluate the outcome of ‘THA in this population at 15−20 years’ follow-up.

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Contributors: X.Y. Mei, O. Safr, A. Gross and P. Kuzyk designed the study. X.Y. Mei acquired and analyzed the data, which Y.J. Gong also analyzed. X.Y. Mei wrote the article, which all authors reviewed and approved for publication.

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Effect of Roux-en-Y gastric bypass on pharmacologic dependence in obese patients with type 2 diabetes

Background: More than half the diabetes-related health care costs in Canada relate to drug costs. We aimed to determine the effect of Roux-en-Y gastric bypass (RYGB) on the use of insulin and orally administered hypoglycemic medications in patients with diabetes. We also looked to determine overall cost savings with the procedure.

Methods: We reviewed the bariatric clinic records of all patients with a confirmed diagnosis of type 2 diabetes mellitus who underwent RYGB between 2010/11 and 2014/15. Percentage estimated weight loss was recorded at 1 year, along with reductions in glycated hemoglobin (HbA1c) level and use of oral hypoglycemic therapy and insulin. We estimated medication costs using Manitoba-specific pricing data.

Results: Fifty-two patients with at least 12 months of complete follow-up data were identified. The mean percentage estimated weight loss was 50.2%. The mean HbA1c level decreased from 7.6% to 6.0%, the mean number of orally administered hypoglycemics declined from 1.6 to 0.2, and the number of patients receiving insulin decreased from 18 (35%) to 3 (6%) (all \( p < 0.001 \)). The rate of resolution of type 2 diabetes was 71%. Estimated mean annual per-patient medication costs decreased from \$508.56 to \$79.17 (\( p < 0.001 \)). Potential overall health care savings could total \$3769 per patient in the first year, decreasing to \$1734 at 10 years.

Conclusion: Roux-en-Y gastric bypass resulted in significant improvement in diabetic control, with a reduction in hypoglycemic medication use and associated costs in the early postoperative period. Potentially, large indirect and direct cost savings can be realized in the longer term.
Obesity-related type 2 diabetes mellitus is a growing pandemic. In 2015, just over 3 million Canadians had a diagnosis of type 2 diabetes.1 The majority of these patients are overweight or obese.2 Patients with diabetes are much more likely than those without the disease to be admitted to hospital, to require renal replacement therapy and to undergo major amputation.2 Optimal long-term glycemic control can minimize the incidence of these complications but is difficult to achieve with medical management alone.3,4 Bariatric surgery is increasingly indicated in patients with type 2 diabetes and a body mass index (BMI) greater than 35. Several studies have shown that bariatric surgery can achieve dramatic early improvements in glycemic control.5–9 Although patients may relapse, long-term studies have shown acceptable remission rates.10–12 In 2 recent long-term randomized trials, a substantial proportion (29%–37%) of patients maintained diabetes remission at 5 years.13,14 Among patients who did not achieve full remission or who relapsed, diabetic control was better maintained and medication use was lower than in patients who did not have bariatric surgery. In addition, bariatric surgery has been shown to decrease both micro- and macrovascular complications of diabetes in long-term follow-up studies.8,12,13

Direct and indirect diabetes-related health care costs in Canada are estimated at $10.1 billion and are predicted to rise to $13.8 billion by 2020.15 Bariatric surgery is expensive, and patients require multidisciplinary evaluation preoperatively and long-term follow-up after surgery. Studies are divided as to whether bariatric surgery can provide cost savings, although most authors agree that surgery is cost-effective in terms of quality-adjusted life-years.16–24 Among studies looking specifically at patients with type 2 diabetes, findings are equally mixed.17,18,20,24,25

More than half of the estimated direct health costs of type 2 diabetes relate to drug costs.1 Several studies have shown a reduction in hypoglycemic medication use following bariatric surgery.26–29 Such a reduction in the requirement for medication can result in significant cost savings for patients and health care systems. It is estimated that the economic burden of diabetes in Manitoba will reach $639 million by 2020.30 The Winnipeg Regional Health Authority established a multidisciplinary bariatric surgery program in 2010, and more than 1000 bariatric procedures have been completed to date. The primary aim of this project was to determine the effect of Roux-en-Y gastric bypass (RYGB) on the use of insulin and oral hypoglycemic therapy in a population of obese patients with type 2 diabetes. The secondary objective was to estimate cost savings per patient related to diabetes management using local cost estimates.

METHODS

After ethics board review and approval, we reviewed the bariatric clinic records of all patients with a confirmed diagnosis of type 2 diabetes who underwent RYGB at Victoria General Hospital, a 230-bed hospital in Winnipeg, over a 5-year period (2010/11–2014/15). Patients were identified from a prospectively maintained bariatric database. Patients with type 1 diabetes were excluded from the study. All patients undergoing bariatric surgery are enrolled in a behavioural modification program before surgery that includes nutrition, activity and psychosocial counselling. All the procedures over the study period were performed by a team of 3 bariatric surgeons.

Inclusion criteria included a preoperative diagnosis of type 2 diabetes and having undergone RYGB with a minimum of 12 months of complete follow-up data. A diagnosis of type 2 diabetes was defined as a documented pretreatment glycated hemoglobin (HbA1c) level greater than 6.5% or the use of hypoglycemic medication (orally administered or insulin). The following data were extracted: age, sex, length of time between diabetes diagnosis and surgery, BMI, HbA1c level, and number and type of hypoglycemic medications preoperatively and 12 months following surgery. We expressed postoperative weight loss using the postoperative BMI and the percentage estimated weight loss using a BMI of 25 as the ideal body weight. Body mass index was calculated as close to the time of surgery as possible and several months after the patients had started their preoperative interventions. Postoperative BMI was recorded at 12 months. Perioperative HbA1c was taken as close as possible to the time of surgery and then at the 12-month follow-up visit. Remission of diabetes was predefined as an HbA1c level of 6.5% or less and the patient’s having ceased all antidiabetic medications.

We estimated medication costs using Manitoba-specific pricing data,31 assuming a standard dosage of medication. Insulin dosage was not known for individual patients, and therefore we assumed a conservative starting dosage of 25 units/d based on Canadian guidelines.32 We performed an analysis of long-term cost savings using estimates of type 2 diabetes prevalence and estimated direct and indirect costs in Manitoba calculated by Diabetes Canada.30 Diabetes Canada estimates yearly costs of $5298 per patient with diabetes. For the purposes of the model, we assumed that any patient not achieving remission (i.e., still receiving at least 1 hypoglycemic medication or HbA1c level > 6.5% at 12 mo postoperatively) would continue to generate health care costs at that level. Similarly, patients who achieved remission but were predicted to subsequently relapse were assumed to generate yearly costs of $5298 from the time of relapse. Patients in remission were assumed to generate no diabetes-related costs. In extrapolating these cost savings forward, we estimated that the relapse rate would be 6% of patients per year.14,15

We used StatsDirect version 3.0.141 to analyze the data. We analyzed differences between pre- and postoperative variables using the paired t test (normal data) or the
Mann–Whitney test (nonnormal data) and compared categorical variables using the Fisher exact test. A \( p \) value < 0.05 was considered statistically significant.

**RESULTS**

Fifty-two patients who underwent RYGB and had at least 12 months of complete follow-up data were identified. Most of the patients (43 [83%]) were women. The mean BMI decreased from 44.8 (33.6–58.2) preoperatively to 33.5 (range 21.0–47.5) at 1 year. This represented a mean percentage estimated weight loss of 50.2%. The mean HbA1c level decreased from 7.6% (range 4.9%–12.1%) to percentage estimated weight loss of 50.2%. The mean number of orally administered hypoglycemics declined from 1.6 to 0.2 \( (p < 0.001) \), and the number of patients receiving insulin decreased from 18 (35%) to 3 (6%) \( (p < 0.001) \).

At 12 months, 37 patients (71%) had achieved resolution of type 2 diabetes. The remaining 15 patients (29%) all had improvements in HbA1c level compared to preoperative levels (mean 7.1% v. 8.7%). In addition, their mean number of orally administered hypoglycemic agents decreased from 2.6 to 1.1, and the number receiving insulin decreased from 11 (73%) to 3 (20%).

The patients who achieved remission and those who did not were similar in age, sex and preoperative BMI (Table 1). Compared to patients who did not achieve remission, those who achieved remission had lower preoperative HbA1c levels (mean 7.2% v. 8.7%, \( p = 0.01 \)), required fewer hypoglycemic agents preoperatively (mean 1.8 v. 2.5, \( p = 0.02 \)) and were less likely to be receiving insulin therapy preoperatively (7 [19%] v. 11 [73%], \( p < 0.001 \)). Patients whose diabetes resolved had a significantly shorter duration of diabetes preoperatively (4.0 yr v. 6.1 yr, \( p < 0.001 \)). The percentage estimated weight loss was not significantly different between the 2 groups (52.0% v. 45.6%, \( p = 0.3 \)).

The mean length of stay was 1.3 (standard deviation 0.6) days. Complications were identified in 4 patients (8%). In 1 patient, an ulcer developed at the gastrojejunostomy. This was seen on endoscopy, which was performed for patient symptoms. The patient was treated with omeprazole (20 mg twice daily) and sucralfate (1 g 4 times daily), with endoscopic resolution documented at 6 weeks. One patient required a transfusion of 1 unit of packed red blood cells owing to symptomatic anemia on postoperative day 1. Two patients required readmission for nausea, liquid intolerance and upper abdominal pain; both were managed conservatively with analgesia and supportive care and were discharged the day after presenting.

We estimated that mean annual hypoglycemic medication costs per patient decreased from $508.56 preoperatively to $79.17 at 12 months \( (p < 0.001) \). Even among the patients who remained diabetic, we estimated that mean annual medication costs decreased ($856.30 v. $274.46, \( p < 0.001 \)).

Based on our analysis of cost savings and on local estimates of the cost of diabetes,\(^{30}\) assuming a relapse rate of 6% per year, we estimated savings to the health care system of $3769 per patient in the first year, declining to $2865 and $1734 at 5 and 10 years, respectively. Lifetime savings per patient could total $33 324. Doubling the relapse rate to 12% would still result in a potential lifetime saving of $17 642 per patient. In comparison, the estimated per-patient cost of RYGB in our unit at the time of study was $5989 (includes the cost of the preoperative behavioural modification program, the operation and routine postoperative care).

**DISCUSSION**

Type 2 diabetes represents a large and ever-growing burden on health care systems around the world. There is currently little evidence available regarding the effect of laparoscopic RYGB on the use of diabetic medications in obese people with type 2 diabetes. This is despite the large increase in bariatric surgical procedures throughout the country over the last decade.\(^{13}\) The cost to the Canadian taxpayer of performing bariatric surgery in Canada was estimated at $48 million in 2012/13.\(^{33}\) It is important, therefore, that the cost-effectiveness of such an intervention be determined.

Our results in a cohort of patients who underwent laparoscopic RYGB support previous findings that bariatric surgery is highly effective at instigating both weight loss and diabetic remission. Seventy-one percent of patients were in remission at 1 year. Just as important, patients who did not achieve remission still experienced significant reductions in both HbA1c level and medication requirements. Our results support the findings of other authors who have noted that remission is more likely in patients with a

### Table 1. Preoperative characteristics of patients who achieved or did not achieve remission of type 2 diabetes mellitus at 12 months after Roux-en-Y gastric bypass

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Remission</th>
<th>Non remission</th>
<th>( p ) value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, yr, mean ( \pm SD )</td>
<td>48.5 ± 7.38</td>
<td>49.1 ± 5.99</td>
<td>0.81</td>
</tr>
<tr>
<td>Female sex</td>
<td>32 (86)</td>
<td>11 (73)</td>
<td>0.30</td>
</tr>
<tr>
<td>Preoperative body mass index, mean ( \pm SD )</td>
<td>44.6 ± 5.35</td>
<td>45.4 ± 6.48</td>
<td>0.71</td>
</tr>
<tr>
<td>Preoperative glycosylated hemoglobin level, %, mean ( \pm SD )</td>
<td>7.2 ± 1.48</td>
<td>8.7 ± 1.81</td>
<td>0.01†</td>
</tr>
<tr>
<td>No. of medications, mean ( \pm SD )</td>
<td>1.8 ± 0.83</td>
<td>2.5 ± 0.81</td>
<td>0.023†</td>
</tr>
<tr>
<td>Insulin use</td>
<td>7 (19)</td>
<td>11 (73)</td>
<td>&lt; 0.001†</td>
</tr>
</tbody>
</table>

\( SD = \) standard deviation.
*Except where noted otherwise.
†Unpaired \( t \) test.
‡Fisher exact test.
§Mann–Whitney test.
shorter preoperative duration of diabetes and lower preoperative HbA1c levels and in those not requiring insulin.14–16

Based on these results, we estimate that diabetes-related medication costs decrease significantly within the first year after surgery ($508.56 to $79.17 per patient). Extrapolating potential cost savings forward, we estimate potential lifetime savings of $33,324 per patient. In comparison, the cost per procedure in our unit is estimated at $5989.

These results are consistent with those of other studies that have shown similarly significant reductions in the requirement for diabetic medications and resultant cost savings.25,29,37,38 Similar reductions in medication use have been reported for other conditions such as hypertension and dyslipidemia.29,37,39,40

The evidence that bariatric surgery can provide long-term clinical benefits to patients with diabetes is well established.10–14 In addition, there is substantial evidence to support the overall cost-effectiveness of surgery in the bariatric population.17–19,23,41 However, it is important to recognize the difference between cost-effectiveness, usually assessed using evaluation of quality-adjusted life-years,42 and the ability of an intervention to realize cost savings for a health care system.

Long-term follow-up from the Swedish Obese Subjects study showed that drug costs were lower in patients with diabetes who underwent bariatric surgery than in those in a control group.43 However, the study did not show differences in overall health care costs. Similarly, in a large study based in the United States, Weiner and colleagues44 compared a surgical group with a matched nonsurgical group of obese patients and concluded after 6 years of follow-up that there was no overall reduction in health care costs. In contrast, Swedish and Spanish studies based on simulation models showed large long-term cost savings along with increased quality-adjusted life-years.44,45

It should be noted, however, that many of the studies with long-term follow-up provide data on historical procedures. For example, only a small proportion of patients in the Swedish Obese Subjects study23 underwent laparoscopic RYGB; the majority underwent a restrictive procedure (gastric band or vertical banded gastroplasty). Both of these procedures have been largely abandoned because of their reduced efficacy.46 Similarly, in the study by Weiner and colleagues,44 only 38.3% of patients underwent laparoscopic RYGB, with the remainder receiving open RYGB or a restrictive procedure. These procedures are not necessarily relevant to modern-day practice, where laparoscopic RYGB and laparoscopic sleeve gastrectomy are the most commonly performed procedures.46 Cremieux and colleagues39 compared costs between patients undergoing open and laparoscopic surgery and found that it took twice as long to recoup the costs of surgery in the open surgery group as in the laparoscopic group.

