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The Hospital for Sick Children, a paediatric academic health science centre fully affiliated with the University of Toronto is inviting applications for the position of Surgeon-in-Chief. The Hospital for Sick Children is a tertiary care, world-renowned facility committed to providing excellence in care, research and teaching.

The Surgeon-in-Chief is responsible to the President for the clinical, research, academic and administrative activities of surgical services in support of the mission and strategic directions of SickKids. The Surgeon-in-Chief is a key member of the President’s senior management team, ensuring the successful integration of surgical services into the Hospital’s overall business plan. This includes contributing to the development and implementation of the Hospital’s strategic plan, ensuring all policies, programs and initiatives are consistent and supportive of the Hospital’s mission, vision and values. The Surgeon-in-Chief is expected to contribute to quality of care improvements, operational efficiencies, and the optimization of human, financial, and infrastructural resources. The Surgeon-in-Chief supports the ongoing design and implementation of leading-edge programs, processes, and technologies ensuring continuous improvement and is expected to strengthen the integration of care, education, research, and to promote the successes, needs and opportunities of the Department of Surgery to ensure viability for fundraising. The Surgeon-in-Chief is a role model through strong relational skills and visibility, and through effective internal and external communications. Evidence of existence in clinical care, teaching and research is required. The Surgeon-in-Chief collaborates with the University of Toronto to ensure cooperation and compliance with the affiliation agreement between the University and the Hospital. We are looking for an internationally recognized surgeon leader with a strong record of clinical and scholarly accomplishment eligible for appointment as an Associate Professor or Professor at the University of Toronto. Candidates must have training and certification in Paediatric Surgery or a Surgical Sub-specialty and extensive senior management experience in a health care system as well as a strong knowledge of the physician, surgeon and interdisciplinary professional. Salary will commensurate with qualifications and experience, minimum $500,000.

Candidates should submit their curriculum vitae by: May 31, 2014 to Dr. Michael Apkon, President & CEO, 555 University Avenue, Toronto, Ontario, Canada M5G 1G6. E-mail: sickkids.presidentandceo@sickkids.ca.

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The Regina Qu’Appelle Health Region (RQHR) is the largest health care delivery system in southern Saskatchewan, and one of the most integrated health delivery agencies in the country. We are inviting applications for the position of Section Head, General Surgery to provide leadership in a clinical, teaching and research environment. The Section Head will develop a collaborative, shared vision for general surgery and specialized oncology care with a rationalization of service across our acute-care hospitals. We are seeking applicants with accomplishments in academic, clinical and leadership environments who have excellent communication skills and a strong passion for patient/family focused care.

This 0.2 FTE contract position will allow the successful incumbent to also provide clinical duties in General Surgery on a fee for service basis. Successful candidates will hold certification from the Royal College of Physicians and Surgeons of Canada in General Surgery and be eligible for licensure to practice in Saskatchewan. In accordance with immigration requirements, preference will be given to Canadian citizens and permanent residents of Canada. The successful candidates will be eligible for a faculty appointment with the University of Saskatchewan, and will be provided opportunities for training and leadership in the RQHR management system.

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CHIEF, DEPARTMENT OF SURGERY

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The Children’s Hospital of Eastern Ontario (CHEO) invites applications for the position of Chief of the Department of Surgery. We seek an experienced academic leader who will be responsible for directing and developing the clinical, teaching and research activities of the Department. The Chief of Surgery oversees the Divisions of Cardiovascular Surgery, Dental Surgery, Neurosurgery, Orthopaedic Surgery, Otolaryngology, Paediatric Surgery, Plastic Surgery, Urology and the Gymnastics Service. The Chief of Surgery works in close collaboration with the Chief of Anesthesiology and Director of Perioperative Services. At present, there are 24 full time surgeons.

The successful candidate should hold an MD degree with further training and experience in a Paediatric surgical specialty. She/he should have strong leadership skills and a proven record of excellence in clinical care and academics. The candidate should be eligible for a full time academic appointment at the rank of Associate or Full Professor in the Faculty of Medicine, University of Ottawa. Functionality in French is an asset.

CHEO is located in Canada’s capital, Ottawa, Ontario, which is one of the most beautiful cities in the country. The greater Ottawa area is home to nearly 1 million people and provides a thriving, multicultural and bilingual environment rich with history and cultural activities in addition to an abundance of sporting and natural resources.

Interested candidates should submit a covering letter and detailed curriculum vitae by: May 9, 2014.

Dr. Carol Pitters, Chief of Staff
Children’s Hospital of Eastern Ontario
401 Smyth Road, Ottawa, ON, K1H 8L1
Email: pitters@cheo.on.ca • Tel 613 737-7000 x 2068

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Education through recreation

By this time of year, many specialty societies will have completed their annual meetings or winter symposia, where members obtain most of their annual continuing professional development credits. The initial reason for the timing was the opportunity to meet in a ski resort where the day could be split between winter recreation and continuing medical education. Ironically, just as the term for the latter activity was broadened to include other professional attributes, the opportunities for leisure were restricted by a seemingly endless wave of puritanical reform that reduced the acceptability of ski resorts as sites for academic meetings. While it is essential for surgeons to be free of even the appearance of being subject to influence, the reluctance to mix work with leisure runs counter to a century of progress.

The pervasiveness of this reluctance became clear to me when I met with a group of Western University medical students to write a report regarding an after-hours surgical anatomy club. Club meetings are held in the anatomy laboratory, where a surgical team is invited to demonstrate an operation on a cadaver. Following the laboratory portion, the group retires to the university pub for free-ranging discussions among the students, residents and surgeons. Sessions are so popular that a booking system using social media sells out within 2 minutes. There was apprehension regarding the inclusion of the recreational component of the club in the report even though it was critical to its popularity and to its effectiveness. The challenge for the group was to describe how the pub session contributed to the success of the endeavour without compromising patient dignity or club purpose. We found our answer in the philosophy of education through recreation.1

The concept of education through recreation was first applied in the 19th century to childhood development.2 George H. Read, the Chicago sociologist who identified the developmental role of play in childhood, divided human activity into 3 general types: work, art and play.2 The principle was broadened to include young adults, but the emphasis was restricted to physical activities.2 It was the basis for the rise of organized sports and initiatives such as the Olympic Games. Another Chicago sociologist, Nels Anderson, who spent a considerable part of his career at the University of New Brunswick, developed the concept that the currency of life is time: time spent working earns time for leisure.3 In his book explaining this concept, Anderson referred to the English educationist Lawrence P. Jacks, who had been asked by the United States National Recreation Association to consider the matter for a booklet endorsing outdoor activities in the National Parks. Jacks’ wonderful summary has been appropriated by various authors and followers of Zen Buddhism since it was written in 1932:

A master in the art of living draws no sharp distinction between his work and his play, his labour and his leisure, his mind and his body, his education and his recreation. He hardly knows which is which. He simply pursues his vision of excellence through whatever he is doing and leaves others to determine whether he is working or playing. To himself he always seems to be doing both. Enough for him that he does it well.4

Successful surgery requires total immersion, taking time from all 3 of life’s activities: work, art and play. Surgeons rob their families of their time to achieve success. Education through recreation is the opportunity to learn in a seamless fashion through all of life’s activities. The concept is as valid as its close relative, lifelong learning, which is considered to be the basis for continuing professional development.

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Coeditor, Canadian Journal of Surgery
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References

L’éducation par les loisirs

À ce temps-ci de l’année, de nombreuses sociétés de spécialistes auront tenu leur assemblée annuelle ou leur colloque d’hiver, événements durant lesquels les membres obtiennent la plupart de leurs crédits annuels de développement professionnel continu. Cette période de l’année avait été choisie à l’origine parce c’était l’occasion de se rencontrer dans une station de ski où la journée paraissait être divisée entre les sports d’hiver et l’éducation médicale continue. Paradoxalement, alors que le sens de l’expression « éducation médicale continue » a été élargi pour inclure d’autres attributs professionnels, les possibilités de loisirs ont été réduites par une vague interminable de réformes puritaines qui ont rendu les stations de ski moins acceptables pour tenir ce genre de réunions éducatives. Bien qu’il soit essentiel pour les chirurgiens d’être exempts du moindre soupçon d’influence, la réticence à mélanger travail et loisirs va à l’encontre d’un siècle de progrès.

L’omniprésence de cette réticence m’est apparue clairement lorsque j’ai rencontré un groupe d’étudiants en médecine de l’Université Western en vue de rédiger un rapport sur un club d’anatomie chirurgicale tenu après les heures de cours. Les réunions du club ont lieu dans le laboratoire d’anatomie, où une équipe chirurgicale est invitée à démontrer une chirurgie sur un cadavre. Après la partie laboratoire de la rencontre, le groupe se rend à la brasserie de l’université où se tiennent des discussions libres entre les étudiants, les résidents et les chirurgiens. Les rencontres sont si populaires qu’un système de réservation sur les médias sociaux affiche complet en moins de 2 minutes. On craignait d’inclure la composante récréative du club dans le rapport, même s’il s’agissait d’un élément essentiel de sa popularité et de son efficacité. Le défì pour le groupe était de décrire la façon dont les échanges à la brasserie contribuaient à la réussite de l’événement sans compromettre de décrire la façon dont les échanges à la brasserie contribuaient à la réussite de l’événement sans compromettre la détente. Il ne saurait les différencier. Il recherche simplement l’excellence en toute chose, laissant aux autres le soin de déterminer s’il est en train de travailler ou de jouer. Selon lui, il fait toujours les deux en même temps. Il lui suffit de bien les faire.

Pour réussir une chirurgie, le chirurgien doit s’immerger totalement et prendre du temps aux trois activités de la vie : le travail, l’art et le jeu. Les chirurgiens dérobent du temps passé avec leurs familles pour atteindre le succès. L’éducation par les loisirs est l’occasion d’apprendre de façon transparente à travers toutes les activités de la vie. Le concept est aussi valable que son proche parent, l’apprentissage par les loisirs.

Le concept de l’éducation par les loisirs a été appliqué pour la première au 19e siècle au développement de l’enfant. George H. Read, sociologue de Chicago qui a identifié le rôle du jeu dans le développement de l’enfant, avait divisé l’activité humaine en 3 grandes catégories : travail, art et jeu. Le principe a été élargi pour inclure les jeunes adultes, mais l’accent était limité aux activités physiques. Cette façon de penser a été à la base de la croissance des sports organisés et des initiatives telles que les Jeux olympiques. Un autre sociologue de Chicago, Nels Anderson, qui a passé une grande partie de sa carrière à l’Université du Nouveau-Brunswick, a créé le concept selon lequel le temps est la monnaie d’échange de la vie : le temps passé au travail gagne du temps pour les loisirs. Dans son livre expliquant ce concept, M. Anderson cite le pédagogue anglais Lawrence P. Jacks, à qui la National Recreation Association des États-Unis avait demandé de songer à rédiger un livret préconisant les activités de plein air dans les parcs nationaux. Le merveilleux résumé de M. Jacks a été repris par divers auteurs et adeptes du bouddhisme zen depuis sa publication en 1932 :

Un maitre dans l’art de vivre n’établira pas de distinction précise entre le travail et le jeu, le labeur et le loisir, l’esprit et le corps, l’apprentissage et la détente. Il ne saurait les différencier. Il recherche simplement l’excellence en toute chose, laissant aux autres le soin de déterminer s’il est en train de travailler ou de jouer. Selon lui, il fait toujours les deux en même temps. Il lui suffit de bien les faire.

Vivian C. McAlister, MB
Co-rédacteur, Journal canadien de chirurgie

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Références


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Prevention of delirium in trauma patients: Are we giving thiamine prophylaxis a fair chance?

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Background: Delirium is associated with increased morbidity and mortality in injured patients. Wernicke encephalopathy (WE) is delirium linked to malnutrition and chronic alcoholism. It is prevented with administration of thiamine. Our primary goal was to evaluate current blood alcohol level (BAL) testing and thiamine prophylaxis in severely injured patients.

Methods: We retrospectively reviewed the cases of 1000 consecutive severely injured patients admitted to hospital between Mar. 1, 2009, and Dec. 31, 2009. We used the patients' medical records and the Alberta Trauma Registry.

Results: Among 1000 patients (mean age 48 yr, male sex 70%, mean injury severity score 23, mortality 10%), 627 underwent BAL testing at admission; 221 (35%) had a BAL greater than 0 mmol/L, and 189 (30%) had a BAL above the legal limit of 17.4 mmol/L. The mean positive BAL was 41.9 mmol/L. More than 4% had a known history of alcohol abuse. More patients were assaulted (20% v. 9%) or hit by motor vehicles (10% v. 6%) when intoxicated (both \( p < 0.05 \)). Most injuries occurred after falls (37%) and motor vehicle collisions (33%). Overall, 17% of patients received thiamine prophylaxis. Of the 221 patients with elevated BAL, 44% received thiamine prophylaxis. Of those with a history of alcohol abuse, 77% received thiamine prophylaxis.

Conclusion: Despite the strong link between alcohol abuse, trauma and WE, more than one-third of patients were not screened for alcohol use. Furthermore, a minority of intoxicated patients received adequate prophylaxis against WE. Given the low risk and cost of BAL testing and thiamine prophylaxis and the high cost of delirium, standard protocols for prophylaxis are essential.

Contexte : Le délire est associé à une morbidité et une mortalité accrues chez les traumatisés. L’encéphalopathie de Wernicke (EW) est un délire associé à la malnutrition et à l’alcoolisme chronique que l’on peut prévenir en administrant de la thiamine. Notre objectif principal était d’évaluer le recours actuel aux tests d’alcoolémie et au traitement prophylactique à la thiamine chez les grands traumatisés.


Résultats : Sur 1000 patients (âge moyen 48 ans, sexe masculin 70 %, indice moyen de gravité des traumatismes 23, mortalité 10 %), 627 ont subi un test d’alcoolémie à leur admission; 221 (35 %) présentaient un taux d’alcoolémie supérieur à 0 mmol/L et 189 (30 %) avaient un taux d’alcoolémie au-dessus de la limite permise de 17.4 mmol/L. Le taux moyen des tests d’alcoolémie positifs était de 41.9 mmol/L. Plus de 4 % de ces cas avaient des antécédents d’alcoolisme. Les patients qui étaient sous l’effet de l’alcool ont davantage été victimes d’agressions (20 % c. 9 %) ou d’accidents impliquant un véhicule (10 % c. 6 %; tous deux \( p < 0.05 \)). La majorité des traumatismes ont été causés par des chutes (37 %) ou des accidents de la route (33 %). Dans l’ensemble, 17 % des patients ont reçu un traitement prophylactique à la thiamine. Parmi les 221 patients qui présentaient un taux d’alcoolémie élevé, 44 % ont reçu de la thiamine en prophylaxie. Parmi ceux qui présentaient des antécédents d’abus d’alcool, 77 % ont reçu un traitement prophylactique à la thiamine.

Conclusion : Malgré le lien étroit entre abus d’alcool, traumatismes et EW, plus du tiers des patients n’ont subi aucun test d’alcoolémie. En outre, seule une minorité de patients intoxiqués ont reçu une prophylaxie adéquate contre l’EW. Compte tenu des
Delirium is associated with increased morbidity and mortality and length of stay in hospital (LOS) for severely injured patients. Many patient variables have been identified as risk factors for delirium, including older age, drug use, smoking, alcohol ingestion and poor nutrition. Similarly, the risk of delirium in surgical patients is known to be increased by nonpatient factors, such as the rapidity and severity of a physiologic insult.

As a result, it is clear that most severely injured patients are at an increased risk for delirium given the acute, rapid and extensive nature of major trauma. This risk is further enhanced by the close association between chronic alcohol use and injury. More specifically, alcohol is the primary risk factor for both intentional and unintentional injuries in North America.

A clinically important form of delirium associated with chronic alcohol use is Wernicke encephalopathy (WE), which manifests classically as the triad of mental status changes, ophthalmoplegia and gait ataxia. Unfortunately, recent studies have identified this triad to be present in as few as 10% of all cases of WE. Although few randomized trials are available to guide dosing, scheduling or route of administration, thiamine is recommended for both the treatment and prevention of WE. Current recommendations for either prophylaxis or suspicion of WE are based primarily on clinical experience and observed successes with high physiologic levels (100 mg daily per os [PO], administered intravenously [IV] or intramuscularly [IM] until a regular diet is resumed).

The primary goal of this study was therefore to audit the current practice of blood alcohol level (BAL) monitoring and thiamine prophylaxis at a level 1 trauma centre.

**METHODS**

We retrospectively reviewed the cases of 1000 consecutive severely injured patients admitted to the Foothills Medical Centre (FMC) in Calgary, Alta., between Mar. 1, 2009, and Dec. 30, 2009. The FMC is a Trauma Association of Canada–accredited level 1 trauma centre serving as the trauma referral facility for Southern Alberta, Southwestern Saskatchewan and Southeastern British Columbia. As a result, it treats all injuries among more than 2 million people; there are more than 1100 annual admissions of severely injured patients. We used the Alberta Trauma Registry to obtain patient data (i.e., age, sex, comorbidities, date of injury, mechanism of injury, LOS, intensive care unit [ICU] stay, injuries, ISS, discharge destination, operative procedures, blood alcohol level, presenting vital signs, death). Fidelity was ensured by additional searches of the Alberta Health Services electronic patient medical record. The pattern of thiamine use (i.e., dose, duration, timing of treatment) was obtained from this medical record. It should be noted that Canada's legal alcohol limit for operating a motor vehicle is 17.4 mmol/L (80 mg/100 mL). The University of Calgary Conjoint Health Research Ethics Board approved our study protocol.

**Statistical analysis**

We performed our data analyses using SPSS software version 19.0 (SPSS Inc.). Prior to analysis, we assessed the underlying distribution of all continuous variables using appropriate histograms. Normally or near-normally distributed variables are reported as means ± standard deviation, and non-normally distributed variables are reported as medians with interquartile ranges (IQR). Comparisons were made using the $\chi^2$ test where appropriate. We considered results to be significant at $p < 0.05$.

**RESULTS**

Among 1000 consecutive severely injured patients, demographic characteristics (Table 1), injuries (Table 2) and outcomes (Table 1) were consistent with data from previous years and admissions. Overall, 44 (4.4%) patients had a documented history of alcohol abuse.

In total, 627 patients (62.7%) had a BAL measured in the emergency department of the trauma centre. Of these patients, 221 (35.2%) had a BAL greater than 0 mmol/L, and 189 (30.1%) had a BAL greater than 17.4 mmol/L (80 mg/100 mL). The mean BAL for those who tested positive on admission (221 patients) was 41.9 ± 22.2 mmol/L.

We assessed the mechanism of injury among the entire cohort as well as for the patients with elevated BAL on admission specifically, and these were compared using $\chi^2$ analysis (Table 2). We found a significant difference between

<table>
<thead>
<tr>
<th>Table 1. Demographic and clinical characteristics of study population ($n = 1000$)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Characteristic</strong></td>
</tr>
<tr>
<td>Age, yr</td>
</tr>
<tr>
<td>Male sex, no. (%)</td>
</tr>
<tr>
<td>Injury severity score</td>
</tr>
<tr>
<td>Length of stay, d</td>
</tr>
<tr>
<td>Survival to discharge, no. (%)</td>
</tr>
<tr>
<td>History of alcohol abuse, no. (%)</td>
</tr>
<tr>
<td><strong>SD</strong> = standard deviation. *Unless otherwise indicated.</td>
</tr>
</tbody>
</table>
Table 2. Mechanism of injury among injured patients

<table>
<thead>
<tr>
<th>Mechanism of injury</th>
<th>Total population, n = 1000</th>
<th>Patients with elevated BAL, n = 221</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor vehicle crash</td>
<td>327 (32.7)</td>
<td>68 (30.8)</td>
</tr>
<tr>
<td>Fall</td>
<td>371 (37.1)</td>
<td>67 (30.3)</td>
</tr>
<tr>
<td>Bicycle accident</td>
<td>25 (2.5)</td>
<td>5 (2.3)</td>
</tr>
<tr>
<td>Suicide attempt</td>
<td>25 (2.5)</td>
<td>5 (2.3)</td>
</tr>
<tr>
<td>Assault</td>
<td>92 (9.2)</td>
<td>44 (19.9)</td>
</tr>
<tr>
<td>Explosion/fire/burn</td>
<td>11 (1.1)</td>
<td>2 (0.9)</td>
</tr>
<tr>
<td>Fall from animal/rodeo accident</td>
<td>48 (4.8)</td>
<td>6 (2.7)</td>
</tr>
<tr>
<td>Other*</td>
<td>39 (3.9)</td>
<td>2 (0.9)</td>
</tr>
<tr>
<td>Gunshot wound</td>
<td>4 (0.4)</td>
<td>0</td>
</tr>
</tbody>
</table>

*Other includes struck by falling object, aircraft and watercraft accidents, sports-related injuries, and machinery accidents.

Injury patterns in the general trauma population and patients presenting with an elevated BAL. In particular, more patients were assaulted or hit by motor vehicles (both p < 0.05) when intoxicated (Table 2). In addition, fewer animal-related mechanisms of injury were noted in intoxicated patients (p = 0.043; Table 2).

In total, 173 patients (17.3%) received at least 1 dose of thiamine. On further examination, 98 of the 221 patients (44.3%) with a BAL greater than 0 mmol/L received thiamine during their hospital stay. Unfortunately, only 89 of them (40.3%) received their first dose of thiamine within the first 24 hours in hospital. Of the 44 patients with a documented history of alcohol abuse, 34 (77.3%) received thiamine. Thiamine dosing was 100 mg in all 173 patients who received this treatment. The precise route of administration was not available because it was typically documented as “IV/IM/PO” or “IV/IM.” Finally, the duration of thiamine treatment was a mean of 5.4 ± 9.37 (range 1–66) days.

Discussion

Given high rates of associated alcohol abuse and subsequent malnutrition, the trauma population is at significant risk of being thiamine-deficient before injury and admission. Wernicke encephalopathy is a state of delirium that is most commonly related to thiamine deficiency as a result of either chronic alcohol abuse or other nutritionally deplete states. Thiamine is an important cofactor for enzymes involved in carbohydrate metabolism as part of the Krebs cycle. Because the half-life of thiamine stores in the human body is only 10–19 days, global deficiency can occur as quickly as within 1 month of nutritional deprivation. Low thiamine levels impair glucose metabolism and result in the cerebral and serum accumulation of lactate. The accumulation of these toxic metabolites in particular regions of the brain (e.g., thalami, mammillary bodies, tectal plate, periaqueductal area) induces damage and results in the symptoms associated with WE. It has been speculated that these areas of the brain are characterized by intense thiamine metabolism, making them more susceptible to thiamine deficiency.

Despite current recommendations for the treatment and prophylaxis of WE (100 mg of thiamine IV/IM/PO per day until a regular diet is resumed), only 17.3% of all injured patients at our centre received at least a single dose of thiamine. When limited to patients with an elevated BAL on admission, coverage increased to only 44.3%. Among the highest risk cohort (patients with a documented history of alcohol abuse), nearly 23% of patients did not receive thiamine prophylaxis. Although these results are comparable to a prior study from Denver (47% of 153 intoxicated emergency department patients received thiamine prophylaxis), our low rate of successful thiamine coverage represents a clinically important failure in our care of patients at risk for delirium. Taken together, these studies suggest that without a standard protocol, BAL monitoring and thiamine prophylaxis is easily overlooked in the early care of trauma patients. Given the rarity of adverse events associated with thiamine administration (1 in 250 000 patients may experience anaphylaxis) and the reality that up to 25% of cases of untreated WE lead to death, the importance of prophylaxis becomes clear. Furthermore, Korsakoff syndrome, a persistent state of memory impairment typically requiring institutionalization, will also develop in up to 85% of the patients who survive WE. Considering that thiamine rapidly improves ataxia and ophthalmoplegia within hours of administration as well as global confusion within hours to days of treatment, the utility of prophylaxis and treatment is obvious.

Although it appeared that all patients in our study who received thiamine were given the correct dose (100 mg), an evaluation of the specific route of administration was not possible owing to poor electronic documentation. Route of administration is a relevant economic variable: the costs listed in the Alberta Health Services Drug Formulary are $0.97/dose for an IV injection compared with $0.05/dose for a pill. The mean duration of treatment was 5.4 (range 1–66) days. Although we would like to assume that the duration of treatment was clinically correct, the specific reasons for stopping thiamine prophylaxis were not evident in the electronic record. Presumably therapy was stopped owing to the resumption of a normal diet and/or discharge from the hospital.

Although testing BAL at the time of admission would not detect chronic alcohol abusers if they had not recently consumed alcohol, it would be helpful in predicting which patients may require thiamine prophylaxis or enter withdrawal. Furthermore, high BAL on admission may indicate that a patient has developed a tolerance to alcohol owing to chronic use. Given that only 62.7% of our severely injured patients underwent BAL testing, with 35% showing recent
ingestion of alcohol, it is clear that an improvement in screening is needed.

Despite data suggesting that WE is rare (0.06%–0.13%), postmortem studies have recently reported rates as high as 2.8% in injured patients. This has been emphasized in patients with major injuries (ISS 16–31) who display severe thiamine deficiency within the first week of injury despite routine nutritional support. It also compares to healthy controls who manifest only moderate deficiency for up to 21 days after nutritional deprivation. This suggests that low thiamine levels result from a combination of poor nutritional intake and increased catabolism in critically ill patients. Furthermore, if one uses the classic triad of mental status changes, ophthalmoplegia and gait ataxia as a diagnostic indicator for WE, up to 90% of cases may be missed. Given that altered mental status is the most common finding in patients with WE, it must always remain high on any differential diagnosis for post-admission delirium.