The variation in results between studies may be due to the fact that a variety of methodologies were used, and it is notable that studies based on prediction models tend to overestimate cost savings compared to studies looking at actual, recordable costs.21,23,43,44 In addition, studies performed in different countries are likely to result in different outcomes owing to differences in health care systems. Studies from the United Kingdom tend not to show absolute cost savings,18,19,41,43,47 whereas studies from elsewhere show mixed but generally more positive results.20,22,46,45,48

We used a predicted relapse rate of 6% in our model. This is consistent with that reported in the literature.7,8,14,49

The relapse rate among postsurgical patients with diabetes in Canada is not known, and, clearly, higher relapse rates would result in our model’s overestimating cost savings. We were not able to report our relapse rates for type 2 diabetes owing to local data set limitations. However, our results suggest that even a doubling of the relapse rate may still result in substantial cost savings. Longer-term data are required to establish these trends, but, as shown in our study and others, even patients not achieving remission experience significant improvements. Therefore, it is likely that, even without resolution of diabetes, improved control and therefore further delay of complications should be expected.8,14

Limitations

Some limitations to this study should be noted. Our analysis represents a small sample of patients and is limited to those with 1 year of follow-up data. It is possible that patients failing to attend follow-up visits experience poorer outcomes. The estimates for total health care savings presented in this study rely on predicted data extrapolated forward. This is a fairly rudimentary method for predicting costs and is clearly less reliable than direct, observable measurements of cost. In particular, there are a number of limitations to the cost-prediction model. Our analysis did not take into account other factors such as life expectancy or patient age. Overall mortality is low after bariatric surgery and is therefore unlikely to have a substantial effect on costs.

Furthermore, unlike in studies from larger centres,21,43–45 the model did not factor in the health-related costs of complications. Additional health costs should not substantially affect the findings for our cohort as the complication rate happened to be low in this patient sample. It is assumed that a larger data set would yield complication rates similar to those of the general bariatric surgical population. Thus, costs should be similar to those in the literature, as the study centre’s overall complication rate is in line with international trends. We hope to be able to further evaluate this in our own database when resources permit.

The model used in this investigation was intentionally conservative and likely underestimated cost savings. It assumed that patients not achieving remission and those
who relapse will generate the same mean health care costs as nonsurgical patients with diabetes. Given the observed improvements in metabolic markers, this is unlikely to be the case. We do make the assumption that patients in remission generate no ongoing diabetes-related health care costs. We accept that this is a potential underestimate, but the same assumption is made in other bariatric surgery cost-analysis models, and in the absence of long-term data on the cost-related impact of bariatric surgery on micro- and macrovascular complications, we believe this is reasonable. In addition, we do not consider other, potential cost savings not related to health care. Studies have shown that patients have better employment prospects and claimed significantly fewer benefits following surgery.

Finally, the Diabetes Canada analysis used for the costs analysis includes patients with type 1 diabetes as well as those with type 2 diabetes. This has the potential to influence our results, as the former are usually receiving costlier, insulin-based therapies. However, the proportion of patients with type 1 diabetes is likely to be small and therefore should not unduly influence the overall cost estimate.

**CONCLUSION**

Roux-en-Y gastric bypass results in significant glycemic improvement in obese patients with type 2 diabetes. This improvement results in a measurable reduction in hypoglycemic medication use and associated costs in the early postoperative period. Potentially, large indirect and direct cost savings can be realized in the longer term. Larger, long-term studies using robust costing methods are required to further refine these results.

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**Competing interests:** None declared.

**Contributors:** All authors designed the study. M. Mullan and A. Vergis acquired the data, which A. Sharples, K. Hardy and A. Vergis analyzed. A. Sharples, M. Mullan and A. Vergis wrote the article, which all authors reviewed and approved for publication.

**References**

Surgeon identification of pain catastrophizing versus the Pain Catastrophizing Scale in orthopedic patients after routine surgical consultation

Background: A high level of pain catastrophizing has negative influences on outcomes in many surgical disciplines. Our purpose was to determine whether surgeons are able to accurately identify high catastrophizing in orthopedic patients after routine clinical consultation.

Methods: In this prospective study, English-literate patients aged 18 years or older were assessed by 1 of 11 orthopedic surgeons. Patients completed the Pain Catastrophizing Scale (PCS), and the surgeon rated each patient as having a high or low level of catastrophizing after the clinical encounter. We calculated accuracy and agreement of surgeon assessment with the PCS at a cut-off score of 30 (score ≥ 30 = high level of catastrophizing) and used multivariate testing to determine whether patient age or sex, surgeon experience or subscores of the PCS (rumination, magnification and helplessness) influenced surgeon accuracy.

Results: Among 203 patients (109 women and 94 men), the mean PCS score was 18.4 (standard deviation 12.9), with no sex difference and no significant correlation to patient age. Of the 40 patients who scored 30 or more on the PCS, 22 (55%) were not identified as having high levels of catastrophizing by their surgeon. Accuracy was 0.72, and agreement was 0.2. Female patients were more likely than male patients to be identified as high catastrophizing regardless of PCS score (odds ratio 2.0, 95% confidence interval 1.04–4.0).

Conclusion: Surgeons were not able to accurately identify patients with high levels of pain catastrophizing during routine initial consultation. In considering which patients may most benefit from interventions to improve coping and reduce catastrophizing, explicitly measuring pain catastrophizing will be required.

Contexte : Un niveau élevé de dramatisation face à la douleur a une influence négative sur les résultats dans plusieurs disciplines chirurgicales. Notre objectif était de déterminer si les chirurgiens orthopédistes sont capables d’identifier avec précision un niveau élevé de dramatisation de la douleur chez les patients après une consultation clinique de routine.

Méthodes : Au cours de cette étude prospective, des patients capables de communiquer en anglais âgés de 18 ans ou plus ont été évalués par un de 11 chirurgiens orthopédistes. Les patients ont répondu au questionnaire PCS (Pain Catastrophizing Scale), une échelle de mesure de la dramatisation face à la douleur, et après la consultation clinique, le chirurgien assignait à chaque patient un niveau faible ou élevé de dramatisation. Nous avons calculé la justesse et la concordance de l’évaluation du chirurgien avec le score PCS, avec un score seuil de 30 (score ≥ 30 = niveau élevé de dramatisation) et utilisé un test multivarié pour déterminer si l’âge ou le sexe, l’expérience du chirurgien ou certaines sous-échelles de la PCS (rumination, amplification et sentiment d’impuissance) influençaient sur le jugement du chirurgien.

Résultats : Sur 203 patients (109 femmes et 94 hommes), le score PCS moyen a été de 18,4 (écart-type 12,9), sans différence liée au sexe ni corrélation significative avec l’âge des patients. Sur les 40 patients ayant obtenu un score de 30 ou plus à l’échelle PCS, 22 (55 %) n’ont pas été identifiés comme présentant des niveaux élevés de dramatisation par les chirurgiens. La précision a été de 0,72, et la concordance de 0,2. Les patientes étaient plus susceptibles que les patients d’être...
Mounting evidence suggests that factors other than objective disease severity or technical success of a surgical intervention can influence surgical outcomes. Among these factors is a catastrophizing coping style. High levels of pain catastrophizing leading to an exaggerated negative mental set when pain is experienced or expected is independently associated with higher probability of chronic postoperative pain, lower patient satisfaction following surgery and poorer patient-reported surgical outcomes in various patient populations.\(^1\)\(^-\)\(^7\) Components of catastrophizing are rumination (continued focus on pain), magnification (reported severity of pain is higher than expected) and helplessness (perceived inability to positively affect one’s situation). Catastrophizing is regarded as a maladaptive coping strategy.\(^6\) Although surgeons may intuitively identify some patients as likely to struggle with their postoperative course owing to factors such as catastrophizing, this factor is not routinely quantified in orthopedic patients.

There are several instruments validated to assess catastrophizing, with the Pain Catastrophizing Scale (PCS) having been validated for multiple musculoskeletal conditions.\(^5\) The PCS measures total catastrophizing and also the components of rumination, magnification and helplessness. Given that researchers have identified pervasive and substantial effects of a catastrophizing coping style on treatment outcome,\(^7\) it is important to determine whether surgeons can identify at-risk patients during their routine consultation practice or whether a catastrophizing coping style needs to be formally quantified during clinical assessment. The purpose of this study was to determine whether surgeons can accurately identify patients as having low or high levels of pain catastrophizing after a routine initial consultation. We hypothesized that surgeons have greater accuracy at the extremes of the measurement scale but have poor diagnostic discrimination for most patients with respect to levels of pain catastrophizing.

**METHODS**

This prospective study was conducted at a single academic hospital site from February to March 2017. All English-literate patients over 18 years of age presenting for an initial consultation with a participating surgeon were eligible. A consecutive sample of at least 200 patients was sought. We selected this number owing to the absence of relevant pilot data and to ensure adequate sample size for the multivariate analysis. Potentially eligible patients were prescreened by M.T.S. to ensure that their surgeon had never met them. Identified patients received a letter of information after registration in the clinic. Implied consent was given if the patient continued to complete the PCS. After completing the PCS, the patient placed the form in a closed box.

Following the consultation, the assessing surgeon (who was blinded to the patient’s PCS answers) recorded the patient’s sex and age and indicated whether he or she felt that the patient had high or low levels of pain catastrophizing. The surgeon form was also placed in a closed box. Forms were collected and linked by deidentified identification numbers.

Eleven fellowship-trained orthopedic surgeon volunteers (8 men and 3 women) from the site practice group in subspecialty practices including hip and knee reconstruction, adult trauma, shoulder reconstruction, foot and ankle reconstruction, and hand surgery participated. The surgeons had 8–41 years’ experience (mean 18.4 [standard deviation (SD) 11.6] yr, median 12 yr). Educational rounds were held before the start of the study, and each surgeon viewed the same educational review module about catastrophizing coping styles and study protocol before the start of recruitment. The rounds highlighted different coping styles and the impact of high levels of pain catastrophizing on surgical outcome, and the review module provided basic information about the definition of catastrophizing and description of the components of rumination, magnification and helplessness, as well as review of the potential clinical consequences of a catastrophizing coping style on surgical outcomes. This also provided a review of key material that had been presented in an education rounds 6 months earlier. Learning from the module was not formally assessed. Clinic staff completed an educational module about correct implementation of the study to minimize problems related to blinding of the surgeons to patient responses.

**Statistical analysis**

We performed descriptive statistics regarding demographic characteristics and distribution of catastrophizing scores in the patient population. We assessed the influence of age and sex on levels of catastrophizing using Pearson product correlation (age) and Wilcoxon signed rank (sex) analyses, as the PCS scores did not follow a normal distribution. We analyzed categorical data using \(\chi^2\) tests. Alpha was set at 0.05 for all comparison testing. We calculated
sensitivity, specificity, positive predictive ability and negative predictive ability of surgeons to correctly identify levels of catastrophizing for a cut-off point of 30, with a score of 30 or more indicating a high level of catastrophizing (as per the PCS handbook). We assessed agreement between the surgeon’s assessment and the PCS score by calculating a κ statistic. We used multivariate logistic regression analysis to assess associations between patient age and sex and accuracy of the surgeon’s assessment, the effect of surgeon experience on accuracy and potential influences of PCS subscores (rumination, magnification, helplessness) on accuracy and true-positive rates. Analyses were performed with Microsoft Excel for Mac (version 14.7.3) and GraphPad for descriptive statistics, and SAS 9.4 (SAS Institute) for the multivariate analyses. The study methodology was reviewed and approved by the local research ethics board, and patient consent was implied by completion of the PCS.

RESULTS

A total of 203 eligible patients (109 women and 94 men) with a mean age of 52.9 [SD 14.9] yr [range 19–80 yr] presenting over a 5-week period agreed to participate. The number of patients rated by each surgeon ranged from 5 to 43 (mean 18.3 [SD 11.2], median 17), with the 3 most senior surgeons rating 17 of the 203 patients. Patient characteristics by surgeon are shown in Table 1.

The mean PCS score was 18.4 (SD 12.9) (median 16, range 0–52). There was no difference in mean score between men (17.6 [SD 12.6]) and women (19.1 [SD 13.1]) (p = 0.4) and no clinically significant correlation between patient age and PCS score (r = –0.072, p = 0.3). Forty patients (19.7%) (24 women and 16 men) scored 30 or more on the PCS. There was no sex difference in the number who scored 30 or more (p = 0.4).

The specificity of surgeon accuracy in identifying high- and low-catastrophizing patients was 0.43, sensitivity was 0.79, positive predictive value was 0.33, negative predictive value was 0.85, and accuracy was 0.72 (Table 1). The false-negative rate was 12% for the overall cohort of patients. Agreement between surgeons’ assessment and the PCS score was slight (κ = 0.2). Of the 40 patients with a PCS score of 30 or more, 22 (55%) were not identified as high catastrophizing by their surgeons. There was no effect of patient sex on accuracy (p = 0.7). Female patients were more likely than male patients to be assessed as high catastrophizing (34 [31.2%] v. 18 [19.1%]) (odds ratio 2.0, 95% CI 1.04–4.0).

Multivariate analysis did not show a significant combined effect of patient age and sex on accuracy, false-positive rates or false-negative rates (p > 0.05). Surgeon experience was also not associated with improved accuracy (p > 0.05). Surgeon sex was not a significant influence on

<table>
<thead>
<tr>
<th>Surgeon no.</th>
<th>Patient age, yr, mean ± SD (range)</th>
<th>Patient sex, male:female</th>
<th>Pain Catastrophizing Scale score, mean ± SD (range)</th>
<th>No. with Pain Catastrophizing Scale score ≥ 30*</th>
<th>PPV</th>
<th>NPV</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>61.7 ± 13.3 (27–80)</td>
<td>23:20</td>
<td>21.9 ± 14.8 (0–52)</td>
<td>12/31</td>
<td>0.27</td>
<td>0.71</td>
<td>0.56</td>
</tr>
<tr>
<td>2</td>
<td>54 ± 19 (23–80)</td>
<td>1:4</td>
<td>12.6 ± 10.3 (4–30)</td>
<td>1/4</td>
<td>0.50</td>
<td>1.00</td>
<td>0.80</td>
</tr>
<tr>
<td>3</td>
<td>53.9 ± 11.5 (26–80)</td>
<td>11:10</td>
<td>16.0 ± 12.5 (1–49)</td>
<td>3/18</td>
<td>0.00</td>
<td>0.85</td>
<td>0.81</td>
</tr>
<tr>
<td>4</td>
<td>42.7 ± 14.9 (20–61)</td>
<td>9:8</td>
<td>15.5 ± 13.0 (1–46)</td>
<td>2/15</td>
<td>0.50</td>
<td>1.00</td>
<td>0.88</td>
</tr>
<tr>
<td>5</td>
<td>46.2 ± 13.9 (21–65)</td>
<td>5:22</td>
<td>20.9 ± 12.7 (0–49)</td>
<td>8/19</td>
<td>0.60</td>
<td>0.77</td>
<td>0.74</td>
</tr>
<tr>
<td>6</td>
<td>49.7 ± 13 (30–67)</td>
<td>5:8</td>
<td>17.4 ± 14.9 (0–43)</td>
<td>3/10</td>
<td>1.00</td>
<td>0.83</td>
<td>0.85</td>
</tr>
<tr>
<td>7</td>
<td>48.6 ± 11.7 (27–67)</td>
<td>13:9</td>
<td>15.4 ± 12.5 (1–47)</td>
<td>3/19</td>
<td>0.13</td>
<td>0.86</td>
<td>0.59</td>
</tr>
<tr>
<td>8</td>
<td>50.4 ± 16.1 (19–69)</td>
<td>10:7</td>
<td>19.2 ± 12.3 (0–45)</td>
<td>3/14</td>
<td>0.40</td>
<td>0.92</td>
<td>0.76</td>
</tr>
<tr>
<td>9</td>
<td>66.7 ± 8.2 (53–80)</td>
<td>4:3</td>
<td>19 ± 10.5 (9–35)</td>
<td>2/5</td>
<td>NA</td>
<td>0.71</td>
<td>0.71</td>
</tr>
<tr>
<td>10</td>
<td>61.1 ± 13.6 (33–73)</td>
<td>3:4</td>
<td>13 ± 7.2 (1–20)</td>
<td>0/7</td>
<td>NA</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>11</td>
<td>51.8 ± 16.2 (21–80)</td>
<td>10:14</td>
<td>18.7 ± 11.4 (0–42)</td>
<td>3/21</td>
<td>0.33</td>
<td>1.00</td>
<td>0.75</td>
</tr>
<tr>
<td>Overall</td>
<td>52.9 ± 14.9 (19–80)</td>
<td>94:109</td>
<td>18.4 ± 12.9 (0–52)</td>
<td>40/163</td>
<td>0.33</td>
<td>0.85</td>
<td>0.72</td>
</tr>
</tbody>
</table>

NA = not applicable; NPV = negative predictive value; PPV = positive predictive value; SD = standard deviation.
* A score ≥ 30 denotes a high level of catastrophizing.
accuracy ($p = 0.2$). Surgeon accuracy and patient characteristics varied across surgeon practices.

We examined the potential association between the PCS subdomains (rumination, magnification and helplessness) and surgeon accuracy to determine whether surgeons were better at detecting a specific element of catastrophizing. The rumination score was associated with a lower degree of accuracy than the overall PCS score (odds ratio 0.87, 95% confidence interval 0.75–0.10). The other subscores had no influence on accuracy ($p > 0.05$).

**DISCUSSION**

Surgeons were not good at recognizing patients with high levels of pain catastrophizing during routine clinical assessment. Accuracy was moderate, but agreement between surgeons' assessments and the PCS score was poor. More than half (56%) of the patients with a PCS score of 30 or more were misidentified by their surgeon as having low levels of catastrophizing. This represents an undesirable situation: the patients with the highest self-reported levels of pain catastrophizing are being missed and are the most at risk for the adverse effects of catastrophizing on treatment outcome. A better approach is needed.

Explaining the difficulties that surgeons have in identifying which patients have a catastrophizing coping style is challenging. Patient affect and presentation in clinic is often dependent on many factors consciously or unconsciously registered by the assessing surgeon. This study was designed to look specifically and only at catastrophizing. However, given the poor accuracy and agreement of the surgeons' assessments compared to the PCS score, there are clearly other factors that influence the overall clinical impression. For example, in this study, although patient sex did not influence accuracy, female patients were more likely than male patients to be rated as having high levels of catastrophizing. This may be the result of differing verbal and nonverbal communications about pain between the sexes. There may also be factors such as personality (introversion or extroversion) or anxiety levels that contribute to the assessment along with an impression of catastrophizing. There is the potential for surgeon bias based on how well patient-reported symptom severity and observed structural disease align. Being incorrectly identified as having high levels of catastrophizing could adversely affect a patient’s care if the patient is perceived to benefit less from a given surgical treatment, another undesirable situation. It is important to remember that the presence of higher levels of catastrophizing should not stigmatize a patient. There are interventions that have shown the ability to reduce pain catastrophizing in multiple surgical populations, and making the tools and resources available to such patients offers a potential road to success after surgery.

There are 2 potential approaches to improving the ability to correctly identify patients with high levels of catastrophizing. The first would be to explicitly measure the levels with an instrument. This has the advantages of removing the subjectivity of the surgeon’s assessment, accurate longitudinal assessment during and after treatment, and the ability to compare effects between studies. The second would be to define what catastrophizing looks like in patients and educate surgeons to better identify the features clinically. To an extent, the ability to code pain behaviours associated with high levels of catastrophizing can be made reliable in a research setting with trained personnel. In principle, this would be superior to asking the surgeon to identify catastrophizing by patient affect and presentation. Ensuring that clinicians are sufficiently educated about physical manifestations of catastrophizing and pain behaviours to match the accuracy of a research environment would be challenging.

The education provided to the surgeons in this study was not in any way intended to create “expert” catastrophizing detectors but, rather, to mimic the “real-world” scenario of a clinician who is aware that catastrophizing is a potential negative prognostic factor and has a basic understanding of what catastrophizing is, similar to what one might take away from a rounds presentation (the most likely scenario for surgeons). Surgeons with only a passing familiarity with the concepts of catastrophizing represent the current standard of care, whereas use of a validated tool represents the gold standard. The fact that the surgeons in our study were aware that their abilities were being assessed may have led to the Hawthorne effect in some cases. If our findings reflect the situation that the surgeons were focused on assessing for catastrophizing (rumination, magnification and helplessness) more than usual, our mediocre results represent the best-case scenario.

Difficulty identifying features of patient distress in the clinical setting has also been shown by Kwon and colleagues, who found that surgeon ratings had poor concordance with patient-reported scores on the Distress Risk Assessment Method but that surgeon impressions of distress influenced the likelihood of the patient’s being offered surgical intervention. In that study, surgeons classified the patients into 3 categories: normal, at risk and distressed. The $\kappa$ coefficient was 0.2, and the authors noted that surgeons tended to underestimate patient distress, as surgeons underestimate catastrophizing in the current study. Further investigation may shed light on how surgeons perceive their patients and how this may influence decision-making in unexpected ways.

Other important findings included no difference in catastrophizing scores between male and female patients, and no significant relation to patient age. Some studies have suggested that female patients have higher levels of catastrophizing than male patients, but others have not corroborated this. This may be a function of variation in sample composition. Jacobsen and colleagues proposed that younger patients manifest higher levels of pain catastrophizing than older patients and suggested that this may be due
to less experience coping with painful events. We did not find a significant age relation in our cohort, nor did patient age influence the accuracy of surgeons’ assessments. Further work may clarify whether a relation actually exists.

**Strengths and limitations**

This study has several strengths. First, it took a broad cross-section of surgeons and patients and measured the ability to recognize patients with high levels of catastrophizing in a real-world situation. Second, it did not differentiate between patients selected or opting for surgical management from those who were not offered surgical treatment or who opted against it, which resulted in a wider range of patient than those usually included in surgical studies of catastrophizing (usually only patients undergoing surgery). This provides a new insight into patients seeking orthopedic care as opposed to orthopedic surgery.

Limitations include the potential for accidental loss of data, exclusion of patients who were not literate in English and inability to capture information concerning patients who chose not to participate in the study. The second and third limitations may have introduced bias in terms of patient characteristics but should have had minimal effect on the accuracy of surgeon identification of catastrophizing traits. The number of surgeon raters was relatively small but included the majority of surgeons working in the study environment. Ensuring high levels of protocol adherence and blinding and minimizing logistical issues presented substantial feasibility issues for a multisite trial. Furthermore, the consistency of assessment between surgeons was not examined in this work. To achieve this, we would have had to remove surgeon–patient encounters from the usual clinical environment, which would have affected the applicability of the data. It is also expected that interrater agreement would be poor. This could be examined in further work. A deliberate limitation of this study is that patient diagnosis, disease severity and treatment choice were not recorded for the participating patients. Measuring disease-specific scores for all patients was well beyond the scope of this investigation. Future work will look at the relation between disease severity, treatment choices and catastrophizing levels. Finally, the potential influence of surgeon experience on the ability to correctly identify patients with high levels of catastrophizing must be interpreted with caution. This study revealed a difference in practice pattern between the senior and junior surgeons in that the senior surgeons had a much smaller proportion of new patients versus reassessment consultations. Given that the most senior surgeons rated a small portion of the sample, the strength of inference that may be drawn regarding experience and accuracy is limited. Future work with more evenly matched sample sizes may more conclusively speak to the effect of experience on accuracy.

**CONCLUSION**

Although catastrophizing is an important patient-specific factor affecting outcomes of management of orthopedic disease, surgeons have difficulty correctly identifying patients with high levels of catastrophizing. Catastrophizing may require deliberate measurement to avoid missing patients who could benefit from individualized care to optimize their treatment outcomes.

**Contributors:** M. Sabo designed the study and acquired and analyzed the data, which M. Roy also analyzed. Both authors wrote and reviewed the article and approved the final version for publication.

**References**

Morbidity and mortality following pelvic ramus fractures in an older Atlantic Canadian cohort

Background: Pelvic ramus fractures in older patients are associated with substantial morbidity and mortality. There is a paucity of literature on fractures of the pelvis in this age group. The purpose of this study was to report mortality rates following such injuries. In addition, we aimed to describe and quantify the important resultant morbidity in this vulnerable population.

Methods: We performed a retrospective chart review of all low-energy pelvic ramus fractures in patients more than age 60 years that occurred between January 2000 and December 2005. Data on survival, hospital length of stay, ambulatory status and place of residence were recorded. For comparison, we calculated the mortality rate for a surrogate age- and sex-matched group using Statistics Canada survival data for use as an uninjured control group.

Results: We identified 43 patients (32 women [74%]; mean age 79.4 yr) with isolated low-energy pelvic ramus fractures over the study period. The 1- and 5-year mortality rates were 16.3% (95% confidence interval [CI] 7.8%–30.3%) and 58.1% (95% CI 43.3%–71.6%), respectively, both significantly higher than the point estimates for the control group (6.6% and 31.3%, respectively). Following injury, 14/39 patients (36%) permanently required increased ambulatory aids, and 8 (20%) required a permanent increase in everyday level of care.

Conclusion: The results suggest that there may be increased mortality and morbidity following low-energy pattern pelvic ramus fractures in an older population compared to age- and sex-matched uninjured control subjects.

Contexte: Les fractures du bassin chez les personnes âgées sont associées à une morbidité et une mortalité substantielles. La littérature sur les fractures du bassin dans ce groupe d’âge est peu abondante. Le but de cette étude était donc de faire état des taux de mortalité suite à de telles blessures. Nous avons aussi voulu décrire et quantifier l’importante morbidité qui en résulte chez cette population vulnérable.

Méthodes : Nous avons effectué une revue rétrospective de tous les cas de fractures du bassin consécutives à un traumatisme de faible énergie chez des patients de plus de 60 ans survenues entre janvier 2000 et décembre 2005. Les données de survie, la durée de l’hospitalisation, le statut ambulatoire et le lieu de résidence ont été notées. À des fins de comparaison, nous avons calculé le taux de mortalité pour un groupe témoin indemne assorti selon l’âge et le sexe en nous servant des données de survie de Statistique Canada.

Résultats : Nous avons recensé 43 patients (32 femmes [74%]; âge moyen 79.4 ans) porteurs de fractures du bassin isolées consécutives à un traumatisme de faible énergie pour la période de l’étude. Les taux de mortalité à 1 an et à 5 ans ont été de 16,3% (intervalle confiance [IC] de 95 % 7,8%–30,3 %) et 58,1 % (IC de 95 % 43,3 %–71,6 %), respectivement, tous deux significativement plus élevés que les estimations ponctuelles pour le groupe témoin (6,6 % et 31,3 %, respectivement). Après le traumatisme, 14 patients sur 39 (36%) ont eu besoin de façon permanente et croissante de dispositifs d’aide à la marche et 8 (20%) ont eu besoin de façon permanente d’un niveau de soins quotidiens accru.

Conclusion : Les résultats donnent à penser que la mortalité et la morbidité pourraient être plus marquées après une fracture de la hanche consécutive à un traumatisme de faible énergie chez la population âgée, comparativement à des témoins assortis selon l’âge et le sexe.
Low-energy osteoporotic fractures about the pelvic ring are greatly underrepresented in the current literature despite occurring with much greater frequency than high-energy pelvic injuries. The overall incidence of pelvic fractures is estimated to be 20–37/100 000 person-years; this number drastically increases among patients older than 60 years old, to 92/100 000 person-years, with another very large increase among those aged older than 85, to 446/100 000 person-years.1–3

Krappinger and colleagues’ pooled data from 6 retrospective studies of pelvic ramus fractures (n = 557) to yield a 1-year mortality rate of 16.3%.4–11 The 6 studies, however, formed a very heterogeneous group. Two of the studies were from level 1 trauma centres involving patients who had a trauma team activation and/or had been involved in a motor vehicle accident,11 as opposed to the typical ground-level fall of most osteoporotic injuries. Other studies involved cohorts of varying ages (≥55 yr, >60 yr,12 and 17–97 yr).7

In addition to the mortality associated with a pelvic fracture, there is substantial morbidity following this injury. The general heterogeneity of pelvic fractures combined with the gross underrepresentation of low-energy injuries in the literature has yielded few studies examining morbidity outcomes. The number of patients requiring ambulatory aids is a useful objective measure to assess postinjury mobility that is quite variably reported in the current literature. The available studies suggest that 39%–92% of patients maintain their prefracture level of mobility at 1 year.7,8,12,13 Another important metric in evaluating the impact of these injuries is hospital length of stay and discharge disposition. The mean length of hospital stay following an osteoporotic pelvic ring injury is reported from 0 to 45 days.2,6–8,14–17 There is similar variabilty in discharge disposition, with 37%–95% of patients returning home.2,7,8,14–17 The purpose of this study was to examine mortality following low-energy osteoporotic fractures of the pelvic ring and to determine their effect on ambulation and discharge disposition.