**CONCLUSION**

Preventing delirium should be a priority in the care of all injured patients. Standard testing of BAL at the time of admission could assist in guiding both the prophylaxis of alcohol withdrawal and the need for thiamine prophylaxis against WE. Furthermore, implementation of a protocolized thiamine prophylaxis program aimed at treating all patients with an elevated BAL on admission or with a history of alcohol abuse should be considered in all emergency departments and level I trauma centres. By implementing this as a quality improvement manoeuvre, we hope to improve the rate of adequate prophylaxis for WE.

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**Contributors:** C. Blackmore, J.-F. Ouellet and C.G. Ball designed the study. C. Blackmore, and C.G. Ball acquired and analyzed the data which were also analyzed by D. Niven and A.W. Kirkpatrick. C. Blackmore and C.G. Ball wrote the article, which all authors reviewed and approved for publication.

**References**

Is there any evidence of a “July effect” in patients undergoing major cancer surgery?

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Background: The “July effect” refers to the phenomenon of adverse impacts on patient care arising from the changeover in medical staff that takes place during this month at academic medical centres in North America. There has been some evidence supporting the presence of the July effect, including data from surgical specialties. Uniformity of care, regardless of time of year, is required for patients undergoing major cancer surgery. We therefore sought to perform a population-level assessment for the presence of a July effect in this field.

Methods: We used the Nationwide Inpatient Sample to abstract data on patients undergoing 1 of 8 major cancer surgeries at academic medical centres between Jan. 1, 1999, and Dec. 30, 2009. The primary analyses examined were postoperative complications and in-hospital mortality. Univariate analyses and subsequently multivariate analyses, controlling for patient and hospital characteristics, were performed to identify whether the time of surgery was an independent predictor of outcome after major cancer surgery.

Results: On univariate analysis, the overall postoperative complication rate, as well as genitourinary and hematologic complications specifically, was higher in July than the rest of the year. However, on multivariate analysis, only hematologic complications were significantly higher in July, with no difference in overall postoperative complication rate or in-hospital mortality for all 8 surgeries considered separately or together.

Conclusion: On the whole, the data confirm an absence of a July effect in patients undergoing major cancer surgery.


Méthodes : Nous avons utilisé la base de données Nationwide Inpatient Sample pour extraire les données relatives aux patients soumis à l’une de 8 interventions chirurgicales majeures pour le cancer dans des centres médicaux universitaires entre le 1er janvier 1999 et le 30 décembre 2009. Les principaux paramètres examinés ont été les complications postopératoires et la mortalité perhospitalière. Nous avons effectué des analyses univariées et, par la suite, des analyses multivariées en tenant compte des caractéristiques des patients et des hôpitaux afin de vérifier si la date à laquelle la chirurgie a eu lieu était un prédicteur indépendant des résultats après une chirurgie majeure pour le cancer.

Résultats : L’analyse univariée a révélé que les taux de complications postopératoires globales et de complications des interventions urogénitales et hématoLOGIQUES plus spécifiquement ont été plus élevés en juillet qu’à d’autres moments de l’année. Toutefois, à l’analyse multivariée, seules les complications des suites d’interventions pour un cancer hématoLOGIQUe ont été significativement plus élevées en juillet, sans différence au plan du taux de complications postopératoires globales ou du taux de mortalité perhospitalière pour les 8 interventions considérées séparément ou ensemble.

Conclusion : Globalement, les données confirment l’absence d’un effet juillet chez les patients soumis à une intervention chirurgicale majeure pour un cancer.
According to a landmark report by the Institute of Medicine in 1999, preventable medical errors lead to the deaths of up to 100,000 patients each year in the United States at a cost of $17–29 billion. Every July, academic medical centers in North America experience a changeover in medical staff, with thousands of medical students assuming new roles as interns and other junior staff taking on extra responsibilities. This has given rise to the hypothesis that a higher number of medical errors occurring in July may adversely impact patient care — the so-called “July effect” or “July phenomenon.”

Although there is some evidence in favor of this hypothesis, most studies, including those from medical, surgical, trauma, and obstetric fields, have not demonstrated the presence of the July effect. However, several of these studies were limited by their single-centre nature and their focus on a single patient group. While there have been a few population-based approaches to this question, they have largely been limited to a single specialty, such as neurosurgery, or obstetrics.

Patients undergoing major cancer surgery require increased levels of multidisciplinary care, and given the complexity of their surgery, they are likely to receive care from a team that includes physicians in training. We therefore sought to perform a population-level assessment for the presence of a July effect in outcomes following commonly performed major cancer surgeries. Specifically, we examined complication rates and mortality after major cancer surgeries performed in July compared with the rest of the calendar year, and we attempted to identify whether the month of surgery was an independent predictor of poorer outcome. Our hypothesis was that patients undergoing major cancer surgery at a teaching hospital in the month of July may have been more likely to experience adverse events.

**METHODS**

**Data source**

Relying on the Nationwide Inpatient Sample (NIS), hospital discharges in the United States between Jan. 1, 1999, and Dec. 30, 2009, were abstracted. The NIS is a set of hospital inpatient databases included in the Healthcare Cost and Utilization Project family created by the Agency for Healthcare Research and Quality through a federal–state partnership. The database includes discharge abstracts from 8 million hospital stays and incorporates patient and hospital information, including patients covered by Medicare, Medicaid, private insurance and other types of insurance.

Each discharge includes up to 15 inpatient diagnoses and procedures per hospital admission. All procedures and diagnoses are coded using the International Classification of Diseases, 9th revision, Clinical Modification (ICD–9–CM). Included patient and sociodemographic characteristics are patient sex, race, age, expected source of payment, outcome (in-hospital mortality) and hospital information (unique hospital identifier, date of admission, hospital location, hospital volume). Patients’ socioeconomic status was evaluated using a proxy income, defined by county-specific zip codes according to the U.S. Census.

**Study population**

We selected the following major surgical oncological procedures carried out at an academic medical centre given their complexity and high rates of surgical morbidity: colectomy, cystectomy, esophagectomy, gastrectomy, hysterectomy, pneumonectomy, pancreatectomy and prostatectomy. Analyses were restricted to cancer diagnoses only. Relying on specific ICD–9–CM procedure codes (available on request), we assessed each surgical procedure independently.

**Primary outcome**

The main outcomes were in-hospital mortality and the occurrence of a postoperative complication. They were defined using ICD-9 diagnoses, as described according to previously established methodology, and updated using additional codes. For analytical purposes, we grouped postoperative complications into 12 categories (cardiac, neurologic, respiratory, digestive, genitourinary, vascular, iatrogenic, wound, hematologic, infection, septicemia and others). Coding of complications has been shown to be in agreement when ICD–9 diagnostic and/or procedure codes and medical records are compared.

**Patient and hospital characteristics**

Independent variables for analyses included patient age at hospital admission, race, sex, insurance status, baseline comorbidities, median household income by zip code and hospital location. Information on race was categorized as white, black, Hispanic, other (i.e., Asian or Pacific Islander, Native American) or unknown. Insurance status was classified based on the expected primary payer and included Medicare, Medicaid, private insurance (i.e., Blue Cross, commercial carriers, private health maintenance organizations and preferred provider organizations) and other insurance types, including those who were not insured. Patient age was considered as a continuous variable. Baseline comorbidities were determined using a Charlson Comorbidity Index (CCI)–derived score adapted by Deyo and colleagues.

Income at the patient level was not available within NIS. Consequently, we relied on the median household income for the patient’s zip code, which we derived from U.S. Census data. Four categories were available within the database: less than $25,000, $25,000–$34,999, $35,000–$44,999 and $45,000 or more.

Hospital characteristics, including region (Northeast, Midwest, South and West), location (rural v. urban) and...
teaching status were obtained from the American Hospital Association Annual Survey of Hospitals and defined by the United States Census Bureau. A hospital was considered a teaching institution if it had an American Medical Association–approved residency program, was a member of the Council of Teaching Hospitals or had a ratio of 0.25 or more full-time equivalent interns and residents to non–nursing home beds. Annual hospital volume represents the number of procedures performed at each participating institution during each study calendar year; we calculated annual volume independently for each of the 8 procedures. Patients were divided according to 4 equal hospital volume quartiles: very low, low, high and very high.

**Statistical analysis**

Data distribution was adjusted according to the provided NIS population weights to render estimates more accurate nationally. We used the weighted population when conducting all our analyses.

First, we generated descriptive statistics on frequencies and proportions for categorical variables (sex, race, insurance status, median household income by zip code, CCI, annual hospital volume, hospital location, hospital region, hospital teaching status), stratified according to month of admission (July v. other months). Means, medians and interquartile ranges were reported for continuously coded variables (age). We performed $\chi^2$ and Mann–Whitney tests to compare significant differences within categorical and continuous variables. Second, overall complication rates and mortality were extracted for each month throughout the study period. We performed a Pearson $\chi^2$ test of independence to analyze variations throughout the year. Third, in-hospital mortality and occurrence of complications were stratified according to month of admission (July v. other months). We applied the same statistical analyses as we did with descriptive statistics. Fourth, multivariable logistic regression analyses were fitted to predict the

### Table 1. Baseline characteristics of patients undergoing major cancer surgery in teaching hospitals, Nationwide Inpatient Sample 1999–2009

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>All months</th>
<th>July</th>
<th>August–June</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients, no. (%)</td>
<td>1,370,738</td>
<td>108,270</td>
<td>1,262,468</td>
</tr>
<tr>
<td>Mean age, (median) yr [IQR]</td>
<td>64.8 (65.0)</td>
<td>64.9 (65.0)</td>
<td>64.8 (65.0)</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>63.4</td>
<td>63.4</td>
<td>64.4</td>
</tr>
<tr>
<td>Black</td>
<td>24.0</td>
<td>24.8</td>
<td>23.9</td>
</tr>
<tr>
<td>Hispanic</td>
<td>4.8</td>
<td>4.8</td>
<td>4.8</td>
</tr>
<tr>
<td>Other</td>
<td>6.9</td>
<td>7.0</td>
<td>6.9</td>
</tr>
<tr>
<td>Unknown</td>
<td>24.5</td>
<td>25.9</td>
<td>24.4</td>
</tr>
<tr>
<td>CCI†</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>46.0</td>
<td>46.0</td>
<td>46.0</td>
</tr>
<tr>
<td>1</td>
<td>24.0</td>
<td>24.8</td>
<td>23.9</td>
</tr>
<tr>
<td>2</td>
<td>4.8</td>
<td>4.8</td>
<td>4.8</td>
</tr>
<tr>
<td>≥3</td>
<td>6.9</td>
<td>7.0</td>
<td>6.9</td>
</tr>
<tr>
<td>Hospital location</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>2.4</td>
<td>2.7</td>
<td>2.4</td>
</tr>
<tr>
<td>Urban</td>
<td>97.6</td>
<td>97.3</td>
<td>97.6</td>
</tr>
<tr>
<td>Hospital region‡</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northeast</td>
<td>25.9</td>
<td>27.7</td>
<td>25.8</td>
</tr>
<tr>
<td>Midwest</td>
<td>27.3</td>
<td>28.7</td>
<td>27.2</td>
</tr>
<tr>
<td>South</td>
<td>29.8</td>
<td>25.3</td>
<td>30.2</td>
</tr>
<tr>
<td>West</td>
<td>17.0</td>
<td>18.3</td>
<td>16.9</td>
</tr>
<tr>
<td>Hospital volume per quartile</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very low</td>
<td>9.4</td>
<td>9.4</td>
<td>9.4</td>
</tr>
<tr>
<td>Low</td>
<td>20.8</td>
<td>21.4</td>
<td>20.8</td>
</tr>
<tr>
<td>High</td>
<td>30.2</td>
<td>30.8</td>
<td>30.2</td>
</tr>
<tr>
<td>Very high</td>
<td>39.6</td>
<td>38.4</td>
<td>39.7</td>
</tr>
<tr>
<td>Insurance status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private</td>
<td>46.0</td>
<td>46.0</td>
<td>46.0</td>
</tr>
<tr>
<td>Medicaid</td>
<td>3.7</td>
<td>4.1</td>
<td>3.7</td>
</tr>
<tr>
<td>Medicare</td>
<td>45.9</td>
<td>45.7</td>
<td>45.9</td>
</tr>
<tr>
<td>Other</td>
<td>4.2</td>
<td>4.2</td>
<td>4.2</td>
</tr>
<tr>
<td>Median income by zip code</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤$24,999</td>
<td>14.3</td>
<td>14.3</td>
<td>14.3</td>
</tr>
<tr>
<td>$25,000–$34,999</td>
<td>20.8</td>
<td>20.8</td>
<td>20.8</td>
</tr>
<tr>
<td>$35,000–$44,999</td>
<td>25.4</td>
<td>25.0</td>
<td>25.4</td>
</tr>
<tr>
<td>≥$45,000</td>
<td>37.5</td>
<td>38.0</td>
<td>37.4</td>
</tr>
</tbody>
</table>

CCI = Charlson Comorbidity Index; IQR = interquartile range.
*Unless otherwise indicated.
†Based on comorbidity developed by Charlson and colleagues and adapted by Deyo and colleagues.
‡Hospital region is defined by the United States Census Bureau.

Fig. 1. Complication rate and mortality according to date of admission in teaching hospitals from the Nationwide Inpatient Sample, 1999–2009. Average yearly complication and mortality rates were 19.4% and 1.73%, respectively. Univariate $\chi^2$ test of independence showed significant variations for overall complications ($p < 0.001$) and for mortality ($p = 0.003$).
occurrence of complications following major cancer surgery. July admission was observed as an independent variable. In addition, in patients who experienced 1 or more complications, we considered year of surgery, age, race, baseline CCI, median household income by zip code, hospital location, hospital region and hospital teaching status as covariates. When each complication was analyzed separately, the other complications were also included as covariates. Fifth, we fitted separate models to predict in-hospital mortality and complications as outcomes, stratified according to procedure type. July admission was observed as an independent variable in addition to the aforementioned covariates. To adjust for clustering within surgeons and hospitals, we fitted multivariable logistic regression models with generalized estimating equations. Sixth, length of stay was analyzed using generalized linear modelling, corrected for age, sex, race, insurance status, comorbidities, hospital location, hospital region, hospital volume, median household income by zip code and year of admission.

We performed all statistical analyses using the R statistical package system (R Foundation for Statistical Computing). All tests were 2-sided, with statistical significance set at \( p < 0.00625 \) to adjust for multiple comparisons using the Bonferroni correction.

**RESULTS**

*Baseline characteristics*

A weighted estimate of 1370,738 patients underwent a major cancer surgery at an academic medical centre between 1999 and 2009. The baseline characteristics of this cohort are shown in Table 1.

**Complications and mortality after surgery**

Figure 1 shows overall complication rates and mortality by month of admission. Table 2 shows the results of univariate analyses of complications occurring after all major cancer surgeries. The overall postoperative complication rate was higher in July than other months (19.7% v. 19.4%, \( p = 0.003 \)). Specifically, there were higher rates of genitourinary (1.3% v. 1.2%, \( p < 0.001 \)) and hematologic (2.2% v. 1.9%, \( p < 0.001 \)) complications in July than other months. There were no significant differences in in-hospital mortality (1.7% v. 1.7%, \( p = 0.31 \)). The median length of stay in hospital was significantly different when comparing July with other months (\( p < 0.001 \)).

**Multivariable models of the July effect on complications and mortality**

The results of multivariate analyses showing the July effect on specific postoperative complications and mortality after all major cancer surgeries are shown in Table 3. After adjusting for age, sex, race, CCI, insurance status, hospital volume, household income by zip code, hospital location, hospital region and the year of admission, we found that admission in July was not associated with an increased odds of postoperative complications (OR 1.00, \( p = 0.90 \)), length of stay (\( \beta 0.017, p = 0.42 \)) or in-hospital mortality.
mortality (OR 0.94, \( p = 0.33 \)). Conversely, admission in July was associated with a higher odds of hematologic complications (OR 1.17, \( p < 0.001 \)). In subset multivariate analyses, admission in July was not associated with greater odds of any postoperative complication developing or of in-hospital mortality following any of the 8 major cancer surgeries analyzed individually (Table 4).

**DISCUSSION**

Cancer is one of the major public health problems in the United States, with a predicted incidence of more than 1.6 million cases this year.\(^{27}\) Although there are expected to be more than 325 000 deaths in 2014 from just the 8 major cancers we analyzed in this study, mortality from solid cancers has generally been declining for the past 15–20 years.\(^{27}\) Surgery can offer a curative therapy for cancer, and improvements in surgical technique and technology are, in part, responsible for the downward trend in solid tumour-related mortality.\(^{28–31}\)

While major cancer surgery is technically demanding, the physiologic demands of such surgery on patients necessitate very high standards of postoperative care, with involvement of all members of the multidisciplinary team, including interns, residents, the attending surgeon and nursing staff. Moreover, it is paramount to ensure that the quality of medical care provided remains at the same high level throughout the year, particularly at times of change-over in medical staff, such as that which occurs every July in the United States. Based on these considerations, we sought to examine, at a population level, the July effect on postoperative outcomes following major cancer surgery.

Our results, on the whole, refute the presence of a July effect with regards to major cancer surgery. While the overall rate of postoperative complications was higher in the month of July than the rest of the calendar year on univariate analysis, this association was not observed on multivariate analysis. To account for patients who underwent procedures in the month of June in whom complications may have developed as a result of care in the month of July, we performed separate sensitivity analyses excluding the month of June, and these analyses yielded similar results (see the Appendix, available at cma.ca/cjs). On multivariate analyses for all major cancer surgeries and when considering each procedure separately, the month of July was found to be an independent predictor only of a higher rate of hematologic complications following all major cancer surgeries. Importantly, there was no July effect observed for in-hospital mortality, replicating previous data from surgical fields.\(^{29–31}\) Therefore, the overall data emphasize an absence of any July effect following major cancer surgery.

### Table 3. Multivariate analyses showing the effect of month of admission (July v. others) on the likelihood of adverse events following major cancer surgery in teaching hospitals

<table>
<thead>
<tr>
<th>Factor</th>
<th>No. of all months</th>
<th>OR (95% CI)</th>
<th>p value</th>
<th>OR (95% CI)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postoperative complications</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>250 219</td>
<td>1.00 (0.97 to 1.04)</td>
<td>0.90</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cardiac</td>
<td>37 561</td>
<td>0.95 (0.87 to 1.04)</td>
<td>0.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiratory</td>
<td>35 852</td>
<td>1.19 (0.86 to 1.63)</td>
<td>0.30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digestive</td>
<td>82 035</td>
<td>0.99 (0.94 to 1.05)</td>
<td>0.81</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neurologic</td>
<td>39 216</td>
<td>0.95 (0.87 to 1.03)</td>
<td>0.22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gastrointestinal</td>
<td>16 369</td>
<td>1.11 (0.98 to 1.25)</td>
<td>0.11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vascular</td>
<td>4 074</td>
<td>0.90 (0.70 to 1.18)</td>
<td>0.46</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wound</td>
<td>9 406</td>
<td>1.04 (0.87 to 1.23)</td>
<td>0.69</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infection</td>
<td>28 352</td>
<td>0.93 (0.84 to 1.04)</td>
<td>0.19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hematologic</td>
<td>26 205</td>
<td>1.17 (0.79 to 1.29)</td>
<td>0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Septicemia</td>
<td>24 902</td>
<td>1.06 (0.96 to 1.18)</td>
<td>0.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iatrogenic</td>
<td>73 828</td>
<td>0.99 (0.93 to 1.06)</td>
<td>0.83</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>584</td>
<td>0.99 (0.50 to 1.95)</td>
<td>0.97</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of stay —</td>
<td>0.017 (–0.22 to 0.05)</td>
<td>0.421</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-hospital mortality</td>
<td>22 393</td>
<td>0.94 (0.84 to 1.06)</td>
<td>0.33</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CI = confidence interval; OR = odds ratio.

*Corrected for age, sex, race, comorbidities, insurance status, hospital location, hospital region, hospital volume and median household income by zip code, Nationwide Inpatient Sample, 1999–2009.

†Coefficient as reported from a generalized linear regression modelling for the “July effect,” corrected for all other variables, including complications.

### Table 4. Multivariate analyses showing the effect of month of admission (July v. others) on the likelihood of adverse events following major cancer surgery in teaching hospitals

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Mortality OR (95% CI) p value</th>
<th>Complications OR (95% CI) p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>All surgeries</td>
<td>0.94 (0.84 to 1.06) 0.33</td>
<td>1.00 (0.97 to 1.04) 0.90</td>
</tr>
<tr>
<td>Colectomy</td>
<td>0.93 (0.79 to 1.11) 0.42</td>
<td>0.99 (0.94 to 1.05) 0.83</td>
</tr>
<tr>
<td>Cystectomy</td>
<td>0.86 (0.55 to 0.65) 0.33</td>
<td>0.93 (0.79 to 1.08) 0.31</td>
</tr>
<tr>
<td>Esophagectomy</td>
<td>1.16 (0.67 to 1.99) 0.60</td>
<td>1.08 (0.83 to 1.42) 0.54</td>
</tr>
<tr>
<td>Gastrectomy</td>
<td>0.82 (0.54 to 1.23) 0.34</td>
<td>0.99 (0.84 to 1.17) 0.90</td>
</tr>
<tr>
<td>Hysterectomy</td>
<td>0.69 (0.32 to 1.47) 0.33</td>
<td>1.05 (0.94 to 1.18) 0.40</td>
</tr>
<tr>
<td>Lung</td>
<td>1.00 (0.79 to 1.28) 0.98</td>
<td>0.99 (0.92 to 1.07) 0.83</td>
</tr>
<tr>
<td>Pancreatectomy</td>
<td>0.67 (0.43 to 1.05) 0.08</td>
<td>0.98 (0.84 to 1.15) 0.81</td>
</tr>
<tr>
<td>Prostatectomy</td>
<td>1.19 (0.40 to 3.54) 0.76</td>
<td>0.98 (0.88 to 1.09) 0.68</td>
</tr>
</tbody>
</table>

CI = confidence interval; OR = odds ratio.

*Corrected for age, sex, race, comorbidities, insurance status, hospital location, hospital region, hospital volume and median household income by zip code, Nationwide Inpatient Sample, 1999–2009.
Despite the evidence that first-year residents make more errors at the start of training than later,3 there are several factors that may explain the absence of a July effect for major cancer surgeries. First, and perhaps most importantly, there may have been greater supervision provided by more senior members of the medical team, including fellows and attending surgeons, as well as a greater level of support from the nursing staff. Interns and new residents may have been more cautious at the start of the academic year and may have asked for help at times of difficulty rather than attempt to solve problems themselves.8 Furthermore, much of postoperative surgical care is delivered according to standardized management protocols, which have been shown to improve postoperative surgical outcomes.14,15 This relative uniformity of care may therefore have compensated for the relative inexperience of some members of the health care team at the start of the academic year. Moreover, given the technical expertise required to perform major cancer surgery, it is highly unlikely that newer members of the surgical team would have been heavily involved in these operations from the outset of their training. Thus, patient outcome may not have been compromised in July, given that intraoperative events are predictive of postoperative outcome.26

Some data in the literature support the presence of a July effect in the context of vascular and general surgery,4 surgery for spinal metastases,1 cerebrospinal fluid shunt surgery3 and in a trauma setting.6 Despite relying on a nationwide data set, the study by Dasenbrock and colleagues1 focused on outcomes after a specific surgical procedure and was based on a sample size of fewer than 3000 patients over 4 years. In contrast, our data set was based on more than 1 million patients over a period of 11 years and included 8 different procedures. This is the major strength of our analyses and may explain why our results differ from those previously described in a surgical setting.

Limitations

There are important limitations to our study. Aside from the inherent drawbacks in using a retrospective data set, such as the Nationwide Inpatient Sample, we were unable to control for particular factors that may have influenced outcomes after major cancer surgery, specifically tumour stage and grade. Moreover, “near misses” (i.e., events that may have led to adverse outcomes but were somehow prevented, possibly owing to extra supervision, double-checking or simply good fortune) are not included, and it is possible that these may have been more frequent at the start of the academic year. The NIS includes information only on in-hospital events; therefore, longer-term postoperative course cannot be captured with this data set. Finally, although we were able to correct for hospital surgical volume in multivariate analyses, we were unable to specifically restrict analyses to hospitals with cancer surgery fellowships or those designated as cancer centres. Hence, while recognizing that caution must be exercised in interpreting our findings, to our knowledge, our study is the largest to date to report on the July effect, and we believe that the size and depth of our analysis provide reliability to our conclusions.

CONCLUSION

Our nationwide population-based analysis refutes the presence of a July effect with respect to major cancer surgery. Given the physical and emotional stresses, including potentially curative surgery, placed on patients with cancer, our finding that outcomes following major cancer surgery are equivalent at all times of the year are reassuring to patients and their families as well as to physicians and other members of the health care team. These findings emphasize that despite multiple changes occurring within house staff in academic hospitals, appropriate senior staff supervision and hospital protocols prevent the potential for increased complications.

Competing interests: None declared.

Contributors: P. Ravi, M. Sun and Q.-D. Trinh designed the study. V.Q. Trinh, M. Sun and Q.-D. Trinh acquired the data, which all authors analyzed. P. Ravi and Q.-D. Trinh wrote the article, which all authors reviewed and approved for publication.

References


Corrections

Correction: Canadian Surgery Forum abstracts
DOI: 10.1503/cfs.003614

The Canadian Surgery Forum abstract supplement published in August 2013 contained errors in the table of abstract 76, entitled “Identification of inferior quality of surgical care of elderly patients in the emergent setting: a pilot study.” In addition, the definition of “CCI” should have been “Charlson Comorbidity Index.” We apologize for these errors.

Correction: Canadian Society for Vascular Surgery abstracts
DOI: 10.1503/cvs.003514

The Canadian Society for Vascular Surgery abstract supplement published in December 2013 contained an error in abstract 38, entitled “Retrospective and prospective review of abdominal EVAR cases at Sunnybrook Health Sciences Centre, type II endoleaks: a decade of experience and lessons learned.” Only the first author’s name was listed. The full author list includes K. Maggisano, D. Cannataro, B. Chan, L. Sandhu, A. Dueck, G. Papa, D. Kucey and R. Maggisano. We apologize for this error.
Emotional intelligence in orthopedic surgery residents

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DOI: 10.1503/cjs.022512

Background: Emotional intelligence (EI) is the ability to understand and manage emotions in oneself and others. It was originally popularized in the business literature as a key attribute for success that was distinct from cognitive intelligence. Increasing focus is being placed on EI in medicine to improve clinical and academic performance. Despite the proposed benefits, to our knowledge, there have been no previous studies on the role of EI in orthopedic surgery. We evaluated baseline data on EI in a cohort of orthopedic surgery residents.

Methods: We asked all orthopedic surgery residents at a single institution to complete an electronic version of the Mayer–Salovey–Caruso Emotional Intelligence Test (MSCEIT). We used completed questionnaires to calculate total EI scores and 4 branch scores. Data were analyzed according to a priori cutoff values to determine the proportion of residents who were considered competent on the test. Data were also analyzed for possible associations with age, sex, race and level of training.

Results: Thirty-nine residents (100%) completed the MSCEIT. The mean total EI score was 86 (maximum score 145). Only 4 (10%) respondents demonstrated competence in EI. Junior residents (p = 0.026), Caucasian residents (p = 0.009) and those younger than 30 years (p = 0.008) had significantly higher EI scores.

Conclusion: Our findings suggest that orthopedic residents score low on EI based on the MSCEIT. Optimizing resident competency in noncognitive skills may be enhanced by dedicated EI education, training and testing.

Contexte : L'intelligence émotionnelle (IÉ) est la capacité de comprendre et de gérer les émotions qui se manifestent en soi-même et chez les autres. À l'origine, le concept d'IÉ a été popularisé dans le monde des affaires en tant qu’attribution clé de la réussite, distinct de l'intelligence cognitive. On s'intéresse de plus en plus à l'IÉ pour améliorer l'acquisition des compétences cliniques et théoriques. Or, malgré les avantages évoqués, à notre connaissance, aucune étude n'a encore porté sur le rôle de l'IÉ en chirurgie orthopédique. Nous avons évalué les données de base concernant l'IÉ d’une cohorte de résidents en chirurgie orthopédique.

Méthodes : Nous avons demandé à tous les résidents en chirurgie orthopédique d’un seul et unique établissement de répondre à un questionnaire par voie électronique, soit le test d’intelligence émotionnelle de Mayer–Salovey–Caruso (MSCEIT). Nous avons utilisé les questionnaires dûment remplis pour calculer les scores d’IÉ totaux et 4 scores secondaires. Les données ont été analysées en fonction de valeurs seuils préalablement établies afin de déterminer la proportion de résidents jugés compétents à l’aune de ce test. Les données ont aussi été analysées en fonction de liens possibles avec l’âge, le sexe, la race et le niveau de formation.

Résultats : Trente-neuf résidents (100 %) ont répondu au test MSCEIT. Le score d’IÉ total moyen a été de 86 (score maximum 145). Seuls 4 répondants (10 %) ont démontré une compétence en matière d’IÉ. Les résidents juniors (p = 0.026), de race blanche (p = 0,009) et de moins de 30 ans (p = 0.008) ont présenté des scores d’IÉ significativement plus élevés.

Conclusion : Selon nos conclusions, les résidents en orthopédie obtiennent des scores faibles pour ce qui est de l’IÉ selon le test MSCEIT. Il serait possible d’améliorer les compétences non cognitives des résidents au moyen de cours, de stages et de tests d’IÉ.
Emotional intelligence (EI) can be summarized as the ability to recognize, understand and manage emotions in oneself and others. Since 1998, EI has gained significant importance in the business literature as a fundamental tool for success and leadership. The concepts, however, apply to the field of medicine as well. In a systematic review of 16 articles examining EI in medicine, Arora and colleagues found that greater EI correlated with improved doctor–patient relationships, empathy, teamwork and communication skills. There have also been some suggestions that EI represents the closest available tool to measure the emotional competence of physicians. These attributes align nicely with contemporary medical education, which aims to train physicians who possess not only the expert knowledge and skills to practise medicine within their specialties, but also the ability to demonstrate competence in noncognitive characteristics. Efforts to define and assess such noncognitive skills of a trainee have resulted in educational frameworks, such as the CanMeds roles in Canada. The initiative was developed in the 1990s and identifies 7 core competencies of a qualified physician, including medical expert, communicator, collaborator, manager, health advocate, scholar and professional.

Despite the proposed benefits, to our knowledge, there has been no previous work done in applying EI to an orthopedic surgery residency curriculum. To study EI as a potential educational tool, we first sought to determine the baseline EI among a cohort of surgical residents at an academic institution in Canada.

**METHODS**

**Study participants**

We recruited all orthopedic surgery residents (postgraduate year [PGY] 1–5) at a single institution to complete the online version of the Mayer–Salovey–Caruso Emotional Intelligence Test (MSCEIT), a validated measure of EI. Our decision to include only orthopedic surgery residents was based on a focused effort within the division to improve communication skills. Our institutional review board approved this study.

**Determining EI**

The MSCEIT is the product of efforts made by academics at Yale and the University of New Hampshire to advance the notion of EI. It is a validated and reliable measure of EI that is meant to apply to a wide variety of settings, such as research, corporate, educational, clinical and medical fields. The MSCEIT contains 141 items. The questions aim to assess how well respondents aged 17 years or older perform on emotional problems that are similar to everyday tasks; the tool does not ask respondents to subjectively assess their emotional skills. The costs per administration are about $7 with a research discount or $50 without it.

Prior to completing the questionnaire, respondents were asked to enter demographic information, including age, sex, race and PGY of training. Owing to data limitations of the questionnaire, race could only be recorded as Caucasian, Asian or other. “Caucasian” referred to participants of European or North American background, and “Asian” referred to those from an Oriental background. The “Other” category generally comprised respondents other than those in the former 2 groups. Completed questionnaires were then sent electronically to the publishers for scoring, generating a total EI score and 4 branch scores: perceiving emotions, facilitating thought, understanding emotions and emotional management.

**Statistical analysis**

The MSCEIT assesses a respondent’s level of correctness based on a normative sample of 5000 people. Although most of the data come from participants in the United States, there were a number of collaborating sites from other countries, including Canada, the United Kingdom, South Africa, Australia, the Philippines, India and Sri Lanka. Scores are positioned on a normal curve with an average score of 100, standard deviation (SD) of 15 and a maximum score of 145. The MSCEIT offers guidelines on how to interpret the computed scores; they are shown in Table 1. Using the MSCEIT criteria, we narrowed the categories into 2 representative groups: scores of 110 or greater were classified as “competent” and scores of 109 or less were classified as “consider improvement.”

For each branch score and for the total EI score, we reported the number of residents who were “competent.” We calculated means, medians and SDs for total EI scores and the 4 branch scores. We also sought to determine whether there were differences in total EI scores and age, sex, race and PGY of training. Analyses were performed using a t test for comparison. We considered results to be significant at $p < 0.05$. Age was dichotomized a priori as younger than 30 years or 30 years and older. Similarly, race was grouped as Caucasian or other, and

<table>
<thead>
<tr>
<th>Score range</th>
<th>Interpretation</th>
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</thead>
<tbody>
<tr>
<td>≤ 69</td>
<td>Consider development</td>
</tr>
<tr>
<td>70–89</td>
<td>Consider improvement</td>
</tr>
<tr>
<td>90–99</td>
<td>Low average score</td>
</tr>
<tr>
<td>100–109</td>
<td>High average score</td>
</tr>
<tr>
<td>110–119</td>
<td>Competent</td>
</tr>
<tr>
<td>120–129</td>
<td>Strength</td>
</tr>
<tr>
<td>≥ 130</td>
<td>Significant strength</td>
</tr>
</tbody>
</table>
PGY of training was divided into junior (PGY1–2) and senior (PGY3–5). We performed a multiple regression analysis on these same variables.

**RESULTS**

**Participants**

A total of 39 residents completed the questionnaire, 36 men (92%) and 3 women (8%), for a response rate of 100%. There were 5 PGY1, 6 PGY2, 9 PGY3, 6 PGY4 and 13 PGY5 residents. There were 14 Caucasian (36%) and 5 Asian (13%) residents, while the remaining 20 (51%) residents were grouped into the “other” category by the MSCEIT. Eighteen (46%) respondents were aged 20–29 years, 18 (46%) were aged 30–39 years and 2 (5%) were aged 40 years and older (1 respondent did not provide information on age).

**Emotional intelligence scores**

Table 2 shows the number of residents who scored within the competent range on the MSCEIT in the total EI score and the 4 branch scores. Table 2 also shows the number of respondents who required improvement or scored within the average range on the questionnaire. Overall, only 4 residents (10%) surveyed were considered competent in the total EI score on the MSCEIT. Table 3 shows the means, medians and SDs for the total EI score and 4 branch scores. The mean total EI score in our sample was 86 (median 91, SD 22).

<table>
<thead>
<tr>
<th>Group; no. (%)</th>
<th>Requires improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competent</td>
<td>Average</td>
</tr>
<tr>
<td>Total score</td>
<td>4 (10)</td>
</tr>
<tr>
<td>Perceiving emotions</td>
<td>7 (18)</td>
</tr>
<tr>
<td>Facilitating thought</td>
<td>5 (13)</td>
</tr>
<tr>
<td>Understanding emotions</td>
<td>3 (8)</td>
</tr>
<tr>
<td>Managing emotions</td>
<td>3 (8)</td>
</tr>
</tbody>
</table>

**Analysis of factors associated with EI**

There were significantly higher mean total EI scores among junior residents \(p = 0.026\), Caucasian residents \(p = 0.009\) and those younger than 30 years \(p = 0.008\). However, there was no significant difference in scores between men and women \(p = 0.91\); Table 4). Using regression analysis, these variables accounted for 25.2% of the variance in the total EI scores \(r^2 = 0.252\).

**DISCUSSION**

Among our cohort of orthopedic surgery residents, most required improvement in EI based on the MSCEIT. In fact, 90% of respondents did not meet the numerical threshold for competence on this questionnaire. The dimensions of the test further suggested that residents had difficulty in all 4 branches of the MSCEIT: perceiving emotions, facilitating thought, understanding emotions and emotional management. This finding raises some potential concerns in light of the current climate of medical practice, where communication and teamwork are increasingly more important as medical complexity and multidisciplinary care become more prevalent. Previous research has demonstrated the potential significance of EI in clinical outcomes. Particularly, EI is recognized to be positively correlated with improved doctor–patient relationships and trust.9,10 Stratton and colleagues11 also found that EI was positively associated with communication skills in medical students undertaking a clinical performance exam. In the occupational health literature, EI has been found to be related to less burnout and higher job satisfaction among 110 internists.12

**Limitations**

It is important to remember that the present study is only a descriptive, cross-sectional, exploratory analysis of EI in

<table>
<thead>
<tr>
<th>Table 4. Factors associated with emotional intelligence scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor</td>
</tr>
<tr>
<td>Sex</td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td>Age, yr</td>
</tr>
<tr>
<td>&lt; 30</td>
</tr>
<tr>
<td>( \geq 30)</td>
</tr>
<tr>
<td>Level of training</td>
</tr>
<tr>
<td>Junior</td>
</tr>
<tr>
<td>Senior</td>
</tr>
<tr>
<td>Race</td>
</tr>
<tr>
<td>Caucasian</td>
</tr>
<tr>
<td>Other</td>
</tr>
</tbody>
</table>

**Table 2. Emotional intelligence scores among residents**

**Table 3. Summary measures for emotional intelligence testing using the MSCEIT**

MSEIT = Mayer–Salovey–Caruso Emotional Intelligence Test; SD = standard deviation.
1 group of orthopedic surgery residents. Our study is limited by its small sample size and lack of comparison groups, including faculty members, divisional and departmental leaders and residents in other surgical or medical specialties. In addition, there made no comparisons between MSCEIT scores and resident performance on other standardized evaluations, such as in-training tests, faculty assessments or Royal College exams. These additional comparisons would have provided interesting insight into the potential predictive ability of MSCEIT scores and resident success or, conversely, the possibility that surgeons score poorly on the MSCEIT, but perform better on other tests. As a result, our findings are not meant to draw any firm conclusions regarding the MSCEIT as an assessment tool for resident performance or as a predictor of orthopedic outcomes. Rather, they are intended to stimulate further research in EI as an additional marker of physician competence. This will require progressive steps, but there may be multiple ways to further explore EI. For instance, as mentioned previously, EI measures can be compared among different groups and correlated with other markers of physician success. There can also be longitudinal studies that measure EI repeatedly over time, which may permit a more powerful analysis of changes in EI within the existing surgical curricula. Finally, specific educational initiatives directed at improving EI may allow investigators to explore potential changes. Ultimately, these focused research efforts are aimed at enhancing physician competence and patient care.

Another intimate issue that needs clarification in future research is the concept of plasticity in EI. Previous work has shown that EI may not be a static personal attribute. Satterfield and colleagues measured EI in a group of 28 internal medicine residents at baseline and 1 year later. The authors found that EI scores increased significantly over the course of a year. Although the data are correlational in nature and may have been affected by confounding factors, such as maturation or life experiences, the authors proposed that the changes could have been secondary to direct educational interventions focusing on communication skills and empathy. Research on EI development and training are lacking. Some authors have suggested that emotional skills should be regarded as physical exam skills, which can be longitudinally taught using clinical cases, patient contact, precepting experiences and mentorships. Prospective studies are needed to determine the changes in EI, if any, associated with specific educational initiatives focused on emotional skills.

Our study also has several important strengths. First, the use of the MSCEIT as a measure of EI is strengthened by evidence of sound validity and reliability. This is particularly important since there is no gold standard for the assessment of EI. The questionnaire is also a relatively objective, ability-based test of EI, which avoids the potential subjectivity of other self-reported tests that ask respondents to rate their own emotional skills. In addition, the MSCEIT was administered electronically, and scoring was performed independently by the publishers. This avoids the potential errors and bias that may be introduced if we had completed the scoring manually ourselves.

The present study has also demonstrated some interesting trends. We found a significantly higher mean total EI score among junior residents and those younger than 30 years. Although our small sample size may limit the generalizability of this finding, our result is similar to those of other studies. Jensen and colleagues hypothesized that the decline in EI that they observed may have been related to the stresses and structure of surgical residency training. Further studies with larger sample sizes and repeated EI measures are required to clarify this trend and identify potential areas for intervention.

We also found that there was a significantly higher EI score among Caucasian respondents than Asian or other respondents. Unfortunately, the MSCEIT did not provide an opportunity for the 20 “other” respondents (51%) to elaborate on their racial backgrounds, which would have provided a clearer and more specific description of a substantial proportion of the study cohort. The tool also ignores the possibility of cross-cultural experiences; for example, a Caucasian respondent could have been brought up in Asia. Nevertheless, the potential for bias due to cultural and language differences are not unreasonable. Although the MSCEIT places no restrictions on racial applicability (performance on the questionnaire was considered comparable among racial groups in the normative sample), it is still worth noting that these data were collected from mostly U.S. cities and 58.6% of the normative sample was classified as “Caucasian.”

CONCLUSION

We identified a deficiency in EI among a cohort of orthopedic surgery residents. Emotional intelligence is an attractive model for defining and training future orthopedic surgeons in noncognitive competencies, such as communication, teamwork and professionalism. Overall, our findings are important in generating hypotheses for further work on EI. Future studies should focus on using reliable and validated measures of EI with larger sample sizes and rigorous study designs to evaluate the associations between EI and clinical and academic outcomes as well as the changes associated with EI-specific educational interventions.

Competing interests: None declared.

Contributors: All authors designed the study. K. Chan acquired and analyzed the data, which M. Bhandari also analyzed. K. Chan wrote the article, which all authors reviewed and approved for publication.

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10. Adhesive small bowel obstruction: epidemiology, biology and prevention
    Attard and MacLean

A patient-centred approach toward surgical wait times for colon cancer: a population-based analysis

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Matthew Dixon, MD†‡
Andrew Smith, MD, MSc§
Calvin Law, MD, MPH†§¶
Natalie G. Coburn, MD, MPH†§¶

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This paper was presented in full at the Canadian Society of Surgical Oncology Annual Meeting, April 2011.

Study performed at the Institute for Clinical Evaluative Sciences, Toronto, Ont.

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DOI: 10.1503/cjs.026512

**Background:** Administrative wait times reflect the time from the decision to treat until surgery; however, this does not reflect the total time a patient actually waits for treatment. Several factors may prolong the wait for colon cancer surgery. We sought to analyze the time from the date of surgical consultation to the date of surgery and any events within this time frame that may extend wait times.

**Methods:** We retrospectively reviewed the cases of all adult patients in Ontario aged 18–80 years with diagnosed colon cancer who did not receive neoadjuvant therapy and underwent resection electively between Jan. 1, 2002, and Dec. 31, 2009. Wait times were measured from the date of surgical consultation to the date of surgery. We chose a wait time of 28 days, reflecting local administrative targets, as a comparative benchmark. We performed univariate and multivariate analyses to identify variables contributing to a wait longer than 28 days. Variables were analyzed in continuous linear and logistic regression models.

**Results:** We included 10 223 patients in our study. The median wait time from initial surgical consultation to resection was 31 (range 0–182) days. Age older than 65 years had a negative impact on wait time. Preoperative services, including computed tomography, cardiac consultation, echocardiography, multigated acquisition scan, magnetic resonance imaging, colonoscopy and cardiac catheterization also significantly increased wait times. Wait times were longer in rural hospitals.

**Conclusion:** Preoperative services significantly increased wait times between initial surgical consultation and surgery.

Contre : Au plan administratif, les temps d’attente sont le reflet de l’intervalle entre la prise de décision de traiter et la chirurgie elle-même. Toutefois, cette mesure ne tient pas toujours compte du temps total d’attente d’un patient pour son traitement. Plusieurs facteurs peuvent prolonger l’attente dans le cas d’une chirurgie pour le cancer du côlon. Nous avons voulu mesurer le temps écoulé entre la date de la consultation en chirurgie et la date de la chirurgie, et tout événement à l’intérieur de cet intervalle susceptible de prolonger les délais.

**Méthodes :** Nous avons passé en revue de façon rétrospective le cas de tous les patients adultes ontariens âgés de 18 à 80 ans porteurs d’un diagnostic de cancer du côlon qui n’ont pas reçu de traitement néo-adjuvant et qui ont subi une résection non urgente entre le 1er janvier 2002 et le 31 décembre 2009. Les temps d’attente ont été mesurés entre la date de la consultation en chirurgie et la date de la chirurgie elle-même. Nous avons choisi un temps d’attente de 28 jours qui reflète les objectifs administratifs locaux comme valeur comparative. Nous avons effectué des analyses univariées et multivariées pour faire ressortir les facteurs qui contribuent à des périodes d’attente de plus de 28 jours. Les variables ont été analysées selon des modèles de régression linéaire et logistique continue.

**Résultats :** Nous avons inclus 10 223 patients dans notre étude. Le temps d’attente médian entre la consultation en chirurgie et la résection a été de 31 (entre 0 et 182) jours. L’âge de plus de 65 ans a exercé un impact négatif sur le temps d’attente. Les services préopératoires, notamment la tomodensitométrie, la consultation en cardiologie, l’angiographie isotopique, l’imagerie par résonance magnétique, la coloscopie et le cathétérisme cardiaque ont également significativement prolongé les temps d’attente. Les temps d’attente ont été plus longs dans les hôpitaux ruraux.

**Conclusion :** Les services préopératoires ont considérablement allongé les temps d’attente entre la consultation initiale en chirurgie et la chirurgie elle-même.
Timely access to health care is a priority for patients with cancer and their physicians and has led to interest in the length of time patients wait at the various steps during their treatment. With the important role surgery plays in the treatment plan for many patients with cancer, several stakeholders have focused on the clinical significance of the wait times that these patients experience.

Colon cancer is a prominent cancer for which surgical wait times may impact outcomes. In North America, colon and rectal cancer has an incidence of 48.8 cases per 100 000 and is the second most common cause of cancer-related death.\textsuperscript{1,2} The diagnosis is generally confirmed by colonoscopy, often after a lengthy period experiencing vague symptoms. These symptoms or the diagnosis of cancer will prompt a referral to a surgeon, who may manage further work-up necessary to arrive at a decision to treat and to obtain consent for resection. In many jurisdictions, administratively tracked surgical wait times include only the date from the decision to treat until the date of surgery (Fig. 1). This metric may neglect the time taken for diagnosis and staging; as a result, actual wait times may be much longer than what is captured by administrative data.\textsuperscript{1–10} Furthermore, several events may occur after the date of diagnosis which, although important in surgical planning, may negatively influence the date of surgery. Such events may include preoperative imaging, endoscopy, assessment of medical comorbidities and referral to specialists before consenting for surgery, all of which may increase surgical wait times during the patient journey.\textsuperscript{11}

Currently, there are no established benchmarks delineating acceptable wait times for cancer surgery. In Ontario, existing administrative targets for operative wait times (from date of decision to treat until date of surgery) prioritize patients with debilitating symptoms or aggressive cancer to a 14-day wait time goal and prioritize asymptomatic patients with an invasive cancer to a 28-day wait time goal.\textsuperscript{12,13} Most patients with colon cancer are perceived to match the criteria for the 28-day wait time goal.

As time of diagnosis is not incorporated into the administrative wait time and is difficult to determine through administrative and physician billing databases, it is not currently possible to analyze wait times from the time of clinical diagnosis, symptom development or positive screening test to the time of surgery. Therefore, our goal was to analyze the time from initial surgical consultation to the time of surgery and to analyze all events and required workup that take place in this preoperative period. To calculate this more patient-centred metric, we used administrative data, which have been shown to correlate well with abstracted data from patient charts when calculating wait times.\textsuperscript{14} Our objective was to track the flow of patients with colon cancer through the current management system and define any barriers to care that may exist within the treatment process.

METHODS

We performed a population-based retrospective review of administrative databases kept by the Institute for Clinical Evaluative Sciences (Toronto, Ont.). We included adult patients (aged 18–80 yr) with resectable colon cancer who were surgically treated in Ontario between Jan. 1, 2002, and Dec. 31, 2008. Patients were identified using the Ontario Cancer Registry (OCR), in which they were registered at the time of surgical specimen or cancer biopsy. The Registered Persons Database is a roster of all beneficiaries of the Ontario Health Insurance Plan (OHIP) and was used to collect the following demographic information: patient age, sex, local health integration network (i.e., geographical region), year of diagnosis and rurality. We calculated the Charlson Comorbidity Index (CCI) score using Canadian Institute for Health Information discharge data with regards to comorbidities reported during hospital admissions 1 year before surgery. We used Statistics Canada data to calculate income quintile based on median incomes by postal code of residence. Exclusion criteria were invalid OHIP number, not receiving colon resection within 6 months of inclusion in the OCR, admission for emergency surgery, rectal or rectosigmoid cancer, metastatic disease, receiving chemotherapy or radiation before surgery and not receiving a surgical consultation.

Surgical wait times were measured from the date of surgical consultation to the date of surgery. We recorded the following data for each patient: anaesthesia consultation, cardiology consultation, computed tomography (CT) scan, magnetic...
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resonance imaging (MRI), bone scan, thallium stress test, echocardiogram, multigated acquisition (MUGA) scan, cardiac catheterization, colonoscopy/flexible sigmoidoscopy, resection setting (academic v. community hospital), right-sided cancer (International Classification of Diseases, Tenth Revision, Clinical Modification [ICD-10-CM] codes C18.0, C18.2, C18.3, C18.4, C18.5) versus left-sided cancer (ICD-10-CM codes C18.6, C18.7) and hospital volume (i.e., average yearly number of surgical consultations during the study period).

Statistical analysis

We chose the administrative wait time goal of 28 days as a comparative benchmark, but expected the timeframe being studied to be longer than this administrative goal (Fig. 1). We performed univariate and multivariate analyses to identify variables contributing to a wait time longer than 32 days. Variables were analyzed in continuous linear and logistic regression models. We considered results to be significant at \( p < 0.05 \). All analyses were performed using SAS software version 9.2 (SAS Inc.).

RESULTS

We identified 10 223 patients with colon cancer who were surgically treated during the study period and met inclusion criteria. Cohort demographic and clinical characteristics are summarized in Table 1. The number of patients treated more than doubled over the study period (Table 1). The median age of the cohort was 68 years; 46% were women. There was a significant difference in wait time between patients with right-sided and left-sided colon tumours \( (p < 0.001) \). Most patients lived in an urban setting (83%), and these patients had shorter wait times than those living in rural areas \( (p < 0.001) \). Most patients were treated at community hospitals (76%), and these patients had longer wait times than those treated at academic institutions \( (p < 0.001) \). Wait time was significantly associated with the region where patients underwent resection \( (p < 0.001) \). Importantly, the wait time increased each year over the study period (Table 1). The median wait time overall was 31 (range 0–182, interquartile range [IQR] 16–59) days. Wait time decreased with increasing hospital volumes (Table 1).