Methods

Study design

We studied a retrospective cohort of all patients with pelvic ring injuries who presented in a health board region in eastern Newfoundland between January 2000 and December 2005. Following approval from the provincial research ethics authority, we used a health information coding database to identify all patients more than 60 years old with fractures about the pelvis. All injuries occurred during the 5-year period and were followed for 5 years.

Participants

We identified all patients older than 60 years of age with any type of fracture about the pelvis using a regional database in our health board region. The imaging, primarily plain film radiographs, was examined for each patient by an orthopedic surgery resident (C.B.H.) to delineate fracture pattern. The inclusion criterion was isolated pelvic ramus fracture with or without anterior compression fracture of the sacrum. Patients were excluded if they had concomitant fractures of the lower extremity, fracture involving the acetabulum or pelvic injury requiring surgical fixation.

All patients were treated nonoperatively with standard pain control and ambulation as tolerated with physiotherapy.

Variables

We collected all variables and outcome measures retrospectively from each patient’s electronic and paper health records. The date of death was available for all patients who had died during the study period in their electronic medical record or in some cases by contacting the office of the local medical examiner. Preinjury ambulatory and residency status were documented by social workers or physical or occupational therapists at the time of injury. We determined postinjury ambulatory and residency status by combining information on discharge with follow-up clinic visits with orthopedic and geriatric medicine consultants. We obtained the length of stay in hospital and mechanism of injury from the patient’s charts.

Using the date of injury and date of death, we calculated 1- and 5-year mortality rates. We then calculated 95% confidence intervals (CIs) using the adjusted Wald method and used them for comparison.

We calculated the mortality rate for a surrogate control group (age- and sex-matched uninjured cohort) using Statistics Canada census data. Using the methodology of Finkelstein and colleagues,18 we generated general population yearly survival rates to match the age and sex of those in our cohort from Statistics Canada life table data for Newfoundland and Labrador for 2009–201119 (see Appendix 1, available at canjsurg.ca/011518-a1, for details of calculations).

Results

We identified 80 fractures about the pelvis in patients older than 60 years of age over the study period, of whom 43 had isolated low-energy osteoporotic pelvic ring injuries. The remaining 37 patients were excluded for concomitant lower extremity fractures (17 patients), fractures involving the acetabulum (14) and concomitant hip fractures (6). Complete data for the study variables were available for all 43 included patients.
The mean patient age was 79.4 (standard deviation [SD] 9.2) years. The population was predominantly female (32 [74%]). All patients were admitted to hospital following their injury. The average length of stay in hospital or a rehabilitation facility was 38.1 (SD 38.0) days.

The 1- and 5-year mortality rates following injury in our population were 16.3% (95% CI 7.8%–30.3%) and 58.1% (95% CI 43.3%–71.6%), respectively. There were 4 in-hospital deaths (9%). Using census data from Statistics Canada for Newfoundland and Labrador, we estimated an age- and sex-matched uninjured population to have 1-, 2-, 3-, 4- and 5-year mortality rates of 6.6%, 12.9%, 19.1%, 25.3% and 31.3%, respectively. The improved survival of the general population relative to the study population is graphically illustrated in a survival curve (Fig. 1). Following their injury, just over one-third of patients (14/39 [36%]) (95% CI 22.7%–51.6%) permanently required increased ambulatory aids. They went from walking independently to using a cane/walker (12 [31%]) or from ambulatory with assistance to being primarily confined to a wheelchair (2 [5%]).

There was a permanent increase in the everyday level of care required following injury in 8 patients (20%) (95% CI 10.5%–35.8%). These patients were previously living independently and subsequently had to move into an assisted-living or nursing facility (4 [10%]), or previously were residents of a low-level assisted-living facility and were required to move to a higher-level nursing home (4 [10%]).

**DISCUSSION**

Low-energy fractures about the pelvic ring are a grossly underrepresented group of injuries in the literature. Adequately delineating the outcomes following these injuries will be an integral part of targeting and improving management options.

We found the 1- and 5-year mortality rates in our study population to be sizable, at 16.3% and 58.1%, respectively. These values, which are consistent with the current available literature, would certainly have us believe that this “stable” pelvic injury is not inconsequential. Bible and colleagues reported a 1-year mortality rate of 12.9% among patients more than 60 years old with pelvic ring injuries. Their population was slightly younger than ours (mean age 73.1 yr v. 79.4 yr), and only 23% of injuries were subsequent to a ground-level fall, with the remaining patients incurring higher-energy injuries. With only 53% of pelvic fractures classified as lateral compression type 1, the overall heterogeneity of the injury patterns in that study do not allow for effective comparison with the low-energy fractures in our study.

Studer and colleagues studied a more homogeneous population, comprising patients older than 65 years with low-energy pelvic ring injuries. With a slightly older population (mean age 83.5 yr), they documented a 1-year mortality rate of 18.5%, similar to that in our study.

In our study and others, the 1-year mortality rate was far greater than our age- and sex-matched estimate of 6.6% generated with Statistics Canada census data. The increased mortality rate surrounding these injuries can be grossly explained by 1 of 2 rationales or some combination thereof: the injury causes such a great physiologic insult that the patient is ultimately unable to recover, or the low-energy pelvic fracture is simply a surrogate marker of frailty in patients who would soon succumb to failure of other organ systems independent of their injury.

Comparison to the extensive literature on hip fracture mortality is relevant, as the patient population is similar. In hip fractures, most sources would cite a 1-year mortality rate of about 20%, with reported values ranging from 19% to 50%.

Our findings document substantial morbidity following pelvic ramus fractures as data were available for all patients except those who died in hospital. The proportion of patients requiring increased ambulatory aids was 36%. This value closely matches that for older patients in 3 similar studies showing that 36%–40% of patients had a deterioration in their ambulatory status 1 year following pelvic fracture. Koval and colleagues reported that 8% of patients had deterioration in ambulatory status 1 year after pubic ramus fracture; however, 1-year follow-up data were available for only 60% of patients initially enrolled.

Mobility following fractures of the proximal femur is an often used parameter to compare varying surgical options. In studies comparing arthroplasty versus internal fixation for femoral neck fractures, it was determined that...
there was no difference in the proportion of patients regaining previous levels of mobility, with an overall rate of 46%. This is substantially lower than the 64% of patients in our study who regained their previous level of mobility.

The similarity in mortality rate between pelvic ramus fractures and proximal femur fractures is likely largely related to the similarly frail populations that incur these 2 types of injury. The similarity ends, however, when the injuries themselves are taken into consideration. A patient with a proximal femur fracture is unlikely to ambulate again without surgical intervention owing to the gross mechanical instability of the lower limb following this injury. In contrast, the accepted treatment of pelvic ramus fractures involves mobilizing the patient as tolerated with pain control. The difference in mechanical stability immediately following injury between these fractures likely explains the improved rates of regained mobility in our pelvic fracture population.

The permanent level of care required following injury increased in 20% of our patients. Similar proportions of patients eventually returning to their original residences are reported in the literature (75%–95%). In the study by Studer and colleagues, the proportion of patients who returned home following injury was only 65%, compared to 88% in our study.

In determining targets for intervention to improve outcomes in patients with pelvic ramus fractures, we must organize our treatment based on what is driving these outcomes. In patients in whom the fracture is primarily a marker of frailty, providing access to improved multidisciplinary geriatric care may improve outcomes. Patients in whom the primary issue is the length of rehabilitation may benefit from interventions designed to shorten this process. There are several suggested surgical treatment options in studies that amount to little more than small case studies/series at present. These range from full open operative fixation interventions, to percutaneous hardware insertion, to percutaneous injection of polymethylmethacrylate. Walker and colleagues recently used percutaneous transiliac–transsacral screws in 8 patients with sacral fragility lateral compression type 1 pelvic injuries and reported statistically significant improvements in pain scores and the proportion discharged home compared to their nonstandardized control group.

Limitations

The limitations of our study include the inherent issues in a retrospective chart review study. This dictates that the data lack the known homogeneity and potential additional information of a data set collected prospectively. In addition, the small sample limits the power of the study, resulting in wide CIs and large SDs.

CONCLUSION

This study confirms the considerable mortality following low-energy injuries to the pelvic ring and is consistent with previously published literature. The mortality rate approaches that among patients with hip fractures, a group that is demographically similar but has been researched more extensively. Importantly, the substantial morbidity documented in the current study highlights the major impact of this group of fractures. This information can be useful in counselling patients and their families following these injuries and in directing future study. Further epidemiological research, ideally with prospective data, should further elucidate targets for intervention in addition to fully characterizing the resource and economic burden that these injuries have on health care systems.

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Competing interests: None declared.

Contributors: C. Hamilton and A. Furey designed the study. C. Hamilton acquired the data, which all authors analyzed. C. Hamilton wrote the article, which all authors reviewed and approved for publication.

References


The impact of a new hepatopancreatobiliary surgery program on the management of pancreatic cancer at Health Sciences North

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Background: Centralization of specialist services to urban centres presents a challenge to patients living in rural communities. The hepatopancreatobiliary surgery (HPB) program at Health Sciences North (HSN) is the tenth and newest HPB centre by Cancer Care Ontario and presents a unique opportunity to evaluate the barriers to delivering HPB cancer care to patients in northern Ontario.

Methods: We retrospectively reviewed the cases of patients referred to the Northeastern Ontario Cancer Centre and HSN with a pancreatic cancer diagnosis between 2009 and 2015. July 2013 marked the inception of the HPB surgical program. Our primary outcome was time to HPB surgical consultation. Secondary outcomes included distance of travel and time to curative intent operation.

Results: Our population consisted of 207 patients (98 pre-HPB v. 109 post-HPB). Median time to consultation with an HPB surgeon was decreased in the post-HPB group (43 v. 11 d, \( p < 0.001 \)). An increased proportion of patients with pancreatic malignancies in the post-HPB group received HPB surgical consultations (34% v. 74%, \( p < 0.001 \)), with decreased median distance travelled to surgical consultation (411 v. 79 km, \( p < 0.001 \)). Time to curative intent operation or medical oncology consultation did not significantly increase.

Conclusion: A new HPB program appears to have facilitated the proportion of patients with pancreatic malignancies at HSN receiving an HPB surgical consultation. Patients received complex surgeries, closer to their home regions. It is anticipated that these changes may affect overall outcomes and patient satisfaction and will be the focus of future investigations.

Contexte : La concentration des services spécialisés dans les centres urbains pose un défi pour les patients des communautés rurales. Le programme de chirurgie hépatopancreatobiliaire (HPB) d’Horizon Santé-Nord (HSN) est le 10e et plus récent centre HPB d’Action Cancer Ontario; il offre une occasion unique d’évaluer les obstacles à la prestation des soins oncologiques HPB aux patients du Nord de l’Ontario.


Résultats : Notre population comportait 207 patients (98 pré-HPB c. 109 post-HPB). Le délai médian d’obtention de la consultation en chirurgie HPB a diminué dans le groupe post-HPB (43 j c. 11 j, \( p < 0.001 \)). Une proportion plus grande de patients atteints de cancer du pancréas dans le groupe post-HPB a obtenu une consultation pour chirurgie HPB (34% c. 74 %, \( p < 0.001 \)), et une diminution de la distance médiane à parcourir pour se rendre à la consultation a été constatée (411 km c. 79 km, \( p < 0.001 \)). Le délai d’obtention de la chirurgie à visée curative ou de la consultation en oncologie médicale n’a pas augmenté significativement.

Conclusion : Le nouveau programme HPB semble avoir permis d’accroître la proportion de patients atteints de cancer du pancréas ayant pu bénéficier d’une consultation pour chirurgie HPB. Les patients ont pu subir des chirurgies complexes plus près de chez eux. On prévoit que ces modifications auront une incidence sur les paramètres globaux et la satisfaction des patients et qu’elles feront l’objet d’études.
Centralization of specialist services to regionalized centres presents a challenge to patients living in rural communities in Canada. Only 4% of specialists practise in rural Canada, where up to 20%–30% of Canadians live.\textsuperscript{1–3} Health outcomes in the rural population are generally worse than those in urban centres.\textsuperscript{1} While this is linked to many social determinants of health, access to health care remains an active issue.\textsuperscript{4} With an aging rural population requiring increased health care services, policy-makers have struggled to deliver equitable and accessible health care to all Canadians.\textsuperscript{5,6}

Surgical outcomes depend on many factors, including the individual surgeon as well as the systems in which they work. In general, a positive association is noted between higher surgeon and hospital case volumes and outcomes after surgery.\textsuperscript{7} The association between case volume and surgical outcomes is noted in multiple studies involving major cancer surgery, and in particular, pancreatic resection for neoplasms.\textsuperscript{8–11} Better outcomes may additionally be linked to the higher level of expertise and available resources in high-volume centres and the designation of regional centres for pancreatic resection is a logical solution, combining a positive volume–outcome relation with factors such as population, geography and academic capacity.\textsuperscript{11} As a result of these study findings, Cancer Care Ontario developed guidelines with measurements of performance and accountability encouraged through publicly reported quality indicators.\textsuperscript{12} In 2006, Cancer Care Ontario released Hepatic, Pancreatic and Biliary Tract (HPB) Surgical Oncology Standards, highlighting specific criteria pertaining to the surgeon, hospital and system requirements. Included within this guideline was an expected minimum number of HPB surgery cases performed per year.\textsuperscript{13}

These standards have led to the designation of regional HPB centres across Ontario. This trend has been documented throughout North America and has resulted in increased centralization of specialist surgical services.\textsuperscript{12,14} Although these HPB programs provide high-quality, complex surgical care, patients must often travel long distances to access these specialized services. Initially, there were 9 HPB programs in Ontario, located in regions of southern Ontario, and it was anticipated that patients from northern Ontario may have challenges in accessing specialist HPB surgery.