<table>
<thead>
<tr>
<th>Category; variable</th>
<th>No. (%</th>
<th>Median wait time, d</th>
<th>p value</th>
<th>Category; variable</th>
<th>No. (%</th>
<th>Median wait time, d</th>
<th>p value</th>
</tr>
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<td>Income quintile</td>
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<td>1746 (17.08)</td>
<td>32</td>
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<td>2148 (21.01)</td>
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<td>33</td>
<td></td>
<td>2002</td>
<td>853 (8.344)</td>
<td>25</td>
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<tr>
<td>Right side</td>
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<td></td>
<td>2003</td>
<td>1246 (12.188)</td>
<td>26</td>
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<tr>
<td>Institution type</td>
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<tr>
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<td></td>
<td>2008</td>
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<tr>
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<tr>
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<td>2004</td>
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<tr>
<td>3- Waterloo</td>
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<td></td>
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<td>1501 (14.683)</td>
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<tr>
<td>Wellington</td>
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<td></td>
<td></td>
<td>2006</td>
<td>1603 (15.680)</td>
<td>31</td>
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<tr>
<td>4- Hamilton Niagara Haldimand Brant</td>
<td>1385 (13.55)</td>
<td>29</td>
<td></td>
<td>2007</td>
<td>1744 (17.060)</td>
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<tr>
<td>5- Central West</td>
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<td></td>
<td>2008</td>
<td>1897 (18.556)</td>
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<tr>
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<td></td>
<td>Low, &lt; 125</td>
<td>3172 (31.03)</td>
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<tr>
<td>7- Toronto Central</td>
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<td>Medium, 125–200</td>
<td>3336 (32.63)</td>
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<td>8- Central</td>
<td>1117 (10.93)</td>
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<td>High, &gt; 200</td>
<td>3715 (36.34)</td>
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<tr>
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<td>1121 (10.97)</td>
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<td></td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>10- South East</td>
<td>412 (4.03)</td>
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<td>1903 (18.61)</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>11- Champlain</td>
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<td>28</td>
<td></td>
<td>1</td>
<td>42 (0.41)</td>
<td>45</td>
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</tr>
<tr>
<td>12- North Simcoe Muskoka</td>
<td>444 (4.34)</td>
<td>36</td>
<td></td>
<td>2</td>
<td>5060 (49.50)</td>
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<tr>
<td>13- North East</td>
<td>626 (6.12)</td>
<td>34</td>
<td></td>
<td>3</td>
<td>3218 (31.48)</td>
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</tr>
<tr>
<td>14- North West</td>
<td>210 (2.05)</td>
<td>40.5</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

CCI = Charlson Comorbidity Index; LHIN = Local Health Integration Network.
The median hospital volume was 161 (IQR 113–254) cases per year.

We also examined data for median wait times according to preoperative tests and consultations (Table 2). Not surprisingly, wait times were longer when a test or consultation was done. Preoperative tests with the largest effect on wait times were cardiac catheterization (60.5 d), colonoscopy/sigmoidoscopy (22 d) and thallium stress test (22 d; Table 2).

Factors for multivariate and continuous analyses were grouped according to patient, tumour, institutional and preoperative factors. Data from multivariate analysis are summarized in Table 3. No tumour factors had a negative impact on wait time. The only patient factor having a negative impact on wait-time was age older than 65 years (p < 0.001). Surgical resection at a rural institution had a negative impact on wait time (p < 0.001). Preoperative factors and consultations associated with a negative impact on wait times included CT scan (p < 0.001), cardiac consultation (p < 0.001), echocardiogram (p < 0.001), MUGA scan (p = 0.009), MRI (p < 0.001), colonoscopy (p < 0.001) and cardiac catheterization (p < 0.001). On continuous analysis (Table 4), preoperative factors extended the wait time by several days: CT scan (3 d), lower volume hospital (5 d), echocardiogram (9.5 d), bone scan and cardiology consultation (12 d), MRI (16 d), colonoscopy (23 d) and cardiac catheterization (30 d). No wait time differences by income quintile were found. In patients younger than 50 years, wait time was reduced by 4 days.

**Discussion**

Up to 80% of patients with cancer will require surgery.11–15 Surgical resection of a tumour often represents the entry point into the cancer treatment system, and wait times for surgery can impact the entire patient journey.17 Delays in tumour resection may have adverse effects on outcomes18–20 and create additional psychosocial stress for patients.21–25 Specifically for surgical resection, the patient journey is influenced by how long it takes for symptoms to prompt testing as well as the time required to conduct appropriate testing, the

<table>
<thead>
<tr>
<th>Table 2. Median wait times for preoperative tests and consultations</th>
</tr>
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<tr>
<td>Variable</td>
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<tr>
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<tr>
<td>Anesthesia consultation</td>
</tr>
<tr>
<td>Bone scan</td>
</tr>
<tr>
<td>Cardiac catheterization</td>
</tr>
<tr>
<td>Cardiac consultation</td>
</tr>
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<td>Colonoscopy/sigmoidoscopy</td>
</tr>
<tr>
<td>CT scan</td>
</tr>
<tr>
<td>Echocardiogram</td>
</tr>
<tr>
<td>MRI</td>
</tr>
<tr>
<td>MUGA scan</td>
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<tr>
<td>Thallium stress test</td>
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</table>

CT = computed tomography; MRI = magnetic resonance imaging; MUGA = multigated acquisition.
time to surgical consultation, preoperative staging assessments, discussion at multidisciplinary care conferences and, finally, the wait for surgery.\textsuperscript{9,17} Wait times are also influenced by the volume of other patients requiring preoperative testing, surgery, the availability of limited physical and human resources and the organization of local health care delivery.\textsuperscript{12,17} These factors can create barriers to timely provision of care for patients with cancer. Conversely, some waiting in any system is inevitable. The only way to minimize wait times is by having excess capacity in the system. However, excess capacity creates an inefficient system and may create overutilization.\textsuperscript{12}

We selected a cohort of patients with resectable, nonmetastatic colon cancer who did not require neoadjuvant therapy to analyze surgical wait times because the management is relatively linear and tends toward a less complicated treatment plan. Patients with rectal cancer or metastatic disease were excluded, as these patients have more treatment options, including neoadjuvant chemotherapy and chemoradiation. In this setting, we have found large variations in wait times for patients with colon cancer. As such, patients such as those with esophageal, gastric or rectal cancers, who require a more complex assessment and neoadjuvant treatments can be assumed to have even more lengthy waiting periods from diagnosis to surgery.

Of the 10 223 patients with diagnosed resectable colon cancer, more than half had a surgical wait time longer than the 28-day goal, with a median wait time of 31 days. These results can be interpreted in different ways. If this 28-day goal is exceeded by 3 days, this may not have an adverse impact on outcomes. However, the upper portion of the IQR was 59 days, extending more than 30 days beyond the 28-day goal. Simunovic and colleagues\textsuperscript{26} found that, while disease-specific effects on survival by wait time was nonsignificant, the risk of death in patients with colon cancer was greater when the time interval from decision to treat until surgery was 22 days or more versus 1–7 days (hazard ratio [HR] 1.1, 95% confidence interval [CI] 1.0–1.2, \textit{p} = 0.013) and when the time from diagnostic test to surgery was 43 days or more versus 1–14 days (HR 1.2, 95% CI 1.1–1.3, \textit{p} = 0.003). As cardiac testing appeared to cause major delays in the time to surgery in our cohort, the results may be confounded by cardiac or other comorbidities that we were not able to fully account for in this analysis. Regardless, an upper IQR of 59 days leaves substantial room for improvement. Tumour factors did not add to the wait time, while preoperative investigations added the most time. Computed tomography did not add a great deal of extra wait time (3 d), whereas MRI, bone scan, colonoscopy, cardiology consultation and particularly cardiac catheterization added greatly to wait times.

Academic centres had a shorter wait time than community centres. High-volume centres, which most academic centres are, also had shorter wait times than low-volume centres. These results seem counterintuitive, as high-volume academic centres are thought to be busy centres with longer wait times. Simunovic and colleagues\textsuperscript{26} demonstrated from Surveillance,
Epidemiology and End Results (SEER) Program data for 1993–96 that treatment at high-volume centres in the United States predicted longer wait times. The results from our cohort contradict this finding. Caution must be exercised when comparing data from 2 different eras and between 2 different health care systems, as various confounding factors may weaken the comparison. However, factors such as a larger surgical faculty and appropriate support staff, including anesthesiologists and registered nurses; more operating rooms; and the infrastructure to conduct all preoperative testing at 1 facility suggests that high-volume academic centres in our study jurisdiction (Ontario) may have greater capacity and efficiency than low-volume community hospitals and are therefore able to achieve shorter wait times.

We found considerable variation in median wait times by geographical region. Overall, 86% of hospital admissions for colon cancer surgery took place within the regions of the patients’ residence at the time of diagnosis, with wide variations among regions. Regions with the lowest median wait times were located in heavily urbanized areas. There was also significant crossover between regional boundaries for colon cancer surgery in urbanized areas, such that more than 16% of residents crossed into adjacent regions for surgery. Furthermore, up to 44% of patients travelled into one of these heavily populated, hospital-dense regions for colon cancer surgery. In contrast, the regions with the highest median surgical wait times were sparsely populated and spread across vast geographical areas. It may be more difficult for patients in these rural areas to travel large distances to a small number of hospitals (compared with highly urbanized hospital-dense regions in smaller geographical areas), and these rural areas do not have adjacent regions to share the demand for colon cancer surgery. This supports prior findings that use of health care services may reflect local availability of services, and differences among regions that do and do not provide care services is greater in areas where services are available, than low-volume community hospitals and are therefore able to achieve shorter wait times.

A concerning finding is that median wait times steadily increased during our study period. The median wait time was 25 days in 2002 and increased to 35 days by 2008. There were 6600 new cases of colon cancer in Ontario in 2002 compared with 8000 in 2008. The combination of an aging population and the success of colorectal cancer screening campaigns have likely both contributed to this rise in incidence. Unfortunately, it does not appear that the increase in the number of patients requiring colon cancer surgery has been met with an increase in surgical capacity to meet the demand.

Preoperative testing can add weeks to the delay to receiving cancer care within the current system. In response to these delays, diagnostic assessment programs (DAPs) have been established for rapid diagnosis of various cancers. These DAPs are characterized by facilitated access to comprehensive diagnostic services, multidisciplinary consultative expertise, patient information resources and psychosocial support. However, many DAPs are institution-based. Establishing guidelines for necessary preoperative workup on a regional level or devising navigational flow charts to avoid unnecessary tests in an effort to streamline the referral and processing system could increase efficiency and reduce not only the surgical wait time, but also services overused by physicians. Diagnostic assessment programs could include dedicated imaging slots and colonoscopy slots to ensure timely access, creating a central organizing/processing system of referrals. In addition to DAPs, dedicated hospital beds and operating room capacity protected from intake of patients requiring emergency surgery combined with optimized postoperative care pathways reduced surgical wait times for joint replacement surgery, such a strategy may produce similar results for other procedures, such as colon cancer surgery.

Our study was conducted using the date of surgical consultation to the date of surgery as a more patient-centred wait time definition. In Ontario, the decision to treat to the date of surgery is currently tracked to monitor and evaluate the association between system capacity and the demand for surgery to help plan for appropriate system capability. However, this method of tracking wait times does not account for the full wait that patients experience. The decision to treat date is often distinct from the date of diagnosis or the date of surgical consultation and follows the date after all necessary preoperative investigations are completed. Thus, it should not be influenced by any of the factors that we examined. Future directions may seek to shift the definition of wait times toward a more patient-centred metric. A shift toward administrative recording of the date when referral for symptoms occurs, or the date of positive screening test, is more representative of the starting point in the patient journey. Greater awareness and efforts to improve this time interval may in turn improve the patients’ overall satisfaction with their treatment journey and improve outcomes.

**CONCLUSION**

In this retrospective analysis of 10 223 patients, we found that the wait time for essential preoperative services and consultations significantly increased the wait time experienced by patients. Older age, rural address, treatment in low-volume hospital and year of diagnosis were also independent predictors of a longer wait time for colon cancer surgery. Identifying factors affecting wait times will be critical to targeted administrative interventions, especially...
in the jurisdiction we examined, as wait times for colon cancer surgery appear to be increasing over time.

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Competing interests: None declared.

Contributors: A. Gillis, A. Smith, C. Law and N.G. Coburn designed the study. A. Gillis and N.G. Coburn acquired the data, which all authors analyzed. M. Dixon wrote the article, which all authors reviewed and approved for publication.

References

Laparoscopic sleeve gastrectomy: perioperative outcomes, weight loss and impact on type 2 diabetes mellitus over 2 years

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Background: Laparoscopic sleeve gastrectomy (LSG) is an increasingly performed operation for morbid obesity worldwide. To date there has been limited experience in Canada. We report our intermediate results, assessing whether LSG can be safely performed at a Canadian academic teaching hospital and whether it is effective as a bariatric procedure and as metabolic therapy for type 2 diabetes mellitus.

Methods: We performed a retrospective review of all patients who underwent LSG at our institution from Sept. 1, 2007, to June 30, 2011.

Results: We included 166 patients (mean age 44 yr, 82% female) in our study. The mean preoperative body mass index was 49.61. At baseline, 87 (52%) patients had type 2 diabetes. For this subgroup, mean preoperative HbA1c and AC glucose were 7.6% and 8.3 mmol/L, respectively. The mean duration of surgery was 93 minutes. Major complications included 1 staple line leak (0.6%), and 2 patients required reintervention for bleeding (1.2%). The mean hospital stay was 2.6 days. Two patients required readmission (1.2%). Seven minor complications occurred (4%). Postoperative excess weight loss was 49.3% at 6 months, 54.2% at 12 months and 64.4% at 24 months. In the type 2 diabetes subgroup, resolution occurred in 78% and improvement in 7% of patients at 12 months.

Conclusion: Laparoscopic sleeve gastrectomy can be safely performed at Canadian teaching hospitals. It is effective both as a bariatric procedure and as a therapeutic intervention for type 2 diabetes mellitus.

Conteinte : La gastrectomie verticale par laparoscopie (GVL) est une intervention de plus en plus utilisée pour traiter l’obésité morbide partout dans le monde. À ce jour, au Canada, l’expérience en a été limitée. Nous faisons état de nos résultats intermédiaires et nous évaluons si la GVL peut être effectuée de manière sécuritaire dans un hôpital d’enseignement universitaire canadien et si elle est efficace en tant qu’intervention bariatrique et comme traitement métabolique du diabète de type 2.

Méthodes : Nous avons procédé à une revue rétrospective des dossiers de tous les patients qui ont subi une GVL dans notre établissement entre le 1er septembre 2007 et le 30 juin 2011.

Résultats : Nous avons ainsi inclus 166 patients (âge moyen 44 ans, 82 % de femmes) dans notre étude. L’indice de masse corporelle préopératoire moyen était de 49,61. Au départ, 87 patients (52 %) souffraient de diabète de type 2. Pour ce sous-groupe, l’HbA1c et la glycémie à jeun préopératoires moyennes étaient respectivement de 7,6 % et de 8,3 mmol/L. La durée moyenne de la chirurgie a été de 93 minutes. Les complications majeures ont inclus une fuite au niveau de la ligne d’agrafage (0,6 %) et on a dû réintervenir chez 2 patients en raison de saignements (1,2 %). Le séjour hospitalier moyen a été de 2,6 jours. Deux patients ont dû être réadmis (1,2 %). Sept complications mineures sont survenues (4 %). La perte de poids excédentaire postopératoire a été de 49,3 % à 6 mois, de 54,2 % à 12 mois et de 64,4 % à 24 mois. Dans le sous-groupe atteint de diabète de type 2, la résolution est survenue chez 78 % des patients et une amélioration, chez 7 % des patients à 12 mois.

Conclusion : La gastrectomie verticale par laparoscopie peut être effectuée de façon sécuritaire dans les hôpitaux universitaires canadiens. Il s’agit à la fois d’une intervention bariatrique et d’un traitement pour le diabète de type 2.
Sleeve gastrectomy was initially performed as the first part of a 2-step approach in superobese (body mass index [BMI] > 50) patients. Weight loss incurred from this procedure would facilitate a subsequent duodenal switch. Several groups, however, reported adequate, sustained weight loss following the sleeve. The ability to perform this procedure laparoscopically contributed to the enthusiasm for the sleeve gastrectomy as a final procedure for the treatment of morbid obesity.

Being a fairly novel procedure, laparoscopic sleeve gastrectomy (LSG) lacks long-term data, but short-term and intermediate results confirm its effectiveness at inducing and maintaining weight loss and addressing obesity-related comorbidities. Although infrequent, complications related to LSG — especially staple line leak — remain a concern.

In this paper we review our experience with LSG in terms of perioperative outcomes, weight loss and impact on type 2 diabetes mellitus over 24 months of postoperative follow-up.

METHODS

We retrospectively reviewed prospectively recorded data for all patients who underwent LSG at our academic teaching hospital between Sept. 1, 2007, and June 30, 2011. Patient age and sex, preoperative weight and BMI, fasting serum glucose and HbA1c, history of type 2 diabetes and previous abdominal surgeries were recorded. Perioperative data included duration of surgery, conversion to laparotomy; duration of hospital admission, early (within 30 days) and postoperatively) complications and readmission within 30 days. Postoperative percentage excess weight loss (%EWL) was recorded at 6, 12 and 24 months; %EWL was calculated as follows:

\[
\% \text{EWL} = \left( \frac{\text{weight loss} - \text{baseline excess weight}}{\text{baseline excess weight}} \right) \times 100
\]

Baseline excess weight = baseline weight – maximum ideal weight (X).

X was calculated using a BMI of 25, thus X = 25 × m².

For the subgroup of patients who had a diagnosis of type 2 diabetes at baseline, we recorded AC glucose, HbA1c and resolution or improvement of diabetes at follow-up. Resolution was defined as AC glucose below 5.6 mmol/L and HbA1c less than 6.5% with discontinuation of all hypoglycemic drugs, whereas improvement implied a decrease in the dose or number of hypoglycemic drugs required to control serum glucose.

Preoperative care

Patients underwent a standardized preoperative assessment, including complete history, physical examination and psychological evaluation. Further workup based on medical conditions or other risk factors for surgery and/or anesthesia was done appropriately. Selection criteria for weight loss surgery were based on guidelines provided by the American Association of Clinical Endocrinologists, The Obesity Society and the American Society for Metabolic and Bariatric Surgery. Patients with a BMI greater than 40 or a BMI greater than 35 with at least 1 obesity-related comorbidity were considered potential candidates. A large number of patients are waiting to be seen in our program, and all consultations were triaged. We selected patients such that 80% of incoming patients had type 2 diabetes. It was expected that all candidates would follow a supervised weight loss program, including moderate exercise and a high-protein, low-carbohydrate and low-fat diet, and that commitment to the program would be demonstrated by actual weight loss. Smokers were required to quit. Exclusion criteria were obesity related to a reversible endocrine disorder; drug or alcohol abuse; uncontrolled psychiatric illness; and lack of comprehension of risks, benefits, outcomes, alternatives and lifestyle changes required with bariatric surgery.

Surgery was performed by 1 of 2 surgeons (J.E. and D.K.), both experienced in bariatric surgery. The patient was positioned supine on the operating table with both arms abducted 90°. General anesthesia was induced and an endotracheal tube placed. An orogastric tube was inserted and appropriate prophylactic antibiotics administered. Sterile prep and draping of the abdomen was then done.

A standard 6-port technique was used. A pneumoperitoneum was established to a pressure of 15 mm Hg using CO₂ gas. After port placement the patient was placed in a reverse Trendelenburg position. A 10 mm 30° laparoscopic camera was used. A liver retractor was placed to elevate the left lobe of the liver. Starting approximately 5 cm proximal to the pylorus, the greater curvature of the stomach was mobilized by division of the gastrocolic and gastrosplenic ligaments using an ultrasonic dissector. This dissection was completed to the angle of His.

The orogastric tube was then exchanged for a 42-Fr bougie that was positioned along the lesser curvature of the stomach. Using the bougie as a guide, a gastric sleeve was constructed with sequential firings of a 60 mm laparoscopic stapler (Ethicon Endo-Surgery). The staple line commenced approximately 5 cm proximal to the pylorus and ended 1 cm lateral to the esophagogastric junction. Next, the bougie was removed and an esophagogastroduodenoscopy (EGD) performed. Obstruction was excluded and the staple line was inspected for bleeding and/or leaking. After EGD, the transected gastric specimen was retrieved.
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via a port site. This port site was closed at the sheath with an absorbable multifilament suture. Skin incisions were closed.

Postoperative care

Early ambulation was encouraged. Patients were allowed sips of water on postoperative day 1, and intravenous fluid was administered at a rate appropriate for weight. Opioid analgesia was kept to a minimum. Low molecular weight heparin was administered as deep vein thrombosis prophylaxis. All patients underwent a water soluble contrast study on postoperative day 1. With a leak ruled out, diet was advanced to clear fluids followed by soft food. Patients were discharged when oral intake was adequate, pain was well controlled and when independent mobilization reached the preoperative level. All patients attended a follow-up visit with the operating surgeon at 4–6 weeks postoperatively. Subsequent follow-up was done by a multidisciplinary team, including a nurse practitioner, dietician and psychologist, in the obesity clinic.

RESULTS

During the study period, 166 patients underwent LSG and completed 6-week follow-up; mean age was 44 ± 10 years, and 136 (82%) patients were female. Mean preoperative BMI was 49.61 ± 7. A total of 87 (52%) patients had a diagnosis of type 2 diabetes at baseline. For this subgroup, mean preoperative HbA1c and AC glucose were 7.6 ± 1.7% and 8.3 ± 2.9 mmol/L, respectively. In all, 105 (63%) patients had a history of abdominal surgery. Mean duration of surgery was 93 ± 33 minutes. One (0.6%) patient required conversion to laparotomy owing to intra-abdominal adhesions. Mean length of stay in hospital was 2.6 ± 0.8 days.

A total of 12 (7%) complications occurred within the first 30 postoperative days (Table 1). Minor complications included 3 (1.8%) superficial surgical site infections that all resolved with conservative management, 1 (0.6%) urinary tract infection that was managed with appropriate antibiotics, 2 (1.2%) cases of gluteal nerve neuropaxia that resolved spontaneously and 1 (0.6%) extrahepatic biliary obstruction that resolved after endoscopic retrograde cholangiopancreatography (ERCP) and sphincterotomy. The patient who was converted to laparotomy experienced superficial wound dehiscence that was managed conservatively. One (0.6%) patient required readmission for dehydration and electrolyte disturbances caused by intractable nausea and vomiting. Gastrointestinal obstruction was ruled out, and her symptoms subsided with conservative management.

All 166 patients completed the 6-week follow-up. Ninety-nine of 140 eligible patients attended 6-month postoperative follow-up (29% attrition rate). At 12 months the attrition rate was 47% (50 of 109), and at 24 months it was 73% (32 of 44). Eligibility refers to patients who were 2, 12 and 24 months postsurgery at the time of our study. Excess weight loss was 49.3 ± 13% at 6 months, 54.24 ± 19% at 12 months and 64.4 ± 31% at 24 months (Fig. 1). The type 2 diabetes subgroup consisted of 87 patients. Attrition rates were 23% (16 of 66) at 6 months, 48% (25 of 52) at 12 months and 89% (17 of 19) at 24 months. Mean HbA1c was 6.3 ± 1% at 6 months, 6.5 ± 1.2% at 12 months and 6.2 ± 0.5% at 24 months (Fig. 2).

<table>
<thead>
<tr>
<th>Table 1. Complications within the first 30 postoperative days after laparoscopic sleeve gastrectomy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complication</td>
</tr>
<tr>
<td>------------------------</td>
</tr>
<tr>
<td>Staple line leak</td>
</tr>
<tr>
<td>Bleeding</td>
</tr>
<tr>
<td>Sleeve stenosis</td>
</tr>
<tr>
<td>Death</td>
</tr>
<tr>
<td>Minor complications</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

Fig. 1. Percentage of excess weight loss over 24 months of postoperative follow-up.

Fig. 2. Decrease in HbA1c levels in patients with diabetes over 24 months of postoperative follow-up.
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glucose was 6.4 ± 2.2 mmol/L at 6 months, 6.9 ± 2.3 mmol/L at 12 months and 5.6 ± 0.7 mmol/L at 24 months (Fig. 3).

At 12-month follow-up, 21 (78%) patients with diabetes experienced resolution and 2 (7%) showed significant improvement of the disease.

DISCUSSION

Major bariatric-specific complications of LSG include staple line leak (2%), bleeding (1.2%), sleeve stenosis (0.6%) and death (0.19%). We had no sleeve stenosis or death in our series. Three (1.8%) patients underwent surgical reintervention. One (0.6%) patient presented with a staple line leak on postoperative day 7. She required laparoscopic drainage of an abscess and placement of a percutaneous drain. This resulted in a gastrotomy and fundus. We selectively clip or oversew staple material to decrease the risk of staple line bleeding. This technique would add considerably to the cost of the procedure and has not been our practice.

Several studies have confirmed the efficacy of LSG in inducing EWL and improving obesity-related comorbidities. We are aware of concerns with reporting weight loss as EWL using a BMI of 25 as maximum ideal weight, but our study population was a fairly homogeneous group. Excess weight loss is also commonly used, and we were therefore better able to compare our results with those in the published literature.