The HPB program at Health Sciences North (HSN), located in Sudbury, Ontario, was the tenth and newest HPB centre designated by Cancer Care Ontario. Health Sciences North serves as the location for the Northeast Cancer Centre, and provides intensive care unit services, 24-hour operating rooms, 24-hour diagnostics, therapeutic endoscopy and nutrition services. Sudbury is part of the North East Local Health Integration Network (LHIN), 1 of 14 LHINs in Ontario. The North East LHIN covers an estimated area of 400 000 km\textsuperscript{2} and serves 565 000 people.\textsuperscript{15}

In this retrospective study, we examined the impact of the development of the HPB surgery program at HSN on the management of pancreatic cancers before and after its inception in July 2013. Time from diagnosis to HPB surgical consultation was the primary study outcome considered. Secondary outcomes included distance travelled for surgical consultation, surgical intervention, time from surgical consultation to operation and time from diagnosis to medical oncology consultation.

\textbf{METHODS}

\textit{Data sources and inclusion criteria}

A discharge abstract follows every admission to hospital and day surgery intervention, including endoscopic retrograde cholangiopancreatography (ERCPs), and the information included is coded and collected by the Canadian Institute for Health Information (CIHI) in the Discharge Abstract Database (DAD).\textsuperscript{16} The DAD uses the \textit{International Statistical Classification of Disease and Related Problems, 10th revision (ICD-10-CA)}. Following research ethics board approval, data were retrieved from the Regional Northeastern Cancer Centre and the DAD using codes specific to pancreatic cancer, namely ICD-10-CA code of C25^A, to generate a list of cases to review of patients at HSN. All patients with pancreatic malignancies had their electronic medical records (EMR) and paper charts abstracted by 3 authors to create a retrospective database during the abstraction period of June 2016 to March 2017.

The study included patients who received a new diagnosis of pancreatic malignancy between January 2009 and December 2015. All pathologies and stages were included. Patients were excluded if the diagnosis was made before the study period, or outside of Ontario. Pancreatic adenocarcinomas were defined through confirming histology and were collected as a subgroup of this population. Atypical or indeterminate cells as well as intraductal papillary mucinous neoplasms (IPMNs), neuroendocrine tumours (NETs) and cystic neoplasms were recorded as a single separate category.

Data collected included consultations with HPB surgical specialists and medical oncologists, and operative management of patients with pancreatic malignancies. The primary outcome was time from diagnosis to any HPB surgical consultation in Ontario. Secondary outcomes included distance travelled for surgical consultation, surgical intervention, time from surgical consultation to operation and time from diagnosis to medical oncology consultation. Consultations included those that occurred in person or by telehealth. Diagnosis was defined as confirmation of a pancreatic mass through a diagnostic imaging technique.

With the HPB program commencing in July 2013, we compared the management of patients 54 months
pre-HPB program with 30 months post-HPB program. At HSN before July 2013, there were no surgeons with HPB fellowship training. Pancreatic surgery, such as a distal pancreatectomy, was provided with the exception of Whipple procedures. The standard referral process for a Whipple procedure was through an HPB fellowship–trained surgeon in southern Ontario. A single HPB fellowship–trained surgeon joined HSN in July 2013 with an additional HPB fellowship–trained surgeon joining in August 2014. There was no formal mentorship; however, HPB satellite multidisciplinary tumour boards initially occurred in collaboration with Toronto General Hospital.

Statistical analysis

We divided the 7-year study period into 2 periods based on the inception of the HPB program at HSN in July 2013. We compared the management of pancreatic malignancies in the 54 months pre-HPB program, to 109 pancreatic malignancies in the 30 months of the post-HPB program. Statistical significance was calculated using t tests, χ² tests and Mann–Whitney U tests, as appropriate (2-tailed). We considered results to be significant at p < 0.05.

RESULTS

A total of 207 patients (98 pre-HPB v. 109 post-HPB) with a new diagnosis of pancreatic cancer were reviewed from 2009 to 2015, after exclusion of 1 patient, who had received a diagnosis and been seen by an HPB surgeon outside Ontario. Our population included 5 patients in the post-HPB group who were referred to other HPB surgical programs after July 2013. Telehealth or telephone consultations were documented for 2 patients before HPB program inception and were included in our analysis (Table 1).

Pancreatic malignancies, including the subgroup of adenocarcinomas, had shorter median wait times from diagnosis to HPB surgical consultation in the post-HPB group (43 v. 11 d, [p < 0.001] for pancreatic malignancies and 48 v. 10 d, [p < 0.001] for pancreatic adenocarcinoma) (Table 2). Prior to HPB program implementation, 33 of 98 (34%) patients with pancreatic malignancies had a consultation with an HPB surgeon compared with 81 of 109 (74%) in the post-HPB program group (p < 0.001) (Table 3). Median distance travelled to HPB surgery consultation was 411 km pre-HPB and 79 km post-HPB (p < 0.001) (Table 4).

The median time from HPB surgical consultation to date of curative intent operation for pancreatic malignancies in the pre-HPB group was 18 days compared with 22 days in the post-HPB group (p = 0.74). In the subgroup of adenocarcinomas, median consultation to curative intent

<table>
<thead>
<tr>
<th>Table 1. Population demographic and tumour characteristics</th>
<th>Group; mean ± SD or no. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Characteristic</td>
<td>Pre-HPB program (54 mo) n = 98</td>
</tr>
<tr>
<td>Age, yr</td>
<td>71 ± 12</td>
</tr>
<tr>
<td>Male sex</td>
<td>52 (54)</td>
</tr>
<tr>
<td>Adenocarcinoma</td>
<td>49 (50)</td>
</tr>
<tr>
<td>IPMN/NET/cystic neoplasm</td>
<td>4 (4)</td>
</tr>
<tr>
<td>Distal cholangiocarcinoma</td>
<td>0 (0)</td>
</tr>
<tr>
<td>No tissue diagnosis/indeterminate/atypical*</td>
<td>44 (45)</td>
</tr>
<tr>
<td>Other (lymphoma)</td>
<td>1 (1)</td>
</tr>
</tbody>
</table>

HPB = hepatopancreatobiliary; IPMN = intraductal papillary mucinous neoplasm; NET = neuroendocrine tumour; SD = standard deviation.
*Indeterminate/atypical indicates that biopsy or brushings were not sufficient for a diagnosis of a pancreatic malignancy.

<table>
<thead>
<tr>
<th>Table 2. Time from diagnosis to HPB surgical consultation (54 mo pre-HPB program and 30 months post-HPB program)</th>
<th>Diagnosis, period</th>
<th>No. patients</th>
<th>Median (IQR), d</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pancreatic malignancies</td>
<td>Pre-HPB program</td>
<td>19</td>
<td>43 (28–75)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Pancreatic malignancies</td>
<td>Post-HPB program</td>
<td>71</td>
<td>11 (5–24)</td>
<td></td>
</tr>
<tr>
<td>Adenocarcinomas</td>
<td>Pre-HPB program</td>
<td>14</td>
<td>48 (23–77)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Adenocarcinomas</td>
<td>Post-HPB program</td>
<td>45</td>
<td>10 (4–23)</td>
<td></td>
</tr>
</tbody>
</table>

HPB = hepatopancreatobiliary; IQR = Interquartile range.

<table>
<thead>
<tr>
<th>Table 3. Interventions of pancreatic malignancies</th>
<th>Group; no. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervention</td>
<td>Pre-HPB program (54 mo) n = 98</td>
</tr>
<tr>
<td>Pancreatic malignancies</td>
<td>Whipple procedures*</td>
</tr>
<tr>
<td>Pancreatectomy</td>
<td>2 (9)</td>
</tr>
<tr>
<td>Distal pancreatectomy</td>
<td>12 (52)</td>
</tr>
<tr>
<td>Curative intent operations</td>
<td>11 (11)</td>
</tr>
<tr>
<td>Unresectable due to metastasis/local invasion</td>
<td>9 (9)</td>
</tr>
<tr>
<td>Other reasons</td>
<td>60 (61)</td>
</tr>
<tr>
<td>Total HPB consultations</td>
<td>33 (34)</td>
</tr>
</tbody>
</table>

*Indicates that biopsy or brushings were not sufficient for a diagnosis of a pancreatic malignancy.
†These include gastrojejunostomy/cholecystojejunostomy ± venting gastrostomy ± jejunostomy feeding tube. These also include attempted but unresectable Whipple procedures.
‡Reasons post-HPB program were nonoperative candidate due to comorbidities (n = 12), patient died (n = 1), patient declined the surgery offered (n = 3), and no notes available (n = 2). Reasons pre-HPB program were nonoperative candidate due to comorbidities (n = 7), patient declined the surgery offered (n = 2), monitoring of neuroendocrine tumour and IPMN (n = 2), and no notes available (n = 1).
operation time in the pre-HPB group was 20 days compared with 21 days in the post-HPB group ($p = 0.86$) (Table 5). Median time from diagnosis to medical oncology consultation for the pre- and post-HPB groups did not change (Table 6).

The number of curative intent and palliative operations was determined for the 207 pancreatic malignancy cases reviewed. This was excluding all endoscopic or percutaneous interventions. Curative intent operations increased in the post-HPB program patient population by 19% in the pancreatic adenocarcinoma group ($p < 0.001$) and 27% including all pancreatic malignancies ($p < 0.001$). In the pre-HPB group 12 of 23 patients (52%) underwent palliative operations compared with 12 of 53 patients (23%) in the postintervention group ($p = 0.01$) (Table 3). There were no pancreaticoduodenectomies (PDs) completed at HSN in the 54 months before July 2013 compared with 28 PDs in the 30 months after the HPB surgery program. Nine PDs were completed in southern Ontario in the pre-HPB group (Table 3). Patients undergoing Whipple procedures in the post-HPB group had a median hospital stay of 10 days, with 2 days of that stay in the intensive care unit. Ninety-day mortality was 0%. There were 6 deaths, with 5 of 6 due to end-stage recurrent/metastatic adenocarcinoma and 1 of 6 due to an unknown cause (patient was lost to follow-up) (Table 7).

**DISCUSSION**

The primary outcome of time from diagnosis to HPB surgical consultation was significantly decreased after HPB program inception (Table 2). The overall number of pancreatic malignancies seen at HSN and the Northeast Cancer Centre increased since the inception of the HPB program in July 2013. As well, a significantly larger proportion of patients with pancreatic malignancies received an HPB surgical consultation (Table 3). As the prevalence of pancreatic cancer in northern Ontario is not anticipated to have increased during the study period, these changes likely reflect increased referrals and accessibility to an HPB surgeon. The higher proportion of HPB surgical consultations may reflect a group of patients who previously were not referred or who declined referral to a distant tertiary care centre for HPB surgical consultation and treatment. We acknowledge that the increased proportion of HPB surgical consultations post-HPB program may have been hyperinflated owing to a lack of documentation of informal consultations occurring between the primary care provider and an HPB surgeon before the start of the program.

The secondary outcome of distance travelled for HPB surgical consultation was also significantly decreased after the implementation of the HPB surgery program. While not specifically measured, it is anticipated that travel costs would be reduced, and patient satisfaction likely increased.

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**Table 4. Distance of travel in kilometres**

<table>
<thead>
<tr>
<th>Period</th>
<th>No. patients</th>
<th>Mean ± SD (km)</th>
<th>Median (IQR, km)</th>
<th>$p$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-HPB program</td>
<td>33</td>
<td>398 ± 72</td>
<td>411 (349–447)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Post-HPB program</td>
<td>81</td>
<td>148 ± 176</td>
<td>79 (29–267)</td>
<td></td>
</tr>
</tbody>
</table>

HPB = hepatopancreatobiliary; IQR = interquartile range.

**Table 5. Time from diagnosis to date of curative intent operation**

<table>
<thead>
<tr>
<th>Diagnosis, period</th>
<th>No. patients</th>
<th>Median (IQR, d)</th>
<th>$p$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pancreatic malignancies pre-HPB program</td>
<td>9</td>
<td>18 (15–40)</td>
<td>0.74</td>
</tr>
<tr>
<td>Pancreatic malignancies post-HPB program</td>
<td>39</td>
<td>22 (8–40)</td>
<td></td>
</tr>
<tr>
<td>Adenocarcinomas pre-HPB program</td>
<td>8</td>
<td>20 (14–44)</td>
<td>0.86</td>
</tr>
<tr>
<td>Adenocarcinomas post-HPB program</td>
<td>27</td>
<td>21 (6–39)</td>
<td></td>
</tr>
</tbody>
</table>

*This includes patients who had curative intent operations for pancreatic malignancies. Palliative operations are not included.

**Table 6. Time from diagnosis to medical oncology consultation**

<table>
<thead>
<tr>
<th>Diagnosis, period</th>
<th>No. patients</th>
<th>Median (IQR, d)</th>
<th>$p$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pancreatic malignancies pre-HPB program</td>
<td>88</td>
<td>40.5 (12–76)</td>
<td>0.59</td>
</tr>
<tr>
<td>Pancreatic malignancies post-HPB program</td>
<td>63</td>
<td>54.0 (19–75)</td>
<td></td>
</tr>
<tr>
<td>Adenocarcinomas pre-HPB program</td>
<td>50</td>
<td>46.5 (14–78)</td>
<td>0.52</td>
</tr>
<tr>
<td>Adenocarcinomas post-HPB program</td>
<td>46</td>
<td>52.5 (15–62)</td>
<td></td>
</tr>
</tbody>
</table>

HPB = hepatopancreatobiliary; IQR = interquartile range.

**Table 7. Admission and mortality outcomes among patients who underwent Whipple procedures post-HPB program (n = 27)**

<table>
<thead>
<tr>
<th>Outcome</th>
<th>No. (%) or median (IQR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adenocarcinomas</td>
<td>18 (67)</td>
</tr>
<tr>
<td>Adjuvant therapy†</td>
<td>11 (61)</td>
</tr>
<tr>
<td>IPMN/NET/cystic neoplasm</td>
<td>3 (11)</td>
</tr>
<tr>
<td>Other‡</td>
<td>6 (22)</td>
</tr>
<tr>
<td>Length of admission, d</td>
<td></td>
</tr>
<tr>
<td>ICU stay§</td>
<td>2 (1.5–2.5)</td>
</tr>
<tr>
<td>Operative admission</td>
<td>10 (7–10)</td>
</tr>
<tr>
<td>90-day mortality</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Oncologic mortality (days)¶</td>
<td>5 (24)</td>
</tr>
</tbody>
</table>

HPB = hepatopancreatobiliary; ICU = intensive care unit; IPMN = intraductal papillary mucinous neoplasm; IQR = interquartile range; NET = neuroendocrine tumour.

*One case not recorded.
†Two additional patients were offered chemotherapy and refused.
‡Adenomyoma of ampulla (n = 1), lymphoma (n = 1), sclerosing pancreatitis (n = 2), gastric malignancy (n = 1), and choledocholithiasis (n = 1).
§Documented as days stayed in the ICU until ready for floor transfer.
¶Five deaths were from end-stage recurrent/metastatic pancreatic adenocarcinoma; 1 death was from an unknown cause as the patient was lost to follow-up.
by having their consultation and treatment locally (Table 3). Finlayson and colleagues\textsuperscript{17} reported on patient preferences for location of care and the implications of regionalization. Using the scenario of a potentially resectable pancreatic cancer, the authors determined the additional operative mortality risk that patients would accept in order to undergo surgery at a local hospital rather than travelling to a distant regional hospital. If the operative mortality risk was 3\% at the regional hospital, 45\% of patients were willing to accept twice the operative mortality risk, and 23\% of patients would accept 4 times the risk if they could have their operation performed locally. While some have concluded that these patients did not fully comprehend the consequences, others suggest that we likely underestimate the value of having health care provided closer to home.

There was an increase in the rates and complexity of curative intent surgical intervention for pancreatic malignancies and adenocarcinomas since the implementation of the HPB surgery program at HSN. The difference in surgical interventions may again reflect an increase in the number of patients who were referred or who agreed to an operative intervention locally. As well, patients who were deemed unresectable may not have been referred previously for consultation and evaluation for palliative interventions. The increase in surgical intervention and consultations is likely, also a reflection of HPB surgeons managing the majority of pancreatic malignancies, including those previously assessed by general surgeons without HPB training.

The secondary outcome of time from consultation to operation was not significantly different than before the HPB surgical program implementation in pancreatic malignancies or the subgroup of pancreatic adenocarcinomas. This may be attributable to small sample size, as we were not able to obtain the date of operation for many patients seen before July 2013. Time from decision to operate until operative date would be a more appropriate secondary outcome; however, this information was often not available. Currently, according to Cancer Care Ontario, the HPB surgical program at HSN is leading provincial wait times for HPB cancer surgery with a median of 23 days from the decision to perform surgery to operation.\textsuperscript{18}

Time from diagnosis to medical oncology consultation was not significantly changed. The investigators observed that before July 2013, it was often the medical oncologist who directed the care of patients with pancreatic cancer at HSN. With the development of the HPB surgery program, the surgeons are often involved in directing the care of these patients, including organizing additional imaging, biliary decompression and biopsies when indicated, although this was not statistically measured.

Satellite tumour boards with an established HPB program were extremely helpful in the development of the program at HSN. Input from senior mentors and colleagues remains an important component in the management of challenging clinical cases.

Limitations

There are limitations to our study. For the purposes of this retrospective review, it was not feasible to capture the entire population of patients referred from external centres in northeastern Ontario to HPB surgery programs before and after July 2013. While the majority of patients were likely assessed by oncology at the North East Cancer Centre, there may be a small proportion of patients who were seen exclusively at other regional cancer centres, declined referral for surgical consultation, or had pathology that would not benefit from chemotherapy or radiation. The DAD did not include patients if they were referred from the emergency department or a family physician’s practice to southern Ontario directly. In addition, difficulty in retrieving HPB surgery consultation dates and operation dates before July 2013, resulted in relatively small sample sizes. While outcomes are reported on Whipple procedures, it is difficult to determine significance with a variable population and variable tumour characteristics.

Conclusion

Access to specialized surgical care by the rural northern Ontario population remains a concern. Patients who require these services are often confronted by an intimidating diagnosis, long travel times and treatment in an unfamiliar environment. We have examined the impact of the first specialist HPB surgery program in the North East LHIN, located in the province of Ontario, Canada, on the management of pancreatic cancers.

The development of an HPB program in the North East LHIN has increased the number of patients receiving an HPB surgical consultation and undergoing surgical treatment for pancreatic malignancies, including significantly shorter times to consultation, and improvement in distance travelled to consultation and surgery. Patients were able to undergo complex pancreatic operations performed by fellowship-trained HPB surgeons, in their home region.

Further investigation is required to assess whether better access and earlier intervention leads to improved HPB oncologic outcomes in our patient population. However, with improved access to specialist surgical care, it is anticipated these changes have benefited the quality of care and patient satisfaction in the North East LHIN.

Affiliations: From the Division of General Surgery, Department of Surgery, Schulich School of Medicine and Dentistry, Western University (Hartford, Leslie); the Division of Plastic Surgery, Department of Surgery, University of Manitoba (Hartford, Doucet, Ramkumar, Shum, Asai); the Division of General Surgery, Department of Surgery, Health Sciences North, Northern Ontario School of Medicine (Shum, Ramkumar, Asai).
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Competing interests: None declared.

Contributors: L. Hartford, J. Shum and K. Asai designed the study. L. Hartford, V. Doucet and J. Ramkumar acquired and analyzed the data, which K. Leslie and K. Asai also analyzed. L. Hartford, V. Doucet, J. Ramkumar, K. Leslie and K. Asai wrote the article, which all authors reviewed and approved for publication.

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2. Wilson NW, Couper ID, De Vries E, et al. Inequitable distribution of healthcare professionals to rural and remote areas. Rural Remote Health 2009;9.*need to add page numbers
Acute care surgery (ACS) encompasses trauma, surgical critical care and emergency general surgery (EGS). Emergency general surgery patients account for a substantial proportion of emergency department presentations and contribute to the increasing inability of hospitals to provide timely emergency care. Currently, there are roughly 16.2 million emergency department visits in Canada, with 55% of these triaged as urgent or emergent. In the United States, more than 3 million patients are admitted to hospital each year with EGS conditions.

In addition to representing an immense burden of disease, EGS patients are uniquely challenging to manage. Emergency general surgery encompasses a spectrum of illnesses with diverse pathology, including almost any diagnosis that can culminate in abdominal sepsis. The main uniting factor in
this patient population is the urgency with which they require intervention. Preoperative evaluation and optimization are often limited, which leaves these patients particularly prone to poor outcomes. Many studies have shown an association between EGS and negative outcomes, including higher rates of major complications and death.1–9 Compared to patients undergoing elective operations, those undergoing emergency open gastrointestinal surgery are up to 5 times more likely to die within 30 days of their operation; they also experience minor and major complications 3 times as often as their elective surgery counterparts.9

The traditional model of care for EGS patients was an “on-call” system. A surgeon managed all incoming surgical emergencies for 24 hours while simultaneously working within the demands of his or her scheduled elective practice. Potential delays in patient assessment, ordering of supplemental investigations and admission to hospital occurred, as the on-call surgeon would not necessarily be on site when consulted regarding a patient. Patients requiring an emergent operation would interrupt an elective slate, or their surgery would be delayed until a theatre became available. Evening and nighttime operating, although not ideal, was often preferable to cancelling elective cases. The traditional model required surgeons to simultaneously balance EGS on-call duties with the usual demands of scheduled surgery and clinics. These conflicting demands inevitably culminated in the provision of suboptimal care to EGS patients or delays in completion of work in an elective practice. It became increasingly clear that a new model of care was required to streamline the management of EGS patients, improve hospital efficiencies and enhance outcomes.

Dedicated EGS service models were developed in part as a response to growing concerns with the traditional model of EGS care. Emergency general surgery models are broadly defined as clinical service teams that are dedicated to the prompt, comprehensive and evidence-based care of acutely ill general surgery patients. This model represents a change in the organization and staffing of general surgery services across North America. Several common elements of an EGS service are agreed on, although local, regional and national variation exists. A consultant leads the EGS service for a defined period of time, generally 1 week. The consultant is on site and available to provide clinical support to all stages of general surgery patient care during this time. The consultant is generally relieved from elective duties while leading the service. There is complete separation of emergency and elective pathways, with most services having dedicated operating room (OR) time for emergency surgical cases. However, it is important to acknowledge that establishment of an EGS service is not equivalent to having OR time for these cases. In fact, surgeon availability and OR availability are 2 separate issues. This is a potential factor in showing the superiority of the EGS service. Many North American institutions face the challenge of dedicating OR time despite EGS surgeon availability.

The proposed benefits of the EGS service model are numerous. A well-organized, dedicated EGS team with continual on-site presence should increase efficiency in the delivery of care to EGS patients.10–13 Specifically, this team-based approach should lead to faster assessments of surgical consultations, decreased time to hospital admission and improved throughput in the emergency department. With a dedicated EGS OR and surgeon, a patient’s time to operation should also decrease. In addition, a dedicated OR should allow more emergency cases to be handled during daytime hours. Finally, improvements in the timeliness of patient care with EGS are proposed to translate into fewer patient complications and overall enhanced outcomes. A reduction in complications in addition to improved preoperative timeliness of care should result in decreased total hospital length of stay (LOS), with attendant cost benefits to the hospital and health care system. Despite this potential, the degree to which the EGS model can deliver these benefits continues to be debated in the literature.

We performed a systematic review of the literature with the objective to identify whether the EGS service model is associated with greater efficiency in delivery of care and improved outcomes compared to the traditional model. Where possible, we followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines in performing this review.

METHODS

Search strategy

A health science librarian performed a systematic search of the literature across relevant databases (MEDLINE [Ovid], Embase [Ovid], Scopus and Web of Science [Core Collection]) from their earliest date of coverage through March 2017. No language restrictions were used in the search or study selection. Although searches varied in keeping with the options available within each database, a combination of controlled vocabulary and keyword queries were used in most cases. The title, abstract and subject heading (if applicable) fields were searched in all cases. Most commonly used subject headings included emergency medical services; emergency service, hospital; triage; specialties, surgical; acute diseases; appendicitis; cholecystitis; and intestinal obstruction. A series of keyword strategies were created to access literature focusing on the concept of emergency department (services) surgery, acute surgery, appendicitis, cholecystitis and bowel obstruction to ensure that all relevant studies were captured in the search. Although numerous other diseases (e.g., diverticulitis and perianal abscess) are diagnosed in
EGS patients, we specifically addressed appendicitis, cholecystitis and bowel obstruction because of their overwhelming prevalence in the EGS published literature. The reference lists of relevant articles were also searched for appropriate studies. A search for unpublished literature was not performed.

**Study selection**

Studies included in this review had to compare an EGS model with a pre-existing or traditional model of care. Studies also had to include a quantitative outcome evaluation. Studies that featured outcomes for an EGS model with no comparator were excluded. Similarly, qualitative studies were excluded. Primary outcomes for evaluating efficiency of care were surgical response time, time to operation and total hospital LOS. The primary outcome for evaluating patient outcomes was total complication rate. Secondary outcomes included in this review were appendix perforation rate and operative time of day. We chose appendiceal perforation as a secondary outcome to assess whether perforation is more a function of a specific service model or access to care. Studies that reported on at least 1 of the primary outcomes were included in the review.

Possible studies for inclusion were identified from the abstracts of the initial search and were selected according to the inclusion criteria after the full text was read. Two reviewers (J.M. and S.E.S.) chose papers for inclusion independently. Once the studies for inclusion were chosen, the reviewers compared their choices and resolved discrepancies through consensus. A third reviewer (K.H.), the senior member of the research team, resolved outstanding discrepancies. The same 2 reviewers independently abstracted data from included studies using a standardized data extraction form based on the Cochrane Effective Practice and Organisation of Care data collection checklist. We reported results in a descriptive fashion, as substantial heterogeneity was present in which performance and outcome variables were reported as well as in their specific definitions. There is not a registered protocol for this systematic review.

**RESULTS**

**Study characteristics**

The original search strategy yielded 3272 studies, of which 22 met the full criteria for inclusion (Fig. 1). Characteristics of the studies included in this systematic review are summarized in Table 1. All studies were retrospective in nature, with pre/post designs. Seven studies were from the US, 3 were from Canada, 11 were from Australia or New Zealand, and 1 was from Taiwan. Twelve studies evaluated patients with a diagnosis of acute appendicitis, 6 dealt exclusively with biliary disease, and 3 included patients with multiple diagnoses (a combination of biliary disease, acute appendicitis and small-bowel obstruction). One study evaluated all-comers without excluding patients based on diagnosis. Descriptive results of the included studies are summarized in Table 1.
Efficiency of care

Of the 22 included studies, 6 evaluated surgical response time. There was substantial heterogeneity in how this measure was defined. Beardsley and colleagues and Cubas and colleagues defined surgical response time as the interval between the patient’s arrival at triage and evaluation by the surgical team; Beardsley and colleagues additionally measured the time from emergency department assessment to surgical evaluation. Faryniuk and Hochman evaluated the time from emergency department consultation to surgical assessment, whereas Qureshi and colleagues measured the time from emergency department consultation to the time the surgical team decided to admit the patient. Lancashire and colleagues defined surgical response time as the interval from emergency department registration to admission/decision to operate. Given this variation, we did not calculate a pooled result for surgical response time. Compared to the traditional model of care, the EGS service model was associated with significantly decreased surgical response time in all 6 studies (Table 2).