We recorded a mean EWL of 54.24% and 64.4% at 12 and 24 months postoperative follow-up, respectively. Weight loss started soon after surgery with a mean EWL of 49.3% at 6 months. The weight loss achieved by patients in this study is consistent with that reported in the literature.

Laparoscopic sleeve gastrectomy induces weight loss by several mechanisms. As a restrictive procedure, it limits food intake and leads to early satiety. There is compelling evidence of accelerated gastric emptying and increased small bowel transit time, leading to decreased nutrient absorption. Metabolic effects are attributed primarily to reduced production of ghrelin. This hormone is mainly secreted by X/A-like cells in the oxyntic glands in the gastric fundus, which is resected during an LSG. Ghrelin is orexigenic. It induces preprandial hunger and meal initiation and also contributes to long-term body weight regulation.

Selection criteria for weight loss surgery were based on guidelines provided by the American Association of Clinical Endocrinologists, The Obesity Society and the American Society for Metabolic and Bariatric Surgery. We do, however, have a large number of patients waiting to be seen in our program, and we triaged according to the severity of comorbidities and the probability of benefit. Eighty percent of the patients enrolled into the preoperative assessment phase had type 2 diabetes mellitus.

Diabetes resolved in 21 of 27 (78%) patients, and 2 (7%) showed significant improvement of their disease at 12-month postoperative follow-up. Leonetti and colleagues reported similar outcomes. Schauer and colleagues reported 37% resolution at 12-month follow-up in 18 patients with type 2 diabetes who underwent LSG. Resolution was defined as an HbA1c level of 6.0%, compared with 6.5% in our study. Improvement in type 2 diabetes often precedes any significant weight loss, and currently the specific mechanisms mediating the metabolic effects of LSG are still poorly understood. Several hypotheses have been presented, none of which is mutually exclusive. These include compromised secretion of ghrelin and stimulated levels of hindgut hormones.

Ghrelin blocks insulin secretion, stimulates secretion of insulin antagonists growth hormone and adrenocorticotropic hormone, suppresses production of the insulin sensitizing hormone adiponectin and blocks hepatic...
insulin signalling. Reduction in s-ghrelin levels, as seen post-LSG, would therefore have an antidiabetic effect. The hindgut theory states that stimulation of L cells by higher concentrations of undigested nutrients in the terminal ileum causes increased levels of glucagon-like peptide-1 and peptide YY. These incretins exert an antidiabetic effect by enhancing glucose dependent insulin secretion, suppressing glucagon secretion and increasing insulin sensitivity.\(^{20}\)

**Limitations**

The high attrition rates at 12- and 24-month follow-up are an important limitation to our study. Also, the retrospective study design does not allow for assessment of individual patients’ rationale for leaving the program, but many find travel to Halifax to attend the 1 regional clinic too arduous and choose alternative means for follow-up, including email and telephone. Only patients who returned to clinic and for whom objective BMI measurements and laboratory results were available were included in our study. Several measures aimed at improving follow-up rates have been instituted, including involving family physicians with an interest in bariatric medicine. Although still at an early stage, this seems to be a viable alternative for most patients.

In a multicentre observational study, younger age, higher expected BMI loss and lower goal BMI were identified as independent predictors of attrition for patients entering a weight management program.\(^{21}\) It is important to set realistic weight goals at an early stage and to be even more diligent in the follow-up of younger patients.

**Conclusion**

Laparoscopic sleeve gastrectomy can be performed safely at Canadian academic teaching hospitals with acceptable complication rates. While the attrition rate has to be borne in mind, our intermediate data suggest that LSG is an effective stand-alone bariatric procedure and that it has an important role as metabolic therapy for type 2 diabetes mellitus. Long-term data remain limited.

**Competing interests:** D. Klassen is a paid consultant and a hernia product advisory panel member at Ethicon Endo-Surgery Inc. and has received speaker fees for cadaveric laboratory sessions on hernia repair. J. Ellsmere is a consultant for Ethicon Endo-Surgery Inc. No other competing interests declared.

**Contributors:** M. Hoogerboord, S. Wiebe, T. Ransom and J. Ellsmere designed the study. M. Hoogerboord, S. Wiebe, D. Klassen, D. Lawlor and J. Ellsmere acquired the data, which M. Hoogerboord, S. Wiebe and J. Ellsmere analyzed. M. Hoogerboord and J. Ellsmere wrote the article, which all authors reviewed and approved for publication.

**References**

Endoscopic management of gastric band erosions: a 7-year series of 14 patients

Background: Intragastric band migration is an unusual but major complication of gastric banding. We review our experience with endoscopic removal of eroded gastric bands.

Methods: We retrospectively evaluated the cases of 110 morbidly obese patients who underwent adjustable gastric banding between 2005 and 2012 to identify those who experienced band erosion. To remove the migrated band, we used an endoscopic approach with a Gastric Band Cutter.

Results: Band or tube erosion occurred in 14 patients (12.7%). The median time interval from the initial gastric band placement to the diagnosis of band erosion was 32 (range 18–52) months. Upper abdominal pain, port site infection, loss of restriction and weight regain were the most common symptoms. We used the Gastric Band Cutter to remove the band endoscopically. It was able to cut the band successfully in all but 1 patient, in whom twisting of the cutting wire required conversion from endoscopy to laparotomy. In 2 patients, the band, after being cut, was locked in the gastric wall and required laparotomic removal. In 1 patient, we performed surgery for intragastric penetration of the connecting tube broken close to the band.

Conclusion: The Gastric Band Cutter was successful in dividing the band in all but 1 patient, although we could not always complete the procedure endoscopically. Endoscopic removal seems to be effective and safe for band erosion.

Contexte : La migration intragastrique de l’anneau est une complication rare, mais majeure du cerclage gastrique. Nous faisons le point sur notre expérience du retrait endoscopique des anneaux gastriques érodés.

Méthodes : Nous avons évalué de manière rétrospective le cas de 110 patients atteints d’obésité morbre qui ont subi un cerclage gastrique ajustable entre 2005 et 2012 afin de vérifier si les anneaux en place étaient érodés. Pour retirer les anneaux qui avaient migré, nous avons utilisé l’approche endoscopique et un dispositif pour sectionner l’anneau gastrique.

Résultats : L’anneau ou le tube s’est érodé chez 14 patients (12,7 %). L’intervalle médian entre la pose initiale de l’anneau gastrique et le diagnostic d’érosion a été de 32 (entre 18 et 52) mois. La douleur abdominale haute, l’infection du port d’accès, la diminution de la restriction et la reprise de poids ont été les symptômes les plus fréquents. Nous avons utilisé un dispositif pour sectionner l’anneau gastrique afin de retirer l’anneau par voie endoscopique. Le dispositif a permis de sectionner l’anneau avec succès chez tous les patients sauf 1 ; dans ce dernier cas, une torsion du fil à sectionner a nécessité la conversion de l’endoscopie en une laparotomie. Chez 2 patients, une fois sectionné, l’anneau est resté emprisonné dans la paroi gastrique et a nécessité une extraction laparotomique. Chez 1 patient, nous avons effectué une intervention chirurgicale en raison de la pénétration intragastrique de la tubulure de raccord sectionnée à proximité de l’anneau.

Conclusion : Le dispositif servant à sectionner l’anneau gastrique a bien fonctionné chez tous les patients sauf 1, même si les interventions n’ont pas toutes pu être entièrement réalisées par voie endoscopique. Le retrait endoscopique semble être une intervention efficace et sécuritaire dans les cas d’érosion de l’anneau.
Adjustable gastric banding has rapidly become the restrictive procedure of choice in bariatric surgery since its introduction in the early 1990s. The reasons for its success are related to the ability to obtain adequate weight loss without the need for gastric resection or modification of the anatomy of the stomach and intestine. The reversibility of the procedure and the ease of operating laparoscopically enable early discharge from hospital and a rapid recovery.

Despite these well-recognized results, some long-term complications may occur: most frequently pouch dilatation, port disconnection and intragastric band erosion and migration. Band migration occurs in 0.6% to 11% of patients within the first 2 postoperative years. Different hypotheses have been suggested to explain this complication: damage of the gastric wall during band implantation, infection of the band site, overfilling the band and abnormal reaction of the periprosthetic tissue to the presence of the band.

Different methods are used to remove the band, with the preferred methods involving a laparoscopic or laparotomic approach. An endoscopic approach with a device designed to cut the band (the Gastric Band Cutter, AMI) has been proposed, especially when the band has almost completely migrated into the stomach. In our study, we review our experience with endoscopic removal of eroded gastric bands using this special endoscopic instrumentation.

**METHODS**

We carried out a retrospective analysis of all 110 patients who underwent laparoscopic adjustable gastric banding (LAGB) in the General Surgery Unit of our hospital between January 2005 and January 2012 to identify those who experienced band erosion. Soft Gastric Bands (AMI) and the MiniMizer Extra adjustable gastric bands were used for gastric banding.

We gathered data on weight loss and symptoms from patients’ follow-up visits, and we contacted those who had not attended the 6-month follow-up by telephone to obtain this information. An evaluation with endoscopy was performed for symptomatic patients and those who regained weight. In total, 36 (32.7%) patients underwent gastroscopy. Endoscopic views of the migrated bands are represented in Figures 1 and 2.

To remove the migrated bands, we used an endoscopic approach with the Gastric Band Cutter (AMI; Fig. 3). The procedure always took place in an outpatient endoscopy unit with the patient under intravenous propofol sedation. First, the port was removed surgically under local anesthesia, and then the cutting wire of the device was introduced into the stomach through the working channel of a gastroscope, passed around the band visualized in the stomach, and retracted with the gastroscope. The upper ends of the wire were introduced into an external narrow metal tube and passed into the tourniquet of the handgrip. The metal tube (containing the cutting wire looped around the intragastric band) was passed through the esophagus to the stomach. By twisting the handle of the Gastric Band Cutter, the band was readily cut under direct vision by strangulation (Fig. 4) and was then extracted by gentle traction with the rest of the catheter through the mouth. Finally, the gastroscope was again introduced to check the integrity of the gastric wall. The next day, we administered Gastrografin to exclude any leak before discharging the patient.

The study was performed in accordance with the Declaration of Helsinki, and all participants provided written informed consent.
Band or tube erosion occurred in 14 of the 110 patients (12.7%). In these 14 patients (10 women, 4 men), the diagnosis of erosion was made at a median time interval of 32 (range 18–52) months after the operation. The mean preoperative body mass index (BMI) of patients with erosion was 45.3 ± 9.0; at the time of diagnosis of erosion, the mean BMI was 33.2 ± 8.9. The mean age at the time of diagnosis was 36.9 (range 22–55) years. The most common symptoms were epigastric pain (36%), weight regain (29%) and port site infection (29%).

We attempted endoscopic removal in 13 of 14 patients; the procedure was successful in 10 (77%) patients. The median duration of endoscopic removal of the gastric band was 25 (range 15–40) minutes. No complications were observed. All patients regained weight after discharge from the hospital.

Table 1 reports the type of band, the presenting symptoms, the maximum pressure of inflation, the time of diagnosis and the procedure and method used to remove the band in each of the 14 patients.

In 2 patients (no. 2 and 4), it was impossible to remove the bands after the endoscopic cutting because the bands were firmly fixed by adhesions and sutures outside the stomach. In these patients, the MiniMizer Extra adjustable gastric bands had been implanted by laparoscopy. This band has 10 elastic loops on the sides (5 on top and 5 on the bottom), which can be connected directly to the stomach. At least 2 more sutures had been placed anteriorly at the top side of the band and 2 more at the bottom side, through the loops during LAGB. We had to convert to open surgery to remove the bands.

A technical problem occurred in 1 patient (no. 11): the cutting wire, after being passed around the band and retracted, got twisted in the esophagus and was blocked in the area of the cardia, making it impossible to remove both the wire and the band. The procedure had to be converted to a laparotomy to remove them.

Two patients (no. 6 and 9) had histories of pregnancy after the LAGB, which could have led to band erosion.

In 1 patient (no. 13), the connecting tube penetrated into the stomach (Fig. 5). The gastric band could not be seen on an abdominal computed tomography (CT) scan (Figs. 6 and 7) or during laparoscopy in this patient. Only the port and catheter tubing could be extracted surgically. To our knowledge, this is the first case of a broken tube penetration into the stomach in the literature. In this patient, a CT scan of the abdomen (Figs. 6 and 7) showed that the port was in the normal position in the left upper abdominal quadrant and was connected with the tube, that the band was not found...
in the abdomen and that the connecting tube penetrated into the stomach at the level of the fundus.

DISCUSSION

Laparoscopic adjustable gastric banding is effective and safe, and good results are universally reported despite some complications.12–14 Band erosion is a long-term complication reported in several series.6,9,15 The presenting symptoms are nonspecific; in our patients, the most common symptoms were upper abdominal pain, port site infection and weight regain, which are in line with findings from other studies.16–18

According to the literature, band erosion after LAGB occurs in about 0.6%–11% of patients.4,5 In our study, 14 of 110 (12.7%) patients experienced band erosion and underwent gastroscopic or surgical removal of the band system. This rate of erosion is higher than that reported in previously published series. It is well known that there is a significant correlation between band erosion and surgeon experience. The annual risk of band erosion is much higher during the first 2 years of surgical practice than in subsequent years.16 Data from a systematic review of band erosion showed that the rate of erosion was as high as 17% in studies involving fewer than 100 patients and that the rate of erosion decreases over time.19 Therefore, it is possible

<table>
<thead>
<tr>
<th>Patient no.</th>
<th>Band type</th>
<th>Presenting symptoms</th>
<th>Pressure inflation</th>
<th>Time of diagnosis after surgery</th>
<th>Procedure and methods used to remove bands</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AMI Soft</td>
<td>Port site infection</td>
<td>9 mL saline</td>
<td>21 mo</td>
<td>Band removed with Gastric Band Cutter</td>
</tr>
<tr>
<td>2</td>
<td>MiniMizer</td>
<td>Port site infection</td>
<td>3 mL saline</td>
<td>24 mo</td>
<td>After being cut, the band was locked in the gastric wall and required removal by laparotomy</td>
</tr>
<tr>
<td>3</td>
<td>MiniMizer</td>
<td>Epigastric pain</td>
<td>4 mL saline</td>
<td>24 mo</td>
<td>Band removed with Gastric Band Cutter</td>
</tr>
<tr>
<td>4</td>
<td>MiniMizer</td>
<td>Port site infection</td>
<td>3 mL saline</td>
<td>18 mo</td>
<td>After being cut, the band was locked in the gastric wall and required removal by laparotomy</td>
</tr>
<tr>
<td>5</td>
<td>AMI Soft</td>
<td>Epigastric pain</td>
<td>7 mL saline</td>
<td>47 mo</td>
<td>Band removed with Gastric Band Cutter</td>
</tr>
<tr>
<td>6</td>
<td>AMI Soft</td>
<td>Dysphagia</td>
<td>6.5 mL saline</td>
<td>34 mo</td>
<td>Band removed with Gastric Band Cutter</td>
</tr>
<tr>
<td>7</td>
<td>AMI Soft</td>
<td>Weight regain</td>
<td>8 mL saline</td>
<td>24 mo</td>
<td>Band removed with Gastric Band Cutter</td>
</tr>
<tr>
<td>8</td>
<td>AMI Soft</td>
<td>Epigastric pain</td>
<td>4 mL saline</td>
<td>36 mo</td>
<td>Band removed with Gastric Band Cutter</td>
</tr>
<tr>
<td>9</td>
<td>AMI Soft</td>
<td>Weight regain</td>
<td>4 mL saline</td>
<td>27 mo</td>
<td>Band removed with Gastric Band Cutter</td>
</tr>
<tr>
<td>10</td>
<td>MiniMizer</td>
<td>Epigastric pain</td>
<td>5 mL saline</td>
<td>36 mo</td>
<td>Band removed with Gastric Band Cutter</td>
</tr>
<tr>
<td>11</td>
<td>MiniMizer</td>
<td>Weight regain</td>
<td>4 mL saline</td>
<td>40 mo</td>
<td>Twisting of the cutting wire required conversion from endoscopy to laparotomy</td>
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<tr>
<td>12</td>
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<td>Port site infection</td>
<td>10 mL saline</td>
<td>44 mo</td>
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</tr>
<tr>
<td>13</td>
<td>AMI Soft</td>
<td>Weight regain</td>
<td>10 mL saline</td>
<td>30 mo</td>
<td>Tube removed surgically for penetration into the stomach</td>
</tr>
<tr>
<td>14</td>
<td>MiniMizer</td>
<td>Epigastric pain</td>
<td>4 mL saline</td>
<td>52 mo</td>
<td>Band removed with Gastric Band Cutter</td>
</tr>
</tbody>
</table>

Fig. 5. Endoscopic views of intragastric migration of the connecting tube broken close to the gastric band.
that most of the patients with band erosions in our study underwent LAGB during the surgeon's learning phase.

The definite causes of band erosion have yet to be determined; much has been written about the causes and risk factors.\(^{19}\) Reports suggest that unrecognized intraoperative injury,\(^ {20}\) certain bands (e.g., the Vanguard)\(^ {20}\) and overfilling of the band\(^ {8,20}\) may predispose to erosion. In a study involving 454 patients, chronic overfilling of the band was defined as an increased filling volume of 10–12 mL.\(^ 9\) As such, overfilling may have explained the band erosion in some of our patients (no. 12 and 13). Also, port site infection has been reported to be the first symptom of erosion,\(^ {21}\) as seen in some of our patients (Table 1). Although 1 study (23 pregnancies in a series of 359 patients) reported that pregnancy after adjustable gastric banding was not associated with severe complications,\(^ {22}\) band migration after pregnancy has occurred in other studies,\(^ {24,25}\) and severe vomiting in early pregnancy has been hypothesized to be the cause of band migration.\(^ {21}\) Two of our patients (no. 6 and 9) had histories of pregnancy after the LAGB, but we do not know whether vomiting was the cause of migration in these women.

Although most bariatric surgeons agree that band erosion treatment includes removal of the affected band, no consensus exists among authors as to what would be the best method of removal. Some authors remove the band laparoscopically,\(^ {26,27}\) whereas others prefer endoscopic retrieval.\(^ {18}\) Some recent papers report a high success rate with an endoscopic approach for the removal of the migrated band.\(^ {28,29}\) Neto and colleagues\(^ {28}\) reported that endoscopic removal is possible for 85% of patients in the first session with a complication rate of 5.8%. Another study reported that endoscopic removal was attempted in 50 of 63 patients with band erosion, with a 92% success rate and a 10% complication rate.\(^ {29}\) A symptomatic pneumoperitoneum was the main complication reported in both studies. In our series, we removed the band endoscopically in 13 of 14 patients, with 3 patients requiring conversion to laparotomy. Our success rate was 77% in the single session with no complications.

In 1 patient, the endoscopic approach was not possible. In that patient, the connecting tube had been broken close to the band and penetrated into the stomach. We couldn't find the gastric band with abdominal CT or laparoscopy. Only the port and catheter tubing could be surgically extracted. In the other 13 patients, we used the endoscopic approach, but we were able to complete the procedure in only 10 of the patients. We converted to laparotomy in 3 patients: in 1 patient (no. 11) because the cutting wire twisted in the esophagus and was blocked in the stomach and in 2 patients (no. 2 and 4) because of the firmly fixed bands by adhesions and sutures outside the stomach. All patients in whom the endoscopic procedure was unsuccessful, had MiniMizer Extra adjustable gastric bands.

**CONCLUSION**

Endoscopic removal of a migrated band with the Gastric Band Cutter appears to be an effective and safe method for managing band erosion. It allows early discharge of patients and avoids an operation. Our experience indicates
that if a patient had a MiniMizer band implanted, the presence of perigastric sutures and adhesions around the band can make it difficult to remove it endoscopically.

**Competing interests:** None declared.

**Contributors:** U.B. Dogan and C. Yilmaz designed the study. M.S. Akin, S. Yalaki and A. Akova acquired the data, which U.B. Dogan analyzed. U.B. Dogan and M.S. Akin wrote the article, which all authors reviewed and approved for publication.

**References**


Distal revascularization and interval ligation (DRIL) procedure requires a long bypass for optimal inflow

Background: Distal revascularization and interval ligation (DRIL) is commonly used to treat ischemic steal syndrome caused by arteriovenous hemodialysis access and has been associated with good outcomes. However, the literature lacks technical details of a successful intervention. We tested the hypothesis that a brachial-level arteriovenous fistula (AVF) generates a zone of low arterial blood pressure in the brachial artery near the AVF origin.

Methods: We identified patients with ischemic steal syndrome caused by an AVF originating from the brachial artery level who were eligible for the DRIL procedure. All patients were studied with invasive pressure monitoring in the brachial artery at the time of digital subtraction angiography. We measured systolic, diastolic and mean arterial blood pressure at 5 cm intervals from a point in the arterial circulation 5 cm distal to the origin of the AVF and continuing proximally into the subclavian artery.

Results: Our series involved 10 patients with a mean age of 66.5 (range 53–81) years. Four patients were women and 8 had diabetes. All patients had grade 3 ischemic steal syndrome with ischemic rest pain and/or ischemic tissue loss. Mean systolic, diastolic and arterial pressures increased from the level of the AVF until central pressures were reached. Systolic blood pressure was significantly lower than central blood pressure until a level 20–25 cm proximal to the AVF.

Conclusion: The benefits of the DRIL procedure in alleviating ischemic steal syndrome associated with hemodialysis access are best achieved with a DRIL bypass for which inflow originates at least 20–25 cm proximal to the origin of the AVF.
undergoing hemodialysis,\textsuperscript{2,4} Clinically significant ischemic steal syndrome can be expected in 1\%–8\% of patients with this type of dialysis access, and risk factors include female sex, diabetes, age older than 60 years, multiple previous AVF access sites in the same extremity and use of the brachial artery for fistula inflow.\textsuperscript{12–18}

Several options are available for the treatment of ischemic steal secondary to AVF dialysis access. These include ligation of the fistula, which sacrifices the access site. Banding of the AVF can be performed to reduce fistula flow, but thrombosis of the access site is common after this treatment.\textsuperscript{9} Proximalization of arterial inflow (PAI) has been described and involves a graft to maintain patency of the AVF from a proximal inflow source.\textsuperscript{9} Revision using distal inflow (RUDI) involves a graft to move AVF inflow from the brachial artery to an inflow source 2–3 cm distal to the brachial trifurcation.\textsuperscript{10}

Distal revascularization and interval ligation (DRIL) was first described by Schanzer and colleagues\textsuperscript{11} and has become one of the more common operations to treat steal syndrome associated with dialysis access. The technique involves ligation of the brachial artery distal to the AVF inflow and revascularization of the distal arm with a bypass taken from a more proximal inflow source.\textsuperscript{11} Good outcomes following DRIL have been reported by many authors;\textsuperscript{11,16} however, technical factors associated with failure of the procedure have not been identified. Furthermore, details on operative technique, particularly the level of the bypass inflow, are often lacking. Many authors suggest that a short bypass, originating only a few centimetres proximal to the AVF may be adequate.\textsuperscript{11,13,16}

This study was undertaken to test the hypothesis that a brachial level AVF generates a zone of low arterial blood pressure in the brachial artery near the AVF origin. Such a zone of low pressure might extend over a distance within the brachial artery, suggesting that optimal inflow for the DRIL procedure should be taken at a more proximal level than previously recommended.

**METHODS**

The section of Vascular Surgery in the Regina Qu’Appelle Health Region is responsible for creation and maintenance of hemodialysis access for southern Saskatchewan’s hemodialysis program. Hemodialysis services operate from the Regina General Hospital and several satellite dialysis units in communities across the southern part of the province. In 2008, the program served 273 patients on long-term hemodialysis, of whom 70\% had an arteriovenous hemodialysis access, either with a native AVF or with an arteriovenous graft.

Any patient within the hemodialysis population with suspected ischemic steal syndrome secondary to an arteriovenous hemodialysis access is assessed by 1 of 3 vascular surgeons working in the Regina Qu’Appelle Health Region. After appropriate history and physical examination, patients with confirmed ischemic steal syndrome who are considered suitable candidates for the DRIL procedure are referred for catheter angiography of the affected extremity.

Between Apr. 1, 2004, and Oct. 31, 2011, patients with brachial level AVF and ischemic steal syndrome underwent digital subtraction angiography. In brief, each patient underwent transfemoral aortic arch angiography under local anesthesia followed by selective catheterization of the artery to the affected limb with an end-hole angiography catheter. After the acquisition of digital subtraction angiograms, with or without manual compression of the AVF, the catheter was advanced over a guidewire into the dominant artery of the forearm 5 cm distal to the AVF, and the pressure within the artery was electronically transduced with the AVF open. Systolic, diastolic and mean arterial blood pressures were recorded. The catheter tip was then pulled back to the brachial artery at the level of the AVF, and the pressure recording was repeated. Similarly, pressures were recorded at 5 cm intervals from the level of the AVF through the entire length of the brachial artery, into the subclavian artery proximal to the first rib.

Pressure readings were recorded in the patient’s hospital record and retrospectively abstracted, along with the patient’s clinical data (age, sex, presence of diabetes, type of hemodialysis access, time between AVF creation and the onset of ischemic symptoms). The grade of ischemia and the status of the arteries to the affected hand were also recorded, as recommended for current reporting standards.\textsuperscript{7}

We calculated the mean systolic, diastolic and arterial blood pressure for each measurement point in the brachial

<table>
<thead>
<tr>
<th>Table 1. Patient demographic and clinical characteristics</th>
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<tr>
<td>Patient</td>
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<tr>
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<td>3</td>
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</tbody>
</table>

AVF = arteriovenous fistula.
artery for the entire sample. We calculated 95% confidence intervals (CIs) for each average pressure. The study was approved by the Research Ethics Board of the Regina Qu’Appelle Health Region.