Time to OR was assessed in 20 studies. This measure was also defined differently among these studies. The interval between triage registration and operative start was the most common definition, being used in 10 studies. The remainder of the studies used a variety of start times other than triage registration, including time of surgical consultation, surgical diagnosis, surgical evaluation, surgical decision, admission and booking request. Of note, Pepingco and colleagues defined time to OR as median time to definitive procedure, which may include interventions such as endoscopic retrograde cholangiopancreatography rather than a surgical procedure. Compared to the traditional model of care, time to OR was

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**Table 1. Characteristics and descriptive results of studies included in systematic review**

<table>
<thead>
<tr>
<th>Study</th>
<th>Study period, mo</th>
<th>Diagnosis</th>
<th>No. of patients, traditional model/acute care surgery model</th>
<th>Change in surgical response time</th>
<th>Change in time to operating room</th>
<th>Change in length of stay</th>
<th>Change in total complication rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beardsley et al., 2014</td>
<td>3</td>
<td>Acute appendicitis</td>
<td>84/66</td>
<td>Decreased</td>
<td>Decreased</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Britt et al., 2010</td>
<td>12/24</td>
<td>Acute cholecystitis</td>
<td>54/132</td>
<td>—</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Brockman et al., 2013</td>
<td>12</td>
<td>Acute appendicitis</td>
<td>361/357</td>
<td>—</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Cubas et al., 2012</td>
<td>12</td>
<td>Acute appendicitis</td>
<td>82/93</td>
<td>Decreased</td>
<td>Decreased</td>
<td>Decreased</td>
<td>NS</td>
</tr>
<tr>
<td>Earley et al., 2006</td>
<td>18</td>
<td>Acute appendicitis</td>
<td>127/167</td>
<td>—</td>
<td>Decreased</td>
<td>Decreased</td>
<td>Decreased</td>
</tr>
<tr>
<td>Ekeh et al., 2008</td>
<td>14</td>
<td>Acute appendicitis</td>
<td>273/279</td>
<td>—</td>
<td>NS</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Faryniuk et al., 2013</td>
<td>3</td>
<td>Acute appendicitis, acute cholecystitis, small-bowel obstruction</td>
<td>67/142/127*</td>
<td>Decreased</td>
<td>NS</td>
<td>NS</td>
<td>—</td>
</tr>
<tr>
<td>Fu et al., 2014</td>
<td>12</td>
<td>Acute appendicitis</td>
<td>146/159</td>
<td>Decreased</td>
<td>Decreased</td>
<td>Decreased</td>
<td>NS</td>
</tr>
<tr>
<td>Gandy et al., 2010</td>
<td>12</td>
<td>Acute appendicitis</td>
<td>176/226</td>
<td>—</td>
<td>NS</td>
<td>NS</td>
<td>Decreased</td>
</tr>
<tr>
<td>Lancashire et al., 2014</td>
<td>12</td>
<td>Acute appendicitis</td>
<td>247/301</td>
<td>Decreased</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Lau et al., 2011</td>
<td>10/12</td>
<td>Acute cholecystitis</td>
<td>81/71</td>
<td>—</td>
<td>Decreased</td>
<td>NS</td>
<td>Decreased</td>
</tr>
<tr>
<td>Leherne et al., 2010</td>
<td>24</td>
<td>Acute cholecystitis</td>
<td>87/115</td>
<td>—</td>
<td>Decreased</td>
<td>Decreased</td>
<td>Decreased</td>
</tr>
<tr>
<td>Michailidou et al., 2014</td>
<td>12</td>
<td>Acute cholecystitis</td>
<td>94/234</td>
<td>—</td>
<td>Decreased</td>
<td>Decreased</td>
<td>Decreased</td>
</tr>
<tr>
<td>Milzman et al., 2010</td>
<td>18</td>
<td>Acute appendicitis</td>
<td>60/60</td>
<td>—</td>
<td>Decreased</td>
<td>NS</td>
<td>Decreased</td>
</tr>
<tr>
<td>Pepingco et al., 2012</td>
<td>24</td>
<td>Acute cholecystitis</td>
<td>114/157</td>
<td>—</td>
<td>Decreased</td>
<td>Decreased</td>
<td>—</td>
</tr>
<tr>
<td>Perry et al., 2010</td>
<td>14/10</td>
<td>Acute appendicitis, acute cholecystitis, small-bowel obstruction</td>
<td>5346/3836</td>
<td>—</td>
<td>—</td>
<td>Decreased</td>
<td>—</td>
</tr>
<tr>
<td>Pillai et al., 2013</td>
<td>29/01</td>
<td>Acute appendicitis</td>
<td>875/982</td>
<td>—</td>
<td>NS</td>
<td>Decreased</td>
<td>NS</td>
</tr>
<tr>
<td>Poh et al., 2013</td>
<td>12</td>
<td>Acute appendicitis</td>
<td>256/283</td>
<td>—</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Qureshi et al., 2011</td>
<td>18/12</td>
<td>Acute appendicitis</td>
<td>177/137</td>
<td>Decreased</td>
<td>NS</td>
<td>NS</td>
<td>—</td>
</tr>
<tr>
<td>Suen et al., 2014</td>
<td>18</td>
<td>Acute appendicitis</td>
<td>274/399</td>
<td>—</td>
<td>Increased</td>
<td>NS</td>
<td>—</td>
</tr>
<tr>
<td>Suhardja et al., 2015</td>
<td>12</td>
<td>Acute cholecystitis</td>
<td>178/163</td>
<td>—</td>
<td>Decreased</td>
<td>Decreased</td>
<td>—</td>
</tr>
<tr>
<td>Wanis et al., 2014</td>
<td>12</td>
<td>Acute appendicitis, acute cholecystitis, small-bowel obstruction</td>
<td>288/294</td>
<td>—</td>
<td>Decreased</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

Note: NS = nonsignificant difference.
*Traditional model/newly formed acute care surgery service model/established acute care surgery service model.
significant decreased with an EGS service in 11 studies and was significantly increased in 1 study.27 (Table 3).

Hospital LOS was assessed in 19 studies.10,12–17,19–27,29–31 This measure was generally not clearly defined in these studies. Of the 8 studies that provided definitions, 4 looked at the time interval from inpatient admission to discharge, 3 considered the time from triage to discharge, and 1 measured emergency department arrival to discharge. Compared to the traditional model of care, hospital LOS was significantly decreased with an EGS service in 9 studies (Table 4). Nonsignificant differences in LOS were found in the remaining 10 studies. It should be noted that Faryniuk and Hochman12 did not find a significant difference in hospital LOS when all diagnoses (appendicitis, acute cholecystitis, and small-bowel obstruction) were considered. However, on subgroup analysis of only appendicitis and cholecystitis, LOS was significantly reduced with an EGS service (2.63 d v. 1.79 d, p = 0.009).

**Outcomes**

Thirteen studies evaluated the difference in rate of postoperative complications between the traditional model of care and the EGS service model.10,14–17,19–21,25,26,30 To enable comparison of patient outcomes between these studies, only data regarding total postoperative complication rate was abstracted for this review. Six of the included studies found that the total rate of postoperative complications was significantly decreased with an EGS service (Table 5). The remaining studies found no significant difference in the rate of complications between cohorts.

![Table 2. Summary of surgical response time results](image)

<table>
<thead>
<tr>
<th>Study</th>
<th>Diagnosis</th>
<th>Mean surgical response time, h†</th>
<th>Mean difference, h*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beardsley et al.</td>
<td>Acute appendicitis</td>
<td>6.1</td>
<td>–1.1</td>
</tr>
<tr>
<td>Cubas et al.</td>
<td>Acute appendicitis</td>
<td>6.6</td>
<td>–2.2</td>
</tr>
<tr>
<td>Faryniuk et al.</td>
<td>Multiple diagnoses</td>
<td>1.7</td>
<td>–0.9</td>
</tr>
<tr>
<td>Fu et al.</td>
<td>Acute appendicitis</td>
<td>4.7</td>
<td>–1.9</td>
</tr>
<tr>
<td>Suen et al.</td>
<td>Acute appendicitis</td>
<td>7.2</td>
<td>–1.4</td>
</tr>
<tr>
<td>Qureshi et al.</td>
<td>Acute appendicitis</td>
<td>5.6</td>
<td>–2.4</td>
</tr>
</tbody>
</table>

![Table 3. Summary of time to operating room results](image)

<table>
<thead>
<tr>
<th>Study</th>
<th>Diagnosis</th>
<th>Mean time to operating room, h†</th>
<th>Mean difference, h*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beardsley et al.</td>
<td>Acute appendicitis</td>
<td>26.5</td>
<td>–2.0</td>
</tr>
<tr>
<td>Cubas et al.</td>
<td>Acute appendicitis</td>
<td>16.4</td>
<td>–5.4</td>
</tr>
<tr>
<td>Earley et al.</td>
<td>Acute appendicitis</td>
<td>14.0</td>
<td>–3.9</td>
</tr>
<tr>
<td>Fu et al.</td>
<td>Acute appendicitis</td>
<td>7.3</td>
<td>–5.1</td>
</tr>
<tr>
<td>Lau et al.</td>
<td>Acute cholecystitis</td>
<td>35.0</td>
<td>–10.4</td>
</tr>
<tr>
<td>Lehan et al.</td>
<td>Acute cholecystitis</td>
<td>48.0†</td>
<td>–24.0</td>
</tr>
<tr>
<td>Michailidou et al.</td>
<td>Acute cholecystitis</td>
<td>25.7</td>
<td>–4.9</td>
</tr>
<tr>
<td>Milzman et al.</td>
<td>Acute cholecystitis</td>
<td>1.6</td>
<td>–1.0</td>
</tr>
<tr>
<td>Pepingco et al.</td>
<td>Acute cholecystitis</td>
<td>134.4†</td>
<td>–84.0†</td>
</tr>
<tr>
<td>Suen et al.</td>
<td>Acute appendicitis</td>
<td>15.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Suhardja et al.</td>
<td>Acute cholecystitis</td>
<td>32.4†</td>
<td>–7.2</td>
</tr>
<tr>
<td>Wani et al.</td>
<td>Acute appendicitis</td>
<td>3.7</td>
<td>–0.5</td>
</tr>
</tbody>
</table>

*Except where noted otherwise.†Median.

![Table 4. Summary of hospital length of stay results](image)

<table>
<thead>
<tr>
<th>Study</th>
<th>Diagnosis</th>
<th>Mean hospital length of stay, d*</th>
<th>Mean difference, d*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cubas et al.</td>
<td>Acute appendicitis</td>
<td>2.8</td>
<td>–1.0</td>
</tr>
<tr>
<td>Earley et al.</td>
<td>Acute appendicitis</td>
<td>3.5</td>
<td>–1.2</td>
</tr>
<tr>
<td>Fu et al.</td>
<td>Acute appendicitis</td>
<td>3.8</td>
<td>–1.4</td>
</tr>
<tr>
<td>Lehan et al.</td>
<td>Acute cholecystitis</td>
<td>6.0†</td>
<td>–2.0†</td>
</tr>
<tr>
<td>Michailidou et al.</td>
<td>Acute cholecystitis</td>
<td>3.5</td>
<td>–1.4</td>
</tr>
<tr>
<td>Pepingco et al.</td>
<td>Acute cholecystitis</td>
<td>4.9†</td>
<td>–0.9†</td>
</tr>
<tr>
<td>Perry et al.</td>
<td>Acute appendicitis</td>
<td>2.6</td>
<td>–0.6</td>
</tr>
<tr>
<td>Pilai et al.</td>
<td>Acute appendicitis</td>
<td>2.8</td>
<td>–0.2</td>
</tr>
<tr>
<td>Suhardja et al.</td>
<td>Acute cholecystitis</td>
<td>4.0†</td>
<td>–1.0†</td>
</tr>
</tbody>
</table>

*Except where noted otherwise.†Median.
Secondary outcomes

The appendix perforation rate was documented in 10 studies. There was no significant difference in appendix perforation rate between the traditional model of care and the EGS service model in 9 studies. Earley and colleagues found a significantly decreased rate of appendix perforation with an EGS service (12.3% with ACS vs. 23.3% with the traditional model, p < 0.05).

Operative time of day was reported in 13 studies. Brockman and colleagues found that significantly fewer nighttime emergency appendectomy operations occurred with an ACS model (4% vs. 12% with the traditional model, p = 0.005). Similarly, 5 studies showed significantly decreased after-hours operating with an ACS service. Complementing this finding, an increase in daytime operating with EGS service models was noted in 7 studies. Conversely, Earley and colleagues found that more than 40% of operations occurred in the evening (1600–2400) with the traditional model, whereas more than 40% of operations occurred between midnight and 0800 with an EGS service. Fu and colleagues also noted that significantly more patients underwent appendectomy at night (1700–0800) with their EGS model than with the traditional model of care (73% vs. 39%, p < 0.001).

DISCUSSION

Multiple recent studies have evaluated the impact of an EGS service model on efficiency of care and patient outcomes. Substantial variability exists in which outcome variables are reported by each study and in the precise definition of these variables. In addition, there is currently no single accepted EGS model. International variation in the structure and organization of EGS models necessitates caution when generalizing the results of a study conducted in one country to an EGS model in another. With these limitations in mind, our systematic review of the available literature shows that an EGS service model generally results in significant improvements in surgical response time and time to operation and significant decreases in hospital LOS. A decrease in total complication rate is also realized with an EGS service.

In 1966, the National Academy of Sciences branded accidental injuries as “the neglected disease of modern society.” The academy’s report highlighted the importance of reducing time between pathologic occurrence (injury) and the initiation of medical care. As a result, highly organized trauma systems have emerged that continue to have a major impact on patient mortality by systematically measuring outcomes, regionalizing delivery and establishing national standards through evidence-based metrics.

Similar to the goals of trauma systems, EGS aims to streamline patient management, improve hospital efficiencies and enhance outcomes. This model has led to renewed interest in ACS fellowships, dedicated ACS conferences and research establishing evidence-based guidelines for the care of EGS patients. The implementation of the EGS model of care is a good initial step in unifying a previously fragmented patient population and improving the quality of their care. However, the development of trauma systems has shown that measurement of and feedback on performance is integral to the improvement of a system of care.

The need for standardized quality metrics is apparent now that the EGS model has been created and adopted by multiple centres. Currently, a common set of clearly defined, evidence-based and broadly accepted performance measures for evaluating the quality of EGS as a part of, or independently from, ACS do not exist as robustly as they do for trauma systems or as defined by the American College of Surgeons National Surgical Quality Improvement Program. However, this program is not well suited for EGS owing to several factors, including nonoperative management of many EGS diagnoses and the relatively small proportion of EGS cases in the database, which contributes to concerns related to National Surgical Quality Improvement Program sampling methodology. Multiple studies have evaluated the impact of EGS on the efficiency of hospital care and patient outcomes. However, the substantial variability in specific outcome variables and their definitions makes it impossible to generalize or compare these results between centres.

A crucial step in developing standardized quality metrics is common agreement on and definition of outcome variables. The most commonly included measures are surgical response time, time to OR and hospital LOS. Part of the difficulty in establishing common definitions lies in the fact that EGS encompasses an array of heterogeneous diseases with sometimes very disparate hospital courses. However, acute appendicitis and biliary tract disease are the most
common reasons for admission to an EGS service. Patients with these diagnoses have fairly standard points of care along their hospital stays that are measurable. Establishing which point of care measures are important to monitor for the most common EGS conditions and establishing their precise definitions would aid in comparisons both within and between EGS models. To this end, a universal grading system of EGS disease severity has been developed by the American Association for the Surgery of Trauma and has been applied to common diagnoses.