**RESULTS**

Ten patients with ischemic steal syndrome underwent angiography with pullback pressures in the affected extremity during the study period. Their demographic and clinical characteristics are shown in Table 1. Four patients (40%) were women. The mean age of all the patients was 66.5 (range 53–81) years. Eight patients (80%) had diabetes. Eight patients (80%) had autogenous brachial-cephalic upper arm direct access, and 2 had autogenous brachial-basilic upper arm transposition. The time between fistula creation and presentation with ischemic symptoms was recorded for 9 patients, with a mean interval of 10.2 (range 2–41) months.

All patients had grade 3 ischemic steal syndrome with ischemic rest pain and/or ischemic tissue loss. None had an arterial inflow obstruction proximal to the level of the AVF. Six (60%) had angiographically healthy vasculature distal to the AVF and preferential flow through a large arteriovenous anastomosis. Four (40%) had distal arterial occlusive disease in the forearm and hand in addition to a large arteriovenous anastomosis to account for their symptoms.

The results of arterial blood pressure measurements along the length of the brachial artery are shown in Figure 1. The graph shows the mean systolic, mean diastolic and average mean blood pressure and 95% CIs measured at 5 cm intervals beginning at a point in the arterial tree proximal to the arteriovenous anastomosis.

Of the 10 patients in this series, 3 requested ligation of the arteriovenous access and were converted to hemodialysis through tunnelled central venous catheters. Four patients declined further intervention. Of these 4 patients, 3 had ongoing ischemic rest pain or tissue loss at their last follow-up visit, and 1 patient improved spontaneously with no further ischemic symptoms at rest. All 4 of these patients had a functioning arteriovenous hemodialysis access at their last follow-up visit after angiography (5, 24, 36 and 40 mo, respectively).

Three of the patients in this series underwent DRIL with inflow from the axillary artery at the level of the axilla or at the proximal brachial artery at the level of the axillary fold. We used a reversed saphenous vein taken from the patient’s thigh as the conduit in 2 cases. In the patient who did not have an available saphenous vein (due to bilateral in situ vein bypasses of the legs), we used a 6 mm diameter, ring supported, heparin-bonded polytetrafluoroethylene (PTFE) graft (Propaten). All 3 patients had patency of the initial hemodialysis access and the DRIL bypass at the last follow-up visit after the DRIL procedure (7, 12 and 63 mo, respectively). All patients who underwent the DRIL procedure experienced relief of their ischemic hand symptoms.

**DISCUSSION**

Our results demonstrate a linear rise in arterial pressures over the length of the brachial artery proximal to the AVF. This would be expected from the Hagen–Poiseuille equation, which relates the pressure change in a vessel linearly to the length of the vessel and inversely to the fourth power of its radius. Solved for pressure, the equation is

$$\Delta P = \frac{8Q\eta}{\pi r^4},$$

where $\Delta P$ is the change in pressure in the brachial artery between the AVF origin and the pressure measurement point, $Q$ is the blood flow through the artery, $\eta$ is the viscosity of blood, $r$ is the radius of the brachial artery and $l$ is the length of the arterial segment from the measurement point to the origin of the AVF.

The blood flow in an extremity with a functioning AVF is divided between 2 circuits with a common inflow. Blood enters either into the distal arteries, providing nutrient flow to the tissues, or into the AVF. Nutrient blood flow is in a circuit with high vascular resistance, maintained by vascular tone in the precapillary arterioles. Additional resistance to blood flow may be encountered in the presence of distal atherosclerotic occlusive disease. Nutrient blood flow depends on adequate perfusion pressure to overcome the resistance. Within the AVF, the vascular resistance is low and primarily determined by the radius of the narrowest point in the AVF or the length of the AVF flow circuit, as shown by the Hagen–Poiseuille equation. Proximally, the 2 flow circuits have a common inflow and, at the point of divergence, a common pressure.

The DRIL procedure moves the divergent point between nutrient flow and AVF flow proximally on the brachial artery to afford the tissues a higher perfusion pressure. Our data show such higher perfusion pressures are not reliably reached until a distance of more than 20–25 cm proximal to the AVF.

![Fig. 1. Mean systolic, mean diastolic and average mean blood pressure measured at each point in the brachial arteries of 10 patients with ischemic steal syndrome associated with an arteriovenous fistula for dialysis access, with 95% confidence intervals.](image-url)
Only at this distance does the lengthened AVF circuit have enough resistance to maintain adequate pressure in the brachial artery. The concept that lengthening the AVF circuit increases the arterial pressure available for tissue perfusion is consistent with the work of Illig and colleagues, who noted that the topologic outcome of the DRIL procedure is to lengthen the AVF circuit. A similar mechanism of circuit lengthening may underlie the efficacy of the PAI procedure.

Our results corroborate those of a recent study with similar methodology, in which the authors also identified a zone of low pressure in association with a stealing AVF. As with our results, those of Reifsnyder and Arnaoutakis show a gradual rise in arterial pressures transduced in the brachial, axillary and subclavian arteries proximal to a stealing AVF. These authors noted that in only 2 of 9 patients did the brachial arterial pressure rise to adequate levels within the first 5 cm proximal to the AVF. In the remaining 7 patients, the authors observed a gradual rise in blood pressure into the axillary and subclavian arteries. They concluded that optimal inflow requires a DRIL bypass to originate more proximally than previously suggested.

Our study contributes data from an additional 10 patients with ischemic steal syndrome that are reported at fixed distances in relation to the AVF. The pressure data of Reifsnyder and Arnaoutakis are given at relative anatomic locations, such as “mid-brachial” and “proximal brachial.” Like them, we found that the zone of low arterial pressure within the brachial artery extends for a length proximal to the stealing AVF. Our calibrated measurements permit the correlation of the observed pressures with the physical laws governing the applicable hemodynamics.

In our own practice, we use inflow for the DRIL procedure from the third part of the axillary artery within the axilla or from the brachial artery near the anterior axillary fold. In all patients with long limbs, we use inflow from the brachial artery in the proximal third of the upper arm in order to maintain an inflow source 20–25 cm proximal to the AVF.

Our preferred conduit is a reversed saphenous vein harvested from the thigh. Because of the need for a high-pressure proximal inflow source, this mandates the harvest of an adequate length of conduit. Compared with the practice of performing only a short DRIL bypass, our practice of a long DRIL bypass means a more extensive thigh dissection and potentially increased risk of thigh wound complications. In the situation of an unavailable saphenous vein conduit, we have successfully used heparin-bonded PTFE for the DRIL procedure.

**CONCLUSION**

Maximization of the benefits of the DRIL procedure mandate inflow to the DRIL bypass at a proximal level at least 20–25 cm proximal to the AVF.

**References**

Hepatic parenchymal preserving technique in the management of diffuse bilateral neuroendocrine tumour liver metastases: a feasible approach

Background: Aggressive surgical resection of neuroendocrine tumour liver metastases (NET-LM) is associated with symptomatic relief. Debunking up to 90% of tumour burden, even with positive margins, may be beneficial. However, patients with diffuse hepatic metastases may not qualify for resection owing to associated insufficient remnant liver parenchyma. The purpose of this study is to describe an early experience with a hepatic parenchymal preserving (HPP) approach.

Methods: We retrospectively reviewed our institutional neuroendocrine tumours database to identify patients with NET-LM, including symptomatic patients with extensive bilobar involvement, who underwent virtual volumetric assessment (VVA) combined with HPP resection between October 2008 and July 2011.

Results: Our study involved 9 patients. The median number of liver metastases resected was 10 (range 4–50). Symptomatic improvement was observed in all patients. Immediate postoperative normalization of 5-HIAA 24-hour urine levels occurred in 89% of patients. Symptomatic and biochemical response remained stable or improved in 75% of patients at 12 months of follow-up. Four patients had postoperative complications. There was no 90-day mortality.

Conclusion: The described HPP approach is feasible and safe. Most patients experienced symptomatic and biochemical improvement. This reproducible approach could expand surgical resection options for patients with NET-LM and diffuse bilobar involvement.

Contexte: La résection chirurgicale radicale des métastases hépatiques des tumeurs neuroendocrines procure un soulagement des symptômes. La résection d’une portion du fardeau tumorial allant jusqu’à 90 %, même en présence de marges positives, peut être bénéfique. Toutefois, les patients porteurs de métastases hépatiques diffuses ne seront pas toujours de bons candidats à la résection parce que leur parenchyme hépatique résiduel ne sera pas suffisant. Le but de cette étude est de décrire une première expérience avec une approche de préservation du parenchyme hépatique (PPH).

Méthodes : Nous avons passé en revue de manière rétrospective la base de données de notre établissement sur les tumeurs neuroendocrines afin de recenser les patients porteurs de métastases hépatiques, y compris les patients symptomatiques présentant une atteinte bilobaire importante qui ont subi une évaluation volumétrique virtuelle en lien avec une résection de type PPH entre octobre 2008 et juillet 2011.

Résultats : Notre étude a regroupé 9 patients. Le nombre médian de métastases hépatiques réséquées a été de 10 (entre 4 et 50). On a observé une amélioration des symptômes chez tous les patients. Une normalisation postopératoire immédiate des taux urinaires de 5-HIAA sur 24 heures a été observée chez 89 % des patients. La réponse symptomatique et biochimique est demeurée stable ou s’était améliorée chez 75 % des patients au 12e mois de suivi. Quatre patients ont présenté des complications postopératoires. On n’a déploré aucun décès dans les 90 jours.

Conclusion : L’approche par PPH décrite ici est faisable et sécuritaire. La plupart des patients ont présenté une amélioration symptomatique et biochimique. Cette approche reproductible pourrait s’ajouter aux options de résection chirurgicale chez les patients qui présentent des métastases hépatiques de tumeurs neuroendocrines et une atteinte bilobaire diffuse.
Neuroendocrine tumours (NET) represent a diverse set of cancers with heterogeneous behaviour. Metastatic disease at presentation is documented in 30%–90% of patients, occurring more frequently in those with pancreatic and intestinal NET.1 Neuroendocrine tumours of gastrointestinal origin often metastasize to the liver and can be symptomatic as a result of carcinoïd syndrome. Although they are often thought of as slow-growing tumours, once they have metastasized to the liver, if untreated, they have a 30%–40% 5-year survival.2

Systemic chemotherapy has been generally ineffective in the treatment of neuroendocrine liver metastases of non-pancreatic origin.1 However, for unresectable or metastatic pancreatic NET, directed therapies, such as everolimus, an m-TOR inhibitor, and sunitinib, a tyrosine kinase inhibitor, have been found to increase progression-free survival.3–5 The effect of these agents in NET of nonpancreatic origin has yet to be demonstrated. Somatostatin receptor analogues (SSAs) are also beneficial for the treatment of patients with metastatic disease, but do not provide long-lasting benefits in all patients.6 In addition, the main benefit from SSAs in delaying tumour progression occurs in patients with less than 10% liver replacement.7 Surgical resection combined with SSA for symptomatic control has been the mainstay of treatment for neuroendocrine tumour liver metastases (NET-LM) when feasible.

Given the rarity of the disease and its slow progression, there has been controversy and lack of a standard definition for the potential and optimal surgical treatments available. Surgical management for NET-LM can be divided into potentially curative or palliative resections based on the burden of disease. Potential curative intent refers to a complete resection of all gross disease confined to the liver with microscopically negative margins (R0). Curative resections have generally been accomplished with resection of the primary, lymphadenectomy, formal anatomic liver resections and/or nonanatomic wedge resections.8–10 The resections may also be performed with transarterial embolization (TAE), transarterial chemoembolization (TACE) or radiofrequency ablation (RFA) as adjuncts.10,11 The latest European Neuroendocrine Tumor Society (ENETS) Consensus Guidelines support the use of such resections for metastatic disease confined to a single lobe or adjacent segments, or in cases where a single lobe is the location of the majority of the tumour burden with smaller sites of disease involving the other lobe.10 However, the guidelines also state that diffuse, multifocal liver metastases should not be treated surgically with curative intent. In addition, although improved survival has been demonstrated when resections have been completed with a curative intent, up to 75% of the patients will have a recurrence at 5 years.12

The palliative approach refers to debulking for symptom and/or tumour control, with at least 90% of the tumour burden being removed in order to achieve this goal, according to some authors.13 Palliative resections, like resections for curative intent, have consisted of anatomic or nonanatomic resections in an effort to remove as much gross disease as possible. There is lack of consensus as to the timing and extent of surgery that should be undertaken and to what outcome. Symptomatic relief has been accepted as a reasonable goal of surgical intervention, but this approach is limited in some patients who have extensive liver involvement.

The aim of this study was to describe our early experience with a hepatic parenchymal preserving (HPP) approach that could expand surgical resection options for symptomatic patients with NET-LM and diffuse bilobar involvement.

**Methods**

We performed a retrospective review of the prospectively collected Sunnybrook Health Sciences Centre’s neuroendocrine tumours database to identify patients with NET-LM who underwent an HPP approach between October 2008 and July 2011. We reviewed their electronic medical records, imaging reports, pathology reports and clinic notes. Data were collected pertaining to patient demographic characteristics, site of the primary tumour, pathology, symptoms, chromogranin A (CgA) and 5-hydroxyindoleacetic acid (5-HIAA) 24-hour urine levels, number and size of hepatic metastases, operative management and perioperative morbidity and mortality.

Consideration for the HPP approach was given to symptomatic patients with extensive bilobar hepatic metastases. The intent of the surgical intervention in all patients was palliative. The extent of resection was determined based on preoperative magnetic resonance imaging (MRI) or computed tomography (CT), intraoperative clinical assessment and/or intraoperative ultrasonography. The goal was to remove at least 90% of the liver tumour burden, based on preoperative imaging modalities, in order to achieve symptomatic improvement.

The preoperative workup for all patients included a focused history and physical examination, blood work, including CgA, 5-HIAA 24-hour urine levels, and CT or MRI of the chest, abdomen and pelvis. At our institution, it is not routine practice to evaluate patients with octreotide scans. Data pertaining to preoperative assessment were also collected in a retrospective manner.

Patients were selected for the HPP approach if they were symptomatic secondary to diffuse, bilobar liver metastases and if they were not candidates for standard resections. In accordance with the ENETS Consensus Guidelines, patients with liver metastases confined to 1 lobe or adjacent segments underwent standard anatomic resections. Similarly, patients with either 1 lobe primarily affected but with contralateral or deep satellite lesions were considered for TAE, with or without anatomic resection(s). Radiofrequency ablation was not used in this patient population given the large burden of disease that would
necessitate repeated treatments, with treatments limited by tumour size and proximity to vital structures. Our proposed approach encompassed HPP resections in combination with perioperative virtual volumetric assessment (VVA). The HPP procedure consisted of multiple enucleations for lesions in the liver parenchyma combined with wedge resections and nonanatomic and anatomic resections in order to remove at least 90% of the disease burden while simultaneously sparing a remnant liver parenchyma of greater than 30%. We used a technique that involved the identification of a peritumoural plane in which direct blood vessels and parenchyma adherent to the tumour were ligated with the application of a collagen sealing device, resulting in complete, gross enucleation with maximal preservation of the surrounding parenchyma. By identifying a peritumoural plane, the lesions were separated and extracted from the adjacent parenchyma. This allowed the surrounding parenchyma to remain relatively intact, such that both superficial and deep lesions could be accessed and resected with minimal surrounding trauma. The identification of deep lesions was guided by intraoperative ultrasonography. Retrospectively, VVA was performed on patients’ CT scans or MRIs by a single radiologist (L.M.). The segmentation was performed using the GE workstation volumeShare 2 (GE Healthcare). Multiple techniques of segmentation were applied. First, liver contours were drawn on the 3-dimensional volume and segmented. The value of the total liver volume, including metastases, was saved and recorded. Then, a threshold technique was performed on the liver volume obtained, allowing the segmentation of the tumours from the liver parenchyma. If available, MRI was preferred for the segmentation due to the higher lesion to parenchyma contrast ratio. A threshold technique was favoured over a manual segmentation of the metastases because the lesions were too numerous and were located diffusely throughout the liver parenchyma. The distribution and characteristics of the lesions did not allow the radiologist to perform a classic standardized future liver remnant volumetric analysis. At the end of the process, the volume of the liver, excluding the metastases, was obtained. To ensure accuracy, reverse processing was performed to assess the tumour volume. The ratio of total liver volume minus metastases over total liver volume yielded estimates of perioperative parenchymal preservation expected with the HPP procedure. Similar measurements were performed on postoperative imaging to determine residual disease and remaining liver parenchyma. The overall process required approximately 20 minutes per patient to complete.

The study was approved by the Sunnybrook Health Sciences Centre Review Ethics Board.

RESULTS

We identified 9 patients who underwent HPP during our study period: 5 women and 4 men. Patient demographics, tumour and resection characteristics and outcomes are described in Table 1. The HPP approach is shown in Figures 1 and 2.

Symptomatic response

Symptoms were subjectively reported based on detailed questioning of patients at preoperative and follow-up appointments. All patients reported being symptomatic preoperatively and were not experiencing a response to increasing SSA doses. Seven patients reported experiencing

Table 1. Patient demographic characteristics, characteristics of primary tumour and liver metastases, perioperative management and findings, and postoperative outcomes of patients undergoing the hepatic parenchymal preserving approach for neuroendocrine tumour liver metastases

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>% of patients*</th>
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<tbody>
<tr>
<td>Sex, male:female</td>
<td>44.4:55.6</td>
</tr>
<tr>
<td>Age, median (range) yr</td>
<td>60 (39–69)</td>
</tr>
<tr>
<td>Primary tumour location</td>
<td></td>
</tr>
<tr>
<td>Jejunumileo</td>
<td>77.8</td>
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<tr>
<td>Appendix</td>
<td>11.1</td>
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<tr>
<td>Lung</td>
<td>11.1</td>
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<td>Ki-67</td>
<td></td>
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<tr>
<td>&lt; 2%</td>
<td>66.7</td>
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<tr>
<td>2%–20%</td>
<td>22.2</td>
</tr>
<tr>
<td>&gt; 20%</td>
<td>11.1</td>
</tr>
<tr>
<td>Metastatic presentation</td>
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<tr>
<td>Synchronous</td>
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<tr>
<td>Metachronous</td>
<td>55.6</td>
</tr>
<tr>
<td>Extrahepatic metastatic disease</td>
<td>44.4</td>
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<tr>
<td>Preoperative treatment</td>
<td></td>
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<td>Somatostatin receptor analogue</td>
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</tr>
<tr>
<td>Preoperative use</td>
<td>100</td>
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<tr>
<td>Duration of use, median (range) mo</td>
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<tr>
<td>Systemic chemotherapy (cisplatin/etoposide)</td>
<td>22.2</td>
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<tr>
<td>Transarterial embolization</td>
<td>11.1</td>
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<tr>
<td>Intraoperative</td>
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<tr>
<td>Size of largest liver metastasis resected, median (range) cm</td>
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<tr>
<td>No. of liver metastases resected, median (range)</td>
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<tr>
<td>Positive lymph nodes</td>
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<td>R1 margins</td>
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<td>Postoperative outcomes</td>
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<td>Initial postoperative period</td>
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<td>Follow-up, 6 mo</td>
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<td>Follow-up, 12 mo</td>
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<td>Follow-up duration, median (range) mo</td>
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<td>Complications</td>
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</tr>
<tr>
<td>Clostridium difficile infection</td>
<td>11.1</td>
</tr>
<tr>
<td>90-day mortality</td>
<td>0</td>
</tr>
</tbody>
</table>

*Unless otherwise indicated.
flushing, 8 patients had diarrhea, 3 patients experienced cramping or abdominal pain and 1 patient reported fatigue. Four patients described complete resolution of all their symptoms, and the remaining 5 patients reported overall improvement in their symptoms following surgery. At 6- and 12-month follow-up intervals, 6 of 8 patients reported improvement or stability in their symptoms.

**Biochemical response**

All patients had CgA levels and 8 patients had 5-HIAA 24-hour urine levels measured preoperatively. Perioperative CgA and 5-HIAA 24-hour urine levels are shown in Figures 3 and 4.

**Virtual volumetric assessment**

Retrospective VVA performed on preoperative imaging revealed up to 35.7% liver replacement, with a median of 8.4% (range 0.8%-35.7%) of the total liver volume replaced by metastatic disease. All patients who had preoperative imaging and were amenable to VVA (9 patients) had at least 72.5% parenchymal preservation. The median preoperative to postoperative parenchymal preservation was 103.3% (range 72.5%-154.6%). Six of the patients with complete parenchymal preservation had a greater volume of liver parenchyma postoperatively. On postoperative VVA, only 2 patients had residual disease, while 7 patients had no detectable disease on imaging.

**Outcomes**

Operative complications were observed in 4 patients and included 4 intra-abdominal collections managed successfully with percutaneous drainage. Two of the patients with collections presented after discharge and required readmission for 2–3 days to facilitate drain placement. Other complications included a urinary tract infection and *Clostridium difficile* infection. According to the Clavien–Dindo classification of surgical complications, there were 4 grade IIIa and 2 grade II complications.

**Discussion**

Patients with carcinoid syndrome as a result of neuroendocrine tumour liver metastases can be debilitated by the resultant flushing, diarrhea or abdominal pain. Debulking up to 90% of tumour burden, even with positive margins, has been shown to be beneficial for symptom relief.

In the present study, 9 patients were identified who did not meet criteria for standard resections owing to the diffuse nature of their liver metastases but who were increasingly symptomatic, despite systemic therapies, secondary to their disease burden. While standard resections may be
beneficial in debulking some of their disease, it would have been unlikely to meet a target of removing at least 90% of the liver metastases while preserving an adequate amount of normal liver parenchyma. An HPP approach was undertaken in these patients with a primary goal of symptomatic relief. A parenchymal-sparing technique has been described previously for the management of primary pancreatic neuroendocrine tumours, but not in the management of neuroendocrine tumour hepatic metastases. The patients in the present study represent a highly selected group of symptomatic patients who were not candidates for standard anatomic liver resections and in whom ablative or embolization techniques alone would not have provided adequate symptomatic control given the extensive number of liver metastases present. The HPP approach is aimed at such patients, who represent a gap in the management strategies currently available.

Given the characteristics of HPP resections, not surprisingly, positive margins on pathologic assessment were reported for all patients. While it is necessary to obtain negative margins in curative resections of other liver metastases, such as colorectal carcinomas, the impact of margin status in NET-LM is unclear. The heterogeneous behaviour of NET in some patients may allow for potential symptomatic benefit from liver resections, even with positive margins, for diffuse multifocal liver metastases as long as sufficient liver parenchyma is preserved.

Palliative resections have been shown to be beneficial for symptomatic relief for NET-LM. All of the patients who underwent the HPP approach proposed here experienced
improvement in their symptoms; 4 patients experienced complete resolution of their symptoms in the immediate postoperative period. Que and colleagues found that although symptomatic improvement was similar between resections for curative and palliative intent, patients who underwent palliative resections had earlier symptomatic recurrence. It was not unexpected that debulking procedures resulted in early symptomatic recurrence; however, in the present study longer follow-up was required to determine the mean time to symptomatic recurrence.

Biochemical markers of neuroendocrine tumours were also assessed in the present study. Chromogranin A levels were generally not improved by HPP resection, as 5 patients had elevated CgA levels postoperatively. However, CgA did not appear to correlate with symptom control. Woltering and colleagues found that while CgA levels may reflect tumour differentiation and tumour burden, the levels were inversely related to symptom control post-treatment. Although many patients had increased CgA levels following HPP resection, this did not appear to alter the primary outcome of symptomatic relief. Most patients with elevated 5-HIAA 24-hour urine levels measured perioperatively demonstrated normalization of their levels up to 12 months later. This suggests that, similar to standard complete resections for NET-LM, the proposed HPP approach is associated with biochemical improvement postoperatively. Given the symptomatic improvements postoperatively, it is not surprising that 5-HIAA, a breakdown product of serotonin, shows a similar improvement. Elevated 5-HIAA levels are also associated with an increased risk of carcinoid heart disease. Therefore, improvements in 5-HIAA levels following the HPP approach may alter the natural history of such heart disease. Longer follow-up is necessary to determine the durability of this biochemical improvement, but this technique appears promising.

Virtual volumetric assessment was described in this study as a potential adjunct to the HPP resection. Volumetrics are routinely used to calculate the amount of future liver remnant (FLR) following anatomic resections. However, standard volumetrics are not applicable for non-anatomic resections since they incorporate the amount of normal liver parenchyma that will be removed based on anatomic landmarks. While the amount of liver replacement calculated by VVA in the present study appears quite low, it would be much higher in the described patients if standard liver remnant calculations and resections had been undertaken, such that they would not have been eligible for such approaches. It appears as though there was relatively rapid hepatic growth given that several patients had an increase in their postoperative parenchymal volumes. The liver has the unique ability to regenerate following surgery or injury, with normal liver weight being obtained 8–15 days following partial hepatectomy in humans. However, this finding may also be attributed to differences in calculations between perioperative images or to the timing of the imaging, given the retrospective nature of the study. This imaging technique was described and used to assess the total liver volume compared with the tumour burden to provide estimates of the remaining liver parenchyma in the setting of the HPP approach. Virtual volumetric assessment appears to be a feasible approach for the assessment of patients undergoing HPP resections, but validation of the technique in the context of HPP resections needs to be undertaken. For further assessment and validation of the HPP approach, VVA could be facilitated by the use of MRI with gadolinium ethoxybenzyl dimeglumine (Bayer HealthCare Pharmaceuticals Inc.) preoperatively. In addition, Ribero and colleagues have described that calculations for total estimated liver volume that use body surface area provide more accurate FLR calculations.