With common definitions of disease, metrics can be established, and the development of comprehensive EGS databases or registries is possible. These registries could be an integral component in providing quality control and performance improvement in EGS systems; they could act as a database from which specific items could be evaluated, trends could be determined, and items could be linked to outcomes. Trends in EGS diagnoses, benchmarking data, and disease trends by age, geographic location and comorbidity could be readily delineated. Importantly, outcomes for a specific diagnosis could be monitored, providing data that could then be analyzed to evaluate the timeliness, appropriateness and quality of patient care. In addition to establishing benchmarks for care, comprehensive registries would allow hospitals to compare their performance to one another and to a national or international standard.

The value in tracking and improving outcomes underscores the academic potential of EGS models as standalone services or within the context of an ACS model that includes trauma and surgical critical care. Although somewhat beyond the scope of this review, the proliferation of ACS/EGS fellowships across North America is indicative of this. There are currently 22 sites approved for ACS fellowship training by the American Association for the Surgery of Trauma. This suggests a need and desire to develop EGS as an area of focused competency within the specialty.

The view of ACS solely as a change in general surgery services whereby general surgeons who perform elective surgery now dedicate occasional weeks to the practice of ACS is a restricted one. Although this type of general surgeon is critical to the delivery of care that patients broadly receive, it is likely that specialists and leaders in this area are required to properly steward the potential of EGS.

Limitations

A limitation of this review is that, owing to the considerable heterogeneity with which performance and outcome variables were reported in the various studies and in their specific definitions, the results were reported in a descriptive fashion and could not be pooled. A second factor that may affect the applicability of the results stems from the diverse diseases encountered in EGS patients. A single review encompassing all potential EGS diagnoses is impractical until quality metrics are defined for this service model. This further underscores the importance of deriving common definitions and outcomes for EGS services.

CONCLUSION

Emergency general surgery services have the potential to substantially improve the quality of care EGS patients receive. However, a new model of care cannot be successfully implemented without establishing a means to measure performance and provide feedback to drive quality improvement. Standardized definitions of quality metrics for services would allow research results to be compared between centres. An acute care database would provide EGS centres objective, quantitative and consistent data for comparing patient outcomes and system processes. This would promote objective evaluations of care and quality assurance and would serve as a reference point to direct public policy, with the ultimate aim of delivering the highest-quality care possible.

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References


Burnout, resilience and moral injury: How the wicked problems of health care defy solutions, yet require innovative strategies in the modern era

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Physician burnout is an increasingly concerning issue that affects patient care, costs and the sustainability of our health care system. Burnout is not solely related to personal resilience; it is important to recognize the major role of the institution of health care in creating this wicked problem. Only this way can we fully understand the shared responsibility required to develop local strategies to tilt the fulcrum in our favour.

Is burnout a diagnosis or a symptom? Burnout is a syndrome characterized by a loss of interest in one’s work, a sense of hopelessness, depersonlization and exhaustion.\(^1\) A 2018 Canadian Medical Association survey of 2547 physicians found that 30% showed signs of burnout, and 8% had suicidal ideation in the last 12 months. These results were significantly worse among medical residents. Is this a diagnosis that requires further assessment, treatment and study? Or is this a symptom of something else? Burnout historically has not been a popular topic of discussion among physicians. Among surgeons at our institution who completed the Mayo Clinic Physician Well-Being Index in 2018, 86% stated they had felt burned out from work, and 81% stated that their work was hardening them emotionally.

As physicians, we pride ourselves on having developed tremendous resilience after years of preparation in residency and fine tuning in medical practice. We are highly trained through study and apprenticeship to deal with the emotional and physical challenges of a modern medical practice. Yet, why is the suicide rate for physicians in the US 40 per 100 000 — 3 times that of the general population? Burnout suggests that we have failed to develop the skills and abilities that we pride ourselves on and have honed over decades. Could the phenomenon of burnout simply be a symptom of something far more insidious?

In their book, *Patients Come Second*, Spiegelman and Barrett write, “... the motivation to work in health care is a series of sacred encounters. They come from trying to describe a deeper connection with people, trying to make a difference not only to our patients, but also in how people treat one another.”\(^2\) So modern health care creates tremendous expectations and has lofty goals, but then introduces tremendous barriers in front of the women and men expected to attain those goals. What sort of disconnect does this produce?

A day on call and in the operating room can feel like a war zone at times. “Moral injury,”\(^3\) a term initially used to describe how military personnel respond to war, describes the response that we have when we fail to prevent, or simply watch, things that go against our sense of morality and identity. Is this something that happens in our modern health care system?

A Rand Corporation survey on physician burnout found that the primary stressor affecting physicians was their inability to provide accessible,
quality health care.\textsuperscript{3} Without controls over system funding and administration, we are expected to be the financial gatekeeper to universal health care by rationing and rationalizing patient access. Poorly designed electronic medical records, increasing paperwork, medicolegal jeopardy, administration demands, regulatory college requirements, the desire to improve patient experience scores, quality scores, and our own personal needs all create a schism between our “intense drive or need” to meet the patients’ best interests and the reality of modern health care. This creates a deeply emotional and exhausting psychological wound. No amount of yoga, mindfulness, physical activity, or pharmaceuticals can heal this wound. In addition, personal solutions, such as drastically reducing working hours, can have detrimental systemic effects.

**Wicked problems**

A concept first used by Professor Horst Rittel, a design theorist in the 1960s, a “wicked problem” has no easy, reproducible, or attainable solution. A simple problem would be something like getting directions to a destination. A complex problem, such as performing a coronary bypass, can be addressed in a reproducible fashion with quality once the correct team, technology and processes are in place. A solution to a wicked problem, such as how to govern a nation, address pollution, or solve the issues of health care, however, has no single, reproducible solution or end point; results in little agreement; and is unique. Often, the problem itself cannot be defined.

Could our health care system itself be the wicked problem? When one looks at the state of surgeons now, one sees an intense competition for few staff positions; wait times for resources, such as operating room time or diagnostic imaging; high workloads due to institutional disincentives to hire; poor engagement; litigation; burgeoning administrative demands; and harassment — all barriers preventing effective patient care. Most of us find meaning through our work, but what happens when that very work and workplace become toxic? All the resilience in the world will not help because burnout is predominantly an organizational issue, not a personal one.\textsuperscript{2}

**Strategies**

There are no solutions to wicked problems, only better or worse strategies. We must pursue a collaborative approach in which all stakeholders have the opportunity to participate and are actively involved in the creation of strategies, not solutions. Front-line physicians need to have input and the authority to make decisions and drive solutions from the bottom up. We want to deliver efficient, quality care and to be appreciated for that by patients, colleagues and the institution. The Mayo Clinic has produced a seminal article that clearly delineates an organizational approach to recognize and address this vital issue in 9 clear steps.\textsuperscript{4} Key organizational approaches include effective leadership, targeted interventions, promotion of flexibility in work–life integration and provision of resources to enhance resilience. One insight they describe is the 20% rule: spending at least 20% of your time on what you find most meaningful can substantially reduce the risk of burnout. Another key insight is that individual offerings to promote self care should not be the primary focus of the institution, as that can lead to skepticism about the ultimate motivations.

Get involved in the management of your institution — a leader without a title is often the most influential one in a group. Learn your local politics and learn how to get things done at your hospital. Instead of working on structures that will change processes and in turn change your local culture, start at the end and address the issues of culture first to get local buy-in. Improvements in workflow, reduction of unnecessary data collection, streamlining electronic medical records, automated order sets, and an acknowledgement of the sacrifices physicians make to provide excellent care can go a long way to improving satisfaction.\textsuperscript{6} The resources provided to caregivers need to be appropriate both contextually and culturally, and are likely more important than a focus on personal resilience.

In Oakville, we have adopted a number of strategies to address this issue. We are hiring 10 new surgeons over 1 year to address issues related to wait times and volume of work. In addition, to address institutional issues of barriers to timely, quality care, we have started an acute care general surgery service (ACS) with 3 additional new surgeons and are in the process of hiring a physician assistant to support them. The ACS allows us to have a surgeon available to do consults on inpatients and emergency department patients as well as dedicated diagnostic imaging slots and ACS operating room time every afternoon to allow patients to be treated and discharged home as soon as possible. In turn, elective surgeons can focus on their practices without being pulled in multiple directions at the same time. We have created separate breast and colorectal diagnostic assessment programs (DAPs). The breast DAP allows patients with breast imaging abnormalities to receive a same-day biopsy, be guided through their care by a dedicated patient navigator, and be seen by a surgeon rapidly and proceed to definitive care. Similarly, our colorectal DAP takes much of the burden away from surgeons by having patients staged in dedicated diagnostic imaging slots, guided by a patient navigator, and ready for surgical or oncological management faster. We have also introduced a new Oakville Virtual Care Program to provide our surgeons...
with an innovative and novel way to communicate virtually with patients using the Reacts platform (an integrated, collaborative tool for health care professionals). We believe that this will improve access and reduce barriers to health care.

Our coordinator of staff wellness, Louisa Nedkov, presents on topics of burnout, resilience, compassion fatigue and secondary trauma each month at our Department of Surgery meeting to raise awareness and help change the local culture. In addition, she is assisting us in the development of multiple programs involving guided imagery and peer support to enhance surgeon wellness. Francoise Mathieu, a compassion fatigue specialist from TEND, has presented rounds on the topic of managing compassion fatigue and burnout in health care. We are currently assessing the institutional role in secondary traumatic stress using the Secondary Traumatic Stress Informed Organization Assessment framework (www.uky.edu/CTAC).

In Oakville, our Department of Hospitalist Medicine, led by Dr. Stephen Chin in conjunction with Ms. Nedkov, has started regular Schwartz Rounds — “an interprofessional forum where caregivers have the opportunity to discuss difficult emotional and social issues that arise in caring for patients and families.” We are developing a collaborative model of care between surgeons and hospitalists. We have key local advisors with extensive experience in this field, including Dr. Alex Ginty (physicianselfcare.com) and Dr. David Posen (davidposen.com). We have also created a peer support network in the Department of Surgery with representatives from each surgical division to provide support and act as resources to our surgeons. We have on our departmental website (www.oakvillesurgery.com/energy.html) key resource papers and strategies that we are currently developing.

In October 2018 our Department of Surgery had dedicated system rounds in the field of team training. Guided by Dr. Robert Johnston of the Canadian Medical Protective Association, caregivers from the entire program attended to teach one another how to work better together. This initiative has led to a number of system changes that are currently being implemented and to a change in tone about how we need to work together.

The “Revised Declaration of Geneva — A Modern-Day Physician’s Pledge” from 2017 says, “I will attend to my own health, well-being, and abilities in order to provide care of the highest standard.” We need to address some fundamental problems with the health care system if we are to successfully develop and share strategies together.

**CONCLUSION**

We have created a Sisyphean task for our physicians and then abandoned them and laid the blame at their feet. Where is the justice in that? Politics is fundamentally about “who gets what,” and if we are committed to improving the organizational and personal issues leading to burnout and moral injury, we need to get involved in politics both locally and nationally to address this as a shared responsibility. We need to reduce institutional barriers, to provide rapid access to resources for our caregivers, understanding the moral distress we feel when we cannot provide timely, quality care. Our institutions need to be more risk tolerant and understand that, while all change is not improvement, there is no improvement without change.

Empathy needs to be demonstrated throughout the entire continuum of health care, from patients to nurses to physicians and administrators. The institution of health care needs to understand that its very survival depends on an existential pivot to focus on the wellness of caregivers. One of my favourite actors, Sonequa Martin-Green said, “Empathy is inconvenience. It hurts you to empathize with someone. We have our own pain. We don’t want to take on other people’s pain. But that’s what’s needed in this world.” And that will be the key strategy as we roll the boulder up the mountain, together.

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**Affiliation:** From the Oakville Trafalgar Memorial Hospital, Oakville, Ont.

**Competing interests:** None declared.

**References**

Assistant Professor (Tenure Track) | Department of Surgery

The Department of Surgery at The University of British Columbia (UBC) invites applications for an academic surgeon to be appointed at the rank of Assistant Professor, Tenure Track. A clinical appointment at a Vancouver based hospital in the relevant surgical specialty is anticipated.

The UBC Department of Surgery has training programs at the undergraduate, graduate and postgraduate levels, and pursues research to make innovative advancements in knowledge and practice to improve health. The Department consists of more than 400 physicians and scientists as well as over 70 administrative, research and technical staff. Specialty training programs are offered in Cardiovascular Surgery, Colorectal Surgery, General Surgery, Neurosurgery, Otolaryngology, Pediatric Surgery, Plastic Surgery, Radiation Oncology, Surgical Oncology, Thoracic Surgery and Vascular Surgery. The incumbent will join a collaborative clinical and research community in the domains of diabetes, transplantation, and biomedical engineering, and will have access to research relationships at Vancouver Coastal Health Research Institute and the BC Children’s Hospital Research Institute.

Reporting to the Head of the UBC Department of Surgery, the appointed candidate will develop a research program in translational transplantation and regenerative medicine and will be expected to successfully obtain external grant funding. Areas of particular interest could include stem cell biology, islet cell biology, immune tolerance, and cell engineering. The selected candidate will be expected to participate in the teaching activities of the Department, as well as provide mentorship and training to undergraduate, graduate and postgraduate trainees.

The successful candidate will hold an MD or MD/Ph.D. and should have or be eligible for certification from the Royal College of Physicians and Surgeons of Canada in a surgical discipline. The successful candidate will have training and experience in a field of translational transplantation research, regenerative medicine, or cell therapy, have demonstrated ability to achieve excellence in research and teaching, and have a commitment to academic service. Salary will be commensurate with qualifications and experience. A letter of application outlining the applicant’s research and teaching interests, accompanied by a detailed curriculum vitae and names of three references should be directed to:

Karen Larsen
Human Resources Manager, UBC Department of Surgery
Email Karen.larsen@ubc.ca with subject line: Assistant Professor position

Review of applications will begin on August 6, 2019 and continue until the position is filled. The anticipated start date for this position is July 1, 2020 or upon a date to be mutually agreed.

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