Although the HPP approach is appropriate for patients with diffuse liver involvement, which may not be suitable for standard resections, one must still undertake the approach in a safe manner that allows resection of the majority of the tumour burden while maintaining adequate normal liver parenchyma. The HPP approach is suggested for preservation of liver parenchyma in the setting of bilobar disease that would otherwise require extensive resection of adjacent normal liver parenchyma, not for heroic measures.

**Limitations**

The present study is limited by its retrospective nature and small sample size. Future studies will aim to incorporate intraoperative outcome measures and objective symptomatic assessments. Despite these limitations, the results appear promising in this group of patients.

**Conclusion**

The described HPP approach offers symptom relief and improvement in biochemical parameters in the majority of patients studied. This is a reproducible approach that has the potential to expand surgical resection options for palliative intent for patients in whom systemic treatments or directed therapies have failed and who are increasingly symptomatic as a result of diffuse bilobar liver metastases. In addition, VVA may be used to guide selection and evaluation of such patients.

**Competing interests:** None declared.

**Contributors:** All authors designed the study and analyzed the data. A. Nadler, M. Cukier and L. Milot acquired the data. A. Nadler, M. Cukier and C.H. Law wrote the article, which all authors reviewed and approved for publication.

**References**


Implementation of an acute care emergency surgical service: a cost analysis from the surgeon’s perspective

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Background: Acute care surgical services provide comprehensive emergency general surgical care while potentially using health care resources more efficiently. We assessed the volume and distribution of emergency general surgery (EGS) procedures before and after the implementation of the Acute Care and Emergency Surgery Service (ACCESS) at a Canadian tertiary care hospital and its effect on surgeon billings.

Methods: This single-centre retrospective case–control study compared adult patients who underwent EGS procedures between July and December 2009 (pre-ACCESS), to those who had surgery between July and December 2010 (post-ACCESS). Case distribution was compared between day (7 am to 3 pm), evening (3 pm to 11 pm) and night (11 pm to 7 am). Frequencies were compared using the χ² test.

Results: Pre-ACCESS, 366 EGS procedures were performed: 24% during the day, 55% in the evening and 21% at night. Post-ACCESS, 463 operations were performed: 55% during the day, 36% in the evening and 9% at night. Reductions in night-time and evening EGS were 57% and 36%, respectively (p < 0.001). Total surgeon billings for operations pre- and post-ACCESS were $281 066 and $287 075, respectively: remuneration was $6008 higher post-ACCESS for an additional 97 cases (p = 0.003). Using cost-modelling analysis, post-ACCESS surgeon billing for appendectomies, segmental colectomies, laparotomies and cholecystectomies all declined by $67 190, $125 215, $66 362, and $84 913, respectively (p < 0.001).

Conclusion: Acute care surgical services have dramatically shifted EGS from nighttime to daytime. Cost-modelling analysis demonstrates that these services have cost-savings potential for the health care system without reducing overall surgeon billing.

Contexte : La mise sur pied d’un service d’urgences chirurgicales permet d’offrir des soins de chirurgie générale d’urgence complets, tout en assurant une utilisation potentiellement plus efficace des ressources en soins de santé. Nous avons évalué le volume et la distribution des interventions de chirurgie générale d’urgence (CGU) avant et après la mise sur pied d’un service de soins chirurgicaux d’urgence (SSCU) dans un hôpital de soins tertiaires canadien et mesuré son effet sur la facturation émise par les chirurgiens.

Méthodes : Cette étude rétrospective cas–témoins réalisée dans un seul centre a comparé des patients adultes soumis à des interventions de CGU entre juillet et décembre 2009 (pré-SSCU) à ceux qui avaient subi une intervention chirurgicale entre juillet et décembre 2010 (post-SSCU). Nous avons comparé la distribution des cas entre les quarts de jour (de 7 heures à 15 heures), de soir (de 15 heures à 23 heures) et de nuit (de 23 heures à 7 heures). Nous avons utilisé le test χ² pour comparer les fréquences.

Résultats : Pendant la période pré-SSCU, 366 interventions de CGU ont été effectuées : 24 % durant le jour, 55 % durant la soirée et 21 % durant la nuit. Après la mise en place du SSCU, 463 opérations ont été effectuées : 55 % durant le jour, 36 % durant la soirée et 9 % durant la nuit. Les réductions observées au plan des CGU réalisées durant la nuit et la soirée ont été de 57 % et 36 %, respectivement (p < 0.001). La facturation totale soumise par les chirurgiens pour les interventions réalisées avant et après la mise en place du SSCU a été respectivement de 281 066 $ et de 287 075 $ : la rémunération a été de 6008 $ supérieure après la mise en place du SSCU, pour 97 cas additionnels (p = 0.003). L’analyse de modélisation des coûts a révélé qu’après la mise en place du SSCU, la facturation soumise par les chirurgiens pour les appendicectomies, les colectomies segmentaires, les laparotomies et les cholecystectomies a diminué de 67 190 $, 125 215 $, 66 362 $ et 84 913 $, respectivement (p < 0.001).

Conclusion : Les services de soins chirurgicaux d’urgence ont considérablement modifié les interventions de CGU, les faisant passer des quarts de travail de nuit à ceux du jour. L’analyse de modélisation des coûts démontre que le SSCU recèle un potentiel d’économies pour le système de soins de santé sans réduire la facturation totale émise par les chirurgiens.
A cute surgical emergencies represent some of the most common reasons for hospital admission. Acute care surgery (ACS) can be defined as the urgent assessment and treatment of nontrauma general surgical emergencies in adults, with the intention of optimally treating intra-abdominal surgical crises. This includes a diverse number of conditions, such as acute appendicitis, cholecystitis, diverticulitis, pancreatitis, bowel obstruction, intestinal ischemia, intra-abdominal sepsis, incarcerated or strangulated hernias and perforated viscus. Establishing a separate service was justified provided necessarily increasing the overall general surgery operating volume. Until recently, the most common delivery model for the care of these patients revolved around a surgeon who was required to manage all surgical emergencies for a 12- to 24-hour interval while concurrently working within the demands of a scheduled clinical practice. This system has multiple limitations: interference with and required time away from a busy “scheduled” subspecialty practice, providing emergency surgery coverage throughout the night with the high likelihood of still needing to engage in patient care during a busy “post-call” day, and a potential lack of coordinated and current academic expertise within the specific focus of ACS. In response to these limitations, the concept of ACS has recently evolved in Canada.

The delivery of an ACS model requires a dedicated hospital-based service that provides comprehensive care for all general surgical emergencies over a defined period of time (usually 7-day intervals). The potential benefits of this approach to acute surgical care include predictable scheduling for busy surgeons, predictable administration of operating suite resources, improved patient access and potentially improved patient care. Overall cost savings can also be substantial because of a reduction in night-time operating and additional staffing requirements. Beginning in Halifax in 1997, a number of Canadian centres have naturally evolved into this model of providing emergent surgical care. As of 2011, there were 16 fully functioning ACS programs across Canada.

The Acute Care and Emergency Surgery Service (ACCESS) at Victoria Hospital in the London Health Sciences Centre (LHSC) was established in July 2010, when our Division of General Surgery recognized the growing need for organized emergency general surgery (EGS) coverage. Prior to the implementation of ACCESS, there was no structured system for performing EGS cases during the daytime. Emergency patients would usually have their operations in the evening or night, after the completion of a surgeon’s elective daytime caseload; alternatively, patients would stay in the hospital — sometimes for days — before a surgeon was able to perform an operation during the elective schedule. The goal of ACCESS, therefore, was to shift EGS night-time operating to the daytime, without necessarily increasing the overall general surgery operating volume. Establishing a separate service was justified provided that it had a defined scope of practice and would not materially affect the other divisions in the department of surgery.

Unfortunately, the academic advancement of the ACS concept, and therefore evidence-based improvements in outcomes after emergency surgical care, has been historically limited by an inability to capture and synthesize even basic patient data. The ability to improve patient outcomes through evidence-based research is particularly crucial because the emergency care of surgical patients is the common denominator among all general surgeons. Furthermore, there has been a historical absence of a dedicated group willing to advocate for evidence-based improvements in the care of those with general surgical emergencies.

Regardless of professional interests, clinical load or working environment, the list of general surgical emergencies is common to every general surgeon in Canada who participates in a call schedule. It also involves a patient cohort that is unique from subspecialty nonemergency patients from both a physiologic and surgical perspective. As a result, the emerging organization of ACS as a distinct entity is aimed at improving the care and experience of surgically ill patients in their most dire time of need. The purpose of this study was to evaluate the implementation of an ACS service in London, Ont., with attention to the volume and distribution of EGS cases, its economic viability on the basis of surgeon remuneration as well as its impact on hospital resources.

METHODS

All clinical activity reviewed occurred at Victoria Hospital in London, Ont., which serves as a regional level 1 trauma centre for Southwestern Ontario. Victoria Hospital also serves as one of the primary teaching hospitals for the Schulich School of Medicine and Dentistry at Western University. The primary clinical mission of ACCESS is to provide all general surgical coverage of the level 1 trauma centre, the inpatient and emergency department general surgical consults and the outpatient follow-up general surgery clinic for patients who receive surgery from or are assessed by ACCESS.

All 8 general surgeons at Victoria Hospital were involved with ACCESS during the study period. Division faculty members provided all on-call coverage in 7-day intervals, working from 8 am to 5 pm Monday–Thursday and working from 8 am Friday to 8 am the following Monday. Between 5 pm and 8 am on weeknights, all general surgeons participated in a rotating call schedule. Surgeons would suspend their elective practice while covering ACCESS, and their allotted weekly operating room (OR) time for elective cases (15 h) would be subsumed into the daily dedicated OR time for ACCESS. Funding for an additional 13 hours of operating time was provided by a one-time regional project grant to address long wait times in the emergency department. After the project year, funding continued to be provided by the hospital because ACCESS was such a successful program. Because of the high volume of cases at our tertiary-care trauma centre, 2 fully staffed ORs
continued to run between 6 pm and 11 pm, and 1 OR continued to run from 11 pm to 8 am. The distribution of OR time for ACCESS throughout the week was as follows: 7 hours each on Monday and Friday, 6 hours on Wednesday and 4 hours each on Tuesday and Thursday. During the weekends (8 am Saturday to 8 am Monday), there was no dedicated ACCESS OR time; all surgical specialties had an equal opportunity to book and perform operations based on their level of urgency. The ACCESS clinics were also scheduled twice weekly to follow patients who were managed by the service. Other care providers for ACCESS included senior and junior general surgery residents, nonsurgical residents, medical students and a nurse practitioner.

The Western University Department of Surgery includes approximately 82 other surgeons housed in 8 divisions, including general, vascular, plastic/reconstructive, cardiac, thoracic, urologic and pediatric surgery. The Division of General Surgery includes colorectal, hepatobiliary, transplant, surgical oncology, trauma and minimally invasive surgical specialists, many of whom practise primarily at Victoria Hospital. Other surgical practices at Victoria Hospital include vascular, thoracic, urologic, plastic, neurosurgery, orthopedic, anesthesiology and critical care services.

This was a single-centre, retrospective case–control study. The LHSC operative database was queried for all EGS procedures performed during the study periods (pre-ACCESS: July–December 2009; post-ACCESS: July–December 2010). Emergency procedures were defined as procedures booked on the nonelective operative list. All were booked according to their respective level of urgency: A (operation within 0–2 h), B (within 2–8 h), C1 (within 8–12 h) or C2 (within 12–48 h). We compared procedures before and after the implementation of ACCESS. We collected data only for general surgery patients from their electronic medical records. Operations initiated between 7 am and 3 pm were considered to be daytime surgeries, those performed between 3 pm and 11 pm were considered evening surgeries, and those performed between 11 pm and 7 am were considered night-time surgeries.

We compared continuous variables using the Mann–Whitney U test and categorical variables using $\chi^2$ or Fisher exact tests, as appropriate. We considered results to be significant at $p < 0.05$. To be included in our analysis, patients had to be 18 years of age or older and had to have undergone an emergency operative intervention at Victoria Hospital during the pre-ACCESS or post-ACCESS study periods. Exclusion criteria were age younger than 18 years, and surgery performed by the pediatric general surgical service at Victoria Hospital. We also excluded patients who underwent elective general surgery, defined as cases that were booked in regular operative time and did not present through the emergency department. We also excluded patients who were operated on as priority A cases on the assumption that these cases would go to the OR promptly regardless of time of day.

Surgeons working on ACCESS were paid by fee-for-service, regardless of the time of day, and did not receive any further stipends or alternative funding from the hospital. To perform cost-modelling analysis using the well-established $\chi^2$ method, we first calculated the average number of patients undergoing EGS operations per study period. Then, based on the observed distribution of EGS cases pre- and post-ACCESS, we calculated the corrected distribution of EGS cases for each timeframe using the Pearson $\chi^2$ statistic. Using billing codes obtained from the 2011 Ontario Health Insurance Plan (OHIP) Schedule of Benefits and applying the appropriate premiums for after-hours cases (50% of the procedural fee for evenings and 75% of the procedural fee for nights), we calculated remuneration for EGS procedures based on the corrected distributions to determine differences in billing cost for EGS operations pre- and post-ACCESS.

### RESULTS

Pre-ACCESS, 366 EGS procedures were performed: 24% occurred in the daytime, 55% occurred in the evening and 21% occurred at night-time (Table 1). Post-ACCESS, 463 EGS operations were conducted: 55% were performed in the daytime, 36% were performed in the evening and 9% were conducted at night. There was a 57% and 36% reduction in night-time and evening EGS operating, respectively ($\chi^2 = 86.51, p < 0.001$) post-ACCESS and a concomitant 132% increase in daytime EGS operations ($\chi^2 = 86.51, p < 0.001$).

The number of elective general surgery cases declined by 6.1% post-ACCESS, from 1061 to 996 cases, but this decrease was not significant ($\chi^2 = 2.19, p = 0.14$). The total number of general surgery cases (elective and emergent) also remained similar pre- and post-ACCESS (1427 v. 1459 cases, respectively, $\chi^2 = 2.19, p = 0.14$).

The number of emergent non–general surgery cases declined by 6% post-ACCESS (826 v. 877 cases pre-ACCESS), but this decrease was not significant ($\chi^2 = 2.60, p = 0.27$). The total number of non–general surgery cases also declined by 6% post-ACCESS (5159 v. 5472 cases).

<table>
<thead>
<tr>
<th>Case, time</th>
<th>Pre-ACCESS, no. (%)</th>
<th>Post-ACCESS, no. (%)</th>
<th>Difference, %</th>
<th>$p$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency</td>
<td></td>
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</tr>
<tr>
<td>Daytime</td>
<td>88 (24)</td>
<td>257 (55)</td>
<td>+132</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Evening</td>
<td>203 (55)</td>
<td>165 (36)</td>
<td>–38</td>
<td>&lt; 0.001</td>
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<tr>
<td>Night-time</td>
<td>75 (21)</td>
<td>41 (9)</td>
<td>–57</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Total</td>
<td>366</td>
<td>463</td>
<td>+27</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Elective</td>
<td>1061</td>
<td>996</td>
<td>–6</td>
<td>0.14</td>
</tr>
<tr>
<td>Total cases</td>
<td>1427</td>
<td>1459</td>
<td>+2</td>
<td>0.14</td>
</tr>
</tbody>
</table>

ACCESS = Acute Care and Emergency Surgical Service.
pre-ACCESS), but there was no statistical difference ($\chi^2 < 0.0001, p = 0.99$).

We reviewed EGS operations to identify the most common operations performed during the study periods (Appendix, Table S1, available at canjsurg.ca). The 4 most commonly performed operations pre- and post-ACCESS were laparotomy, appendectomy (laparoscopic or open), segmental colectomy and cholecystectomy (laparoscopic or open). While the proportion of laparotomies (29% v. 26% pre- and post-ACCESS, respectively), appendectomies (29% v. 26% pre- and post-ACCESS, respectively) and segmental colectomies (29% v. 26% pre- and post-ACCESS, respectively) were statistically unchanged ($p = 0.63$), the number of cholecystectomies increased significantly from 7% of all EGS surgeries pre-ACCESS to 16% post-ACCESS ($p = 0.001$).

Using the 2011 OHIP Schedule of Benefits, remuneration for performance of EGS operations pre- and post-ACCESS was calculated based on procedural codes (see the Appendix, Tables S2 and S3). After-hours premiums were applied to the operations based on the time of day during which they were performed. Total remuneration pre-ACCESS was $281,066 for 366 EGS procedures, and total remuneration post-ACCESS was $287,075 for 463 EGS procedures ($p = 0.003$). The average billing per case was $767.94 pre-ACCESS and $620.03 post-ACCESS ($p = 0.003$). To account for the difference in the number and distribution of EGS cases, the Pearson $\chi^2$ statistic of 86.51 was used. The corrected distribution of EGS cases for each timeframe in the pre- and post-ACCESS groups was then calculated (Table 2). The cost of performing only appendectomies, laparotomies, segmental colectomies, and cholecystectomies was then calculated to evaluate the difference in remuneration (Table 3). Remuneration for all 4 procedures was significantly reduced post-ACCESS ($\chi^2 = 52.9, p < 0.001$; Table 3).

**DISCUSSION**

Despite a growing consensus on the training requirements for acute care surgeons, the establishment of ACS practices has been much more varied. Several institutions have histories of ACS practices embedded in their medical staff structures, and in such cases the advent of ACS was little more than relabelling an existing professional model.1

At many institutions, the practice of trauma surgery and surgical critical care diverged from nontrauma general surgery into distinct clinical divisions and service lines with little clinical overlap among the other general surgical disciplines.6 In such instances, establishing an ACS service entailed either re-expansion of the trauma surgeon’s clinical and operative domain7,8 or the creation of an emergency surgery service that excluded care of trauma patients.9 In large community hospitals that do not serve as trauma centres, surgical hospitalist practices are emerging to meet the hospitals’ emergency surgery coverage needs. These later models tend not to include surgical critical care.

Our objective was to evaluate the implementation of an ACS service in an established academic surgical department at a university-affiliated teaching hospital. The general surgeons at our institution agreed to participate in ACCESS for several reasons: they would be provided with 28 hours of operating time per week, which was almost double their weekly allotted elective OR time; they would operate less at
night because most emergency cases could be performed during the subsequent day; they would have substantial control over their billing during ACCESS because they were paid by fee-for-service; and, most importantly, they would be able to focus on their elective practices and academic pursuits when they were not covering ACCESS. With respect to the latter, all EGS patients were admitted to ACCESS, even if they received surgery by an on-call surgeon in the evening or night-time, thereby reducing the inpatient load for all non-ACCESS surgeons. It is clear that implementing ACCESS has significantly shifted the distribution of EGS to the daytime (from 21% to 9% post-ACCESS for night-time cases, a reduction of 57%), which correlates with other studies from around the world. Britt and colleagues observed a decline in emergency procedures performed after 5:30 pm, from 44.6% to 30% after the implementation of an ACS service. Parasyn and colleagues demonstrated that emergency theatre use during the day increased from 57% to 69%, with an 11% reduction in acute care operating after hours (5 pm); furthermore, 26% fewer emergency cases were handled between midnight and 8 am. Sorelli and colleagues also observed a significant increase in daytime operating from 57% in 2004 to 74% in 2005, and a significant decline in after-hours operating from 43% to 26%. Because the beneficial effects of ACCESS on after-hours operating were almost immediate, surgeon satisfaction and, consequently, surgeon participation in ACCESS, remained excellent. While the trend of our data mirrors that of other centres, our data show a more significant reduction in after-hours operating likely because our daytime operating hours may be 1–2 hours shorter than in other centres (7 am to 3 pm instead of 8 am to 5 pm or 5:30 pm).

With daily dedicated OR resources, nonemergent but urgent cases that would otherwise have occurred at night-time are instead put on the board for the daytime. Although it was beyond the scope of our study to assess this, we feel such a strategy benefits health care delivery and resource management. There is decreased need for expensive night-time OR staff as well as a concomitant decreased use of night-time OR resources. Patients also receive surgery performed by presumably fresher, more alert staff in the morning rather than late at night. There is ample evidence to show ACS services benefit patients with biliary disease and appendicitis with shorter wait times in the emergency department, faster transition to the OR and shorter recovery times without increasing complication rates. When assessing ACS services for delivery of patient care, von Conrady and colleagues observed a 33% reduction in time from assessment in the emergency department to admission or operation. Preliminary analysis of wait times and health care outcomes at our institution suggests that the time to surgical consultation is shorter post-ACCESS for patients with biliary disease, although we hope to publish our observations in a separate study.

Our spectrum of operative care primarily involved procedures on the digestive tract. Most of these consisted of operations on the colon, appendix, biliary tract and small bowel, which is consistent with most surgical emergencies. Laparotomies, appendectomies, segmental colectomies and cholecystectomies remained the 4 most frequently performed EGS operations at Victoria Hospital pre- and post-ACCESS. The proportion of cholecystectomies, however, rose dramatically from 7% pre-ACCESS to 16% post-ACCESS; 89% of post-ACCESS cholecystectomies were performed during the day, whereas only 34% of pre-ACCESS cholecystectomies were performed during the day. Austin and colleagues made a similar observation with respect to the increased numbers of appendectomies and cholecystectomies performed by general surgeons since the introduction of an ACS service. Surgeons may be more willing to operate on patients with acute cholecystitis and “hot” gallbladders when they have dedicated EGS operating time during the day, rather than operate late at night and potentially negatively affect their schedule the next day.

While the focus of ACCESS was to perform EGS cases during the day, surgeons were also given the discretion to book elective cases during ACCESS OR time if there were no emergency cases on the board. This allowed the OR to function at full capacity without wasting valuable resources and provided the surgeons and anesthesiologists, who were also paid by fee-for-service, with a steady volume of patients. The need to use ACCESS OR time to the fullest extent required surgeons to maintain “standby lists” wherein patients who were booked for elective surgery (e.g., herniorrhaphy, cholecystectomy, hemorrhoidectomy) would be called into the hospital for their surgery on the same day; patients were made fully aware that their surgery could be delayed or postponed due to priority emergency cases. Overall, however, surgeons reported excellent patient satisfaction and did not experience considerable challenges when balancing the use of ACCESS OR resources for emergency and elective cases.

We found that ACCESS did not adversely affect emergency or elective operating for other surgical services. There was no statistical difference in non–general surgery cases (emergency or elective) post-ACCESS. Implementing an ACS service at our institution involved a redistribution of existing general surgery resources to maximize EGS patient care. Post-ACCESS, elective general surgery cases declined by 6.1%, but this decline was not significant. In addition, with the concomitant increase in EGS, the total number of cases (emergent and elective) remained relatively unchanged. While there is evidence to show that wait times for certain procedures (e.g., urgent outpatient cholecystectomies) decreased by 20% with the introduction of an ACS service, there is no North American data to demonstrate any adverse effect on elective surgery wait times by the introduction of an ACS service. This is a future avenue for investigation, as it is critical to balance acute EGS procedures without adversely affecting elective surgical care.
It is also clear that an ACS service is economically sustainable within the confines of our financially restricted, publicly funded health care system. In performing a remuneration model analysis, we demonstrated that ACCESS can help significantly reduce surgeon billing cost for individual cases by shifting operating from the nighttime to the daytime. The biggest contributor to the cost reduction was the significant decrease in after-hours premium billing for each case: the average billing per case decreased by 19%, from $767.94 pre-ACCESS to $620.03 post-ACCESS. The total overall surgeon billing, however, increased post-ACCESS along with the number of EGS cases performed. Because individual surgeon income is a sensitive topic, the surgeons were reluctant to divulge exact billing information for their elective and emergent practices. For the few surgeons who did release billing information, their billings increased by approximately 13% in the first year post-ACCESS. This difference may not be solely due to the increase in emergency operating volume; participating surgeons reported that a greater number of days worked and an increase in fee schedules also contributed to their increased billings. Regardless, this study addresses the concern that the implementation of an ACS service would dramatically reduce surgeon income by reducing the premium billing; even though the remuneration for each additional case was only $62 post-ACCESS, an ACS service may provide an opportunity for increased operating and improved income-earning potential while providing cost-effective service. While these values reflect surgeon billings, it was beyond the scope of this study to perform a cost–benefit analysis from the viewpoint of the hospital.

Our model is cost-effective because it involved a re-arrangement of operating resources rather than creating more ORs or hiring new staff. In the United States, it is interesting to note that the implementation of an ACS service was felt to be financially unsustainable if it depended only on patients paying out-of-pocket; patient revenue covered only 73% of the total cost billed by surgeons for EGS procedures at a level 1 trauma centre in Miami. This is a reflection of the vastly different health care funding strategies between the 2 countries.

**Conclusion**

We have described the successful implementation of an ACS service in an established academic surgery department. We found that ACCESS has resulted in a significant shift from emergent night-time operating to daytime operating, and such an ACS service is a viable and sustainable economic model in our health care system.

**Competing interests:** None declared.

**Contributors:** All authors designed the study. R. Anantha, K. Vogt and V. Jain acquired and analyzed the data, which N. Parry also analyzed. R. Anantha and N. Parry wrote the article, which all authors reviewed and approved for publication.

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Dislocation after the first and multiple revision total hip arthroplasty: comparison between acetabulum-only, femur-only and both component revision hip arthroplasty

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Background: Dislocation may complicate revision total hip arthroplasty (THA). We examined the correlation between the components revised during hip arthroplasty (femur only, acetabulum only and both components) to the rates of dislocation in the first and multiple revision THA.

Methods: We obtained data from consecutive revision THAs performed between January 1982 and December 2005. Patients were grouped into femur-only revision, acetabulum-only revision and revision THA for both components.

Results: A total of 749 revision THAs performed during the study period met our inclusion criteria: 369 first-time revisions and 380 repeated revisions. Dislocation rates in patients undergoing first-time revisions (5.69%) were significantly lower than in those undergoing repeated revisions (10.47%; p = 0.022). Within the group of first-time revisions, dislocation rates for acetabulum-only revisions (10.28%) were significantly higher than those for both components (4.61%) and femur-only (0%) reconstructions (p = 0.025).

Conclusion: Although patients undergoing first-time revisions had lower rates of dislocations than those undergoing repeated revisions, acetabulum-only reconstructions performed at first-time revision arthroplasty entailed an increased risk for instability.

Contexte : Il arrive que la dislocation vienne compliquer la révision des prothèses totales de la hanche (PTH). Nous avons analysé la corrélation entre les éléments révisés durant une arthroplastie de la hanche (fémur seulement, acétabulum seulement ou les 2 éléments) et le taux de dislocation qui accompagne une première ou de multiples révisions de PTH.

Méthodes : Nous avons obtenu les données sur les révisions de PTH consécutives effectuées entre janvier 1982 et décembre 2005. Les patients ont été regroupés selon que la révision de leur PTH concernait le fémur seulement, l’acétabulum seulement ou les 2 éléments.

Résultats : En tout, 749 révisions de PTH effectuées au cours de la période de l’étude correspondaient à nos critères d’inclusion : 369 premières révisions et 380 révisions additionnelles. Les taux de dislocation ont été significativement moins élevés chez les patients soumis à une première révision (5,69 %) que chez les patients qui n’en étaient pas à leur première révision (10,47 %; p = 0,022). Dans le groupe soumis à une première révision, les taux de dislocation consécutives à une révision concernant uniquement l’acétabulum (10,28 %) ont été significativement plus élevés que dans les groupes qui ont subi des reconstructions des 2 éléments (4,61 %) ou du fémur seulement (0 %, p = 0,025).

Conclusion : Même si les patients soumis à une première révision ont présenté des taux moindres de dislocation que ceux qui n’en étaient pas à leur première révision, les premières révisions d’arthroplastie impliquant une reconstruction de l’acétabulum seulement ont comporté un risque plus grand d’instabilité.
Dislocation is a common cause of failure after primary and revision total hip arthroplasty (THA), exceeded only by aseptic loosening. Dislocation is disabling for the patient and compromises the long-term function of the joint and ultimate patient satisfaction.

Dislocation rates after primary THA range from 0.5% to 5%, while their frequency increases to 0.95%–27% after revision THA. Impingement and poor abductor muscle function are often the underlying cause of instability. Thus, surgical technique as well as component design and alignment have a substantial impact on the risk for post-THA dislocation.

Previous reports have shown that larger femoral head size directly influences the primary arc of motion and subsequent stability. In addition, use of an elevated acetabular liner rim in revision THAs decreases the rates of dislocations. In contrast, displaced trochanteric nonunion precludes proper abductor function and has been associated with increased rates of dislocations.

Revision THA is often associated with bone loss either due to osteolysis, infection or iatrogenesis as a result of the removal of well-fixed components. Acetabular bone loss in particular may bias the surgeon to less favourable component alignment and subsequent instability since the combined acetabular and femoral components’ anteverision may not be fully restored. The present study addressed the following clinical questions. What are the rates of dislocation for acetabulum-only, femur-only or both component revision THA? Are the rates of dislocations in each group different between first revision and repeated revisions?

Methods

We obtained data for all revision THAs performed between January 1982 and December 2005 performed by the senior author (A.E.G.). After each revision, data were recorded in a prospective database. We excluded revisions that consisted of liner exchange only or that were specifically performed for infection or instability from our analysis.

We examined the rates of dislocation in patients undergoing first revision and those undergoing repeat revisions according to the revised components: femur only, acetabulum only and both components.

In all cases the surgical procedure was a lateral approach with a trochanteric osteotomy. Patients followed hip precautions that included no active abduction, hip flexion under 90° and no cross-leg adduction for 3 months.

Statistical analysis

We used a nonparametric chi-squared test to compare the incidence of dislocation in each of the groups. We considered results to be significant at $p < 0.05$.

Results

Between January 1982 and December 2005, 887 revision THAs were performed in 761 patients. We excluded 106 revisions (11.9%): 54 that consisted of liner exchange only, 28 that were performed for infection and 24 that were performed for instability. In addition, 32 (3.6%) revisions were in patients who were lost to follow-up, leaving 749 revision THAs in 632 patients available for analysis.

The mean age of patients at the time of surgery was $64 \pm 14.3$ (range 30–93, median 67) years. Five hundred (66.7%) revisions were performed in women and 249 (33.3%) were performed in men. Average follow-up was 13.2 ± 6.9 (range 2–23) years. The database included 369 first revisions and 380 repeat revisions. The indication for revision arthroplasty was aseptic loosening in 659 hips, periprosthetic fractures of the femur in 80, fractures of the implant in 3 and fractures of a femoral allograft in 7 hips. In all, 418 (55.8%) arthroplasties involved revision of both the acetabulum and the femur, 202 (26.9%) involved the acetabulum only and 129 (17.3%) involved the femur only.

There were 61 (8.17%) dislocations in the entire series. Rates of dislocation were similar in men and women. Forty-one (8.2%) dislocations occurred in women and 20 (8.03%) in men ($p = 0.47$). The overall dislocation rate was significantly lower in the first-time revision group (5.69%) than in the repeat revision group (10.47%, $p = 0.022$; Fig. 1). In the first-revision group, the dislocation rate was significantly higher for the acetabulum-only reconstruction (10.28%) than for both components (4.61%) and femur-only reconstructions (0%, $p = 0.025$). In the multiple revision group there was no significant difference between the dislocation rate in the acetabulum-only (9.49%), femur-only (10.75%) and both component reconstructions (11.92%, $p = 0.92$; Fig. 1). Twenty-nine (47.5%) dislocations were managed by closed reduction and 5 were treated with open reduction. Twenty-seven (44.3%) dislocations required revision arthroplasty. The rates of dislocation were 9.2% per year (range 2.7%–28.6%; Fig. 2).

![Fig. 1. The rates of dislocation in first-revision and repeat/revision total hip arthroplasty.](image-url)
DISCUSSION

Dislocations are one of the most disabling complications of hip arthroplasty and may necessitate a prolonged hospital stay or further surgical intervention. Although numerous studies have documented the rates of dislocation after primary THA, to the best of our knowledge there are no reports examining the incidence of both of these complications in a single surgeon’s revision practice over a period of 23 years.

The possible weaknesses of retrospective studies derived from the influence of multifactorial variables (surgical technique, implant designs, operating room environment, perioperative antibiotics protocol and postoperative hip precautions) associated with these complications can be substantially reduced when evaluating a single surgeon’s practice. We acknowledge that the early revisions in the 1980s and early 1990s were performed via a classical Charnley trochanteric osteotomy, whereas all subsequent revisions were performed via a modified trochanteric sliding osteotomy. However, since this is a retrospective study relying on a database, the exact data regarding the type of osteotomy from the early years are missing. Yet, this advancement in the surgical technique was put to all types of revisions and influenced them similarly.

Revision THA is a technically demanding procedure that often requires an extensile exposure for a controlled removal of previously implanted components and management of accompanying bone loss. The main objective of this study was to examine the correlation between the components revised during the revision arthroplasty and the rates of postoperative dislocation and infection. The overall dislocation rate was 8.14% in this series, which is well within the range reported in other studies, thus validating our data.

The first-time revision group had essentially half the rate of dislocation occurring in the repeat revision group (5.69% v. 10.47%, p = 0.022; Fig. 1). First-time revisions consisting of acetabulum-only reconstructions had significantly higher dislocation rates (10.28%) than reconstructions of both components (4.61%) and the femur-only reconstructions (0%, p = 0.025; Fig. 1).

These differences can be attributed to the fact that the acetabular bone loss encountered and the perilous position of a well-fixed femoral stem precluding adequate exposure may bias the surgeon to place the cup in a less favourable orientation. Conversely, in femoral revisions adequate femoral anteversion can be maintained even at the presence of severe bone loss, especially with the availability of modular femoral stems. In revisions of both components, a satisfactory combined anteversion can be more readily established, although the required surgical exposure and soft tissue compromise can be more extensive.

Dislocation rates within the multiple revisions group were similar, regardless of the revision type (p = 0.93; Fig. 1). This finding can be derived from a repeated insult that was inflicted on the soft tissue envelope, specifically the abductor muscles, resulting in at least a temporary compromise in their function and potentially exposing the patient to instability. Since the extent of soft tissue compromise was not consistent in this group of patients, it may have been a confounder that obscured the effect of revising each type of reconstruction leading to these results.

Based on this data, we contend that when performing acetabulum-only revisions the threshold to use ancillary precautions for prevention of postoperative instability.

![Fig. 2: Distribution in absolute numbers and rate of dislocations per year.](image-url)
should be lowered. These measures should include an abductor-sparing surgical exposure, such as a trochanteric slide osteotomy and use of larger size femoral heads or a hooded liner. The fixation of the femoral stem as well as its alignment should be carefully examined. The combined acetabular and femoral anteversion must be appropriately established and impingement systematically ruled out.5,10

CONCLUSION

Both the surgeon and patient should be aware of the increasing risk of instability after acetabulum-only revisions. Since the first revision arthroplasty has the lowest complication rates, every reasonable effort should be made to provide the patient with a stable and durable joint at the time of the index revision arthroplasty.

Competing interests: None declared.

Contributors: Y. Kosashvili, M. Drexler, D. Backstein and O. Safir designed the study. Y. Kosashvili, M. Drexler, D. Lakstein, A. Safir and R. Chakravertty acquired and analyzed the data, which T. Dwyer and A. Gross also analyzed. Y. Kosashvili and M. Drexler wrote the article, which all authors reviewed and approved for publication.

References

A simple strategy to reduce stereotype threat for orthopedic residents

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Background: Stereotype threat, defined as the predicament felt by people in either positive or negative learning experiences where they could conform to negative stereotypes associated with their own group membership, can interfere with learning. The purpose of this study was to determine if a simple orientation session could reduce stereotype threat for orthopedic residents.

Methods: The intervention group received an orientation on 2 occasions focusing on their possible responses to perceived poor performance in teaching rounds and the operating room (OR). Participants completed a survey with 7 questions typical for stereotype threat evaluating responses to their experiences. The questions had 7 response options with a maximum total score of 49, where higher scores indicated greater degree of experiences typical of stereotype threat.

Results: Of the 84 eligible residents, 49 participated: 22 in the nonintervention and 27 in the intervention group. The overall scores were 29 and 29.4, and 26.2 and 25.8 in the nonintervention and intervention groups for their survey responses to perceived poor performance in teaching rounds (p = 0.85) and the OR (p = 0.84), respectively. Overall, responses typical of stereotype threat were greater for perceived poor performance at teaching rounds than in the OR (p = 0.001).

Conclusion: Residents experience low self-esteem following perceived poor performance, particularly at rounds. A simple orientation designed to reduce stereotype threat was unsuccessful in reducing this threat overall. Future research will need to consider longer-term intervention as possible strategies to reduce perceived poor performance at teaching rounds and in the OR.
Surgical residents come from diverse backgrounds, posing many challenges, including the need for creating an effective learning environment. While new models of residency training are emerging, the individual needs of residents must always be considered. If individual needs are not addressed, learners may not take full advantage of their learning opportunities or even fail in their pursuit.

There are many possible explanations for why some students don’t learn or perform well in the training environment, including a phenomenon called stereotype threat. Stereotype threat is defined as the predicament of people in situations, whether positive or negative learning experiences, where they could conform to negative stereotypes associated with their own group membership. Stereotype threat can potentially affect members of any group about whom a negative stereotype exists. The threat is cued by the mere recognition that a negative group stereotype could apply to oneself in a given situation. Well-studied examples of stereotype threat include African Americans performing worse on tasks described as assessing intelligence, whites performing worse on tasks described as assessing natural athletic ability and women performing worse on math-related tasks. For those who have surmounted obstacles to enter the domain (for example, African Americans in higher learning and women in math studies), stereotype threat can be particularly self-threatening.

Stereotype threat adversely affects performance by 3 distinct yet interrelated mechanisms: a physiologic stress response that directly impairs mental processing, a tendency to more actively monitor performance and efforts to suppress negative thoughts and emotions in the service of self-regulation. These mechanisms combine to reduce performance on cognitive and social tasks. Moreover, when the stereotype threat is chronic, “disidentification,” an adaptation that undermines sustained motivation, can occur, leading to withdrawal from learning opportunities. For surgical residents this withdrawal might manifest as being less willing to participate in the operating room (OR) and teaching rounds and/or reduced motivation to address perceived knowledge or technical gaps. Stresses from poor performance in turn may lead to burnout and psychiatric morbidity.

In a demanding and stressful program, like that faced by orthopedic surgery residents, the activation of stereotype threat could potentially jeopardize students’ performance and affect their aspirations. The longstanding under-representation of women and minorities in orthopedic residency programs may set the stage for stereotype threat. Simple interventions, such as sharing of negative learning experiences, have been shown in other situations to reduce stereotype threat. The purpose of this study was to evaluate a simple orientation to reduce stereotype threat in an orthopedic surgery residency program. In particular, the study evaluates whether an orientation provided junior residents with enhanced positive attitudes toward learning.

**METHODS**

**Participants**

The study participants were recruited from the 5-year orthopedic surgery residency program at the University of Toronto from 2003 to 2007. In September of 2003 all of the postgraduate year 1 (PGY1) residents had 2 opportunities to attend a 2-hour orientation session and were thus classified as the intervention group. Residents who were in PGY2–5 in the first year of the initiative were placed into the nonintervention group. From 2004 to 2007, as PGY1 residents entered the residency program the number in the intervention group increased with a concomitant drop in the nonintervention group as residents moved up in PGY level.

**Intervention**

The orientation session was provided to PGY1 residents by the senior author (J.G.W.) in September and January of each year. Thus, in first year, residents in PGY1 received the intervention and those in PGY2–5 did not receive the intervention. In second year, residents in PGY1 and PGY2 formed the intervention group and those in PGY3–5 formed the nonintervention group. By the fifth year, the PGY1 residents received the intervention and all residents in PGY1 through PGY5 formed the intervention group. The session was not didactic but highly interactive based on individual experience to promote the key concepts. During the meeting, the senior author emphasized the high expectations of the orthopedic surgery training program and the high probability of residents’ success. The senior author described common feedback from past residents as well as his own experiences of being at rounds and in the OR. The session included an open discussion of the residents’ recent experiences in the OR and rounds and their responses to those experiences. While some of those experiences may have been negative, many simply emphasized a gap in knowledge or experience. The specific focus was how residents may have felt after their perceived poor performance: incapable, stupid or harassed, with a wish to avoid future exposure. The orientation ended with a discussion of 2 simple potential strategies to respond to perceived poor performance during learning experiences in teaching rounds and the OR: talking with peers (to understand similarity of experiences and share responses to those experiences) and encouragement to form study groups early in residency whereby group members can learn together, share experiences and support each other.

**Outcomes**

Between 2003 and 2007, all residents were asked to complete a questionnaire focusing on elements of stereotype threat. The anonymous questionnaire comprised 2 sections inquiring...
about experience in teaching rounds and in the OR, with the same 7 questions in each section. For each statement in the questionnaire, (e.g., your performance made you feel you were not going to succeed at orthopedics), the resident was asked to indicate their agreement using a scale of 1 (strongly disagree) to 7 (strongly agree). Where appropriate, the scores were revised (i.e., your performance made you want to go and read about the topic) so that higher scores indicated a more negative response to the perceived poor performance. Thus the scores ranged from 7 to 49, and the maximum score of 49 represented the most negative experience.

In 2009, an email was sent to all residents asking them to comment on the following questions:
1) Do you remember attending a meeting/orientation session in the first year of your residency program?
2) Did you feel that this meeting was valuable? If yes, why?
3) Do you remember the content of the meeting? If yes, what?
4) Do you have any suggestions that would improve that orientation meeting?

Statistical analysis

We compared the total questionnaire scores for teaching rounds and the OR as well as each question in the survey between the intervention and nonintervention groups. For residents who responded more than once (i.e., in subsequent years), we used the average of their responses (i.e., questionnaire score at time 1, time 2 and time 3). Paired t tests were performed to determine whether the nonintervention group differed from the intervention group in their scores. For each question, a score from 1 to 7 indicated the level of the negative emotion associated with the perceived poor performance; the higher the score, the greater the level of negative emotion. As noted, for question 7 we inverted the score so that strongly agree was scored as 1 and strongly disagree was scored as 7. Again, for each resident we took the average of their responses for the analyses.

We also used the summary intervention and nonintervention group scores to determine if the level of emotion typical of stereotype threat experienced at rounds differed from that experienced in the OR.

RESULTS

Eighty-four orthopedic surgery residents were invited to participate in this research. Forty-nine (58%) of them responded to the survey at least once: 22 from the nonintervention group and 27 from the intervention group.

Comparison analysis

Paired t tests revealed no significant differences between the groups regarding their overall total scores on both teaching rounds ($p = 0.85$) and OR ($p = 0.84$) surveys. When each question was analyzed individually, no significant differences were found between the intervention and nonintervention groups (Table 1).

Collapsed group analysis

We found a significant difference ($p = 0.001$) in total questionnaire scores between responses to rounds versus responses to the OR, with the experience of rounds eliciting higher overall threat scores (Table 2).

Scores of 4.0 and below indicate a lack of agreement with statements about emotions typical of stereotype threat, and scores above 4.0 indicate high agreement. After a perceived poor performance, on average residents were more likely to want to go and read about the topic, to feel ashamed/embarrassed and to feel less capable than other residents at their stage, but they were less likely to feel unsuccessful or angry, to want to avoid the situation or to hate their jobs. The statement that received the strongest
level of endorsement from the residents was “Your performance made you want to go and read about the topic,” with a mean score of 0.8/7 and 1.3/7 for rounds and the OR, respectively, indicating high agreement.

Response to follow-up email

Seventeen (35%) of the residents in the intervention group responded to the email at the end of our study. Most of them (13 of 17) remembered attending the meeting, 11 of 17 accurately recalled the content of the meeting, and 12 of 17 felt it was valuable to their training. Only 1 resident who attended the meeting did not feel it was valuable. Of those who felt the meeting was valuable, the common sentiments were that “it confirmed that certain feelings of ineptitude that one will experience during residency are common and experienced by the majority;” that it “encouraged us to continue sharing experiences with each other;” and that “it is more important to learn from [the inevitable adverse experiences] than to convince yourself that you suck.” A recurrent suggestion from the residents was the desire to receive follow-up sessions throughout their training.

Discussion

This research demonstrated that residents have more adverse learning attitudes in response to their experience at rounds than the OR. A simple 2-hour orientation did not enhance their positive learning attitudes. While perceived poor performance made them feel incapable and ashamed, it also led to the perceived need to read more.

Training culture is thought to include, in addition to the formal curriculum, an informal and hidden curriculum. The formal curriculum is the structured learning opportunities provided during a surgical residency. The informal curriculum is the nonstructured, opportunistic, personal interaction between teacher and learner. The informal curriculum is particularly relevant in surgery, as the process by which the wisdom of clinical practice is imparted and a trainee’s knowledge and skills become situated in the context of daily work. This informal curriculum, while imperative to surgical training, allows the transmission of behaviours, beliefs and attitudes — the so-called “hidden curriculum.” The hidden curriculum is a function of the implicit values held by the institutions as a whole and of the individual surgical educators and allied health professionals working in the trainee’s learning environment.

While arising even in response to a perceived gap in knowledge or experience in positive learning experiences, the risk of stereotype threat may be worsened in negative learning experiences. Gofton and Regehr warn that the messages of the hidden curriculum are likely central in the perpetuation of particularly negative stereotypes. For example, a potential stereotype is that orthopedic surgeons must have substantial physical strength to perform their duties. Women may be less encouraged by attending surgeons through this informal curriculum owing to fewer opportunities to perform procedures, to be the first assistant in the operating suite and to be involved in the running of a surgical service. Other evidence suggests that some women are deterred from surgery by impressions regarding the lifestyle of orthopedic surgeons (e.g., no time for family, personal life), and a lack of available role models (i.e., few female mentors). Logel and colleagues reported that in domains in which women are negatively stereotyped, interacting with a sexist man can further trigger social identity threat, thereby undermining women’s performance. Perceived sex discrimination and sexual harassment while on surgery rotations have been suggested to contribute to the lower rate of selection of orthopedic surgery by female medical students. Owing to the consistent under-representation of certain minorities, stereotypes entrenched and perpetuated by the hidden curriculum as well as more blatant triggers, the daily culture of surgical residency provides ample opportunity for stereotype threat and disidentification. While much of the focus has been on women, the literature would support that any stereotype to which individuals self-identify places them at risk for stereotype threat: The impact of stereotype threat on learning could be substantial and raises the need for potential mitigating strategies.

Strategies that emphasize blurring group differences have been shown to reduce stereotype threat. Rosenthal and Crisp reported that having women focus on overlapping characteristics between sexes (a blurring intergroup bias intervention) before completing a test allowed them to answer more math questions correctly. Cohen and colleagues demonstrated that a brief in-class writing “self-affirmation” assignment reinforcing individual self-worth through reflecting on positive group memberships improved the grades of African American students and reduced the racial achievement gap by 40%. According to these authors, a small reduction in psychological threat can set off a recursive cycle where a slight improvement in subsequent performance can lessen performance-inhibiting threat, thereby leading to sustained or improved performance over time. Teaching about stereotype threat (i.e., specifically informing individuals that their test anxiety may be due to stereotype threats) also has the potential to improve women’s performance on math tests. Another possible strategy is the power of optimistic teachers who convince students of their potential by providing successful performance challenges, thereby reinforcing the ability of students to succeed and in turn reducing the belief that success is tied only to innate abilities. Finally, simply informing participants that membership in specific subgroups has no effect on task ability can eliminate stereotype threat in testing the leadership aspirations of women.

The success of these simple interventions prompted the
development of an orientation session for junior residents. The orientation focused on the probable success of the residents. The orientation session also provided opportunities for the residents to focus on commonalities among their training experiences, including the experience of the senior surgeon. Finally, the session included an open discussion of the residents’ recent positive and negative experiences in the OR and teaching rounds in an attempt to blur group differences and allow for self-affirming revelations. However, the findings of this study indicate that while our intervention from a senior staff member contained many of the elements of previously successful strategies, our brief intervention was not sufficient in reducing orthopedic residents’ negative experiences at rounds and in the OR. Because most of our study participants remembered the orientation and felt that it was valuable to their training, it may be that enhancing the content of the intervention and/or increasing the frequency (which was also desired by our residents) of such sessions could have a greater impact with sustained effects. Most prior research on stereotype threat has focused on performance in exam conditions on a single occasion with almost no attention to performance over the long term. Thus, a key component of the future interventions will be the need to consider repeated long-term exposure.

Between the 2 components of the training program assessed, we found that significantly higher stereotype threat scores were elicited about rounds. A previously discussed model proposed by Schmader and colleagues identified pathways by which negative self-relevant stereotypes could impair working memory and increase physiologic stress responses that directly impair cognitive performance. The authors suggested these pathways could play a substantial role in real-world performance contexts, such as interviews or public speaking. Future investigation of stereotype threat in the orthopedic surgery training environment should pay particular attention to experiences during rounds. The results of our study, feelings of low self-worth but not feelings of anger toward the teacher, suggest that learners tend to internalize their perceived poor performance. Mentors and even the residents themselves must be cognizant of the messages they convey to each other, how these messages affect the training environment and the powerful psychological effects on learning. In addition to focusing on residents’ responses to learning experiences, educators should also be the focus of improved pedagogical techniques. “Grilling” residents during rounds may not be the most effective method of transmitting information and encouraging learning.

Limitations

Our study has several potential limitations. First, our stereotype threat questionnaire was not tested for reliability and validity. The questionnaire, however, had face validity because it assessed the important elements typical of stereotype threats. Second, the stereotype threat questionnaire was our only outcome measure for testing the effects of our intervention. Additional outcome measures would be objective measures of performance in rounds, in the OR or on standardized evaluations, such as the orthopedics in-training examination. Qualitative methods are also needed to gain greater insight into residents’ learning experiences. Third, a before and after study is less rigorous than other designs. While no major changes occurred in the training program during the study period, factors other than stereotype threat may have been active and responsible for changes. However, we felt randomly assigning individuals at the same PGY level would likely lead to substantial contamination between the intervention and nonintervention groups, minimizing the ability to detect a difference. Fourth, our intervention was directed at the residents rather than the staff. However, changing the attitudes and behaviour of staff was considered less likely to be successful. Furthermore, even subtle cues — the “hidden” curriculum or “the threat in the air” — that are probably impossible to eliminate are likely to have a dramatic effect on resident performance. Finally, stereotype threat may occur even in response to positive learning experiences. Thus, reducing the impact of the hidden curriculum on residents seems more likely to be a successful strategy in reducing stereotype threat. We did not directly measure stereotype threat by subgroup because we were uncertain which threat might apply to which subgroup (e.g., sex, race, foreign-trained physicians). Furthermore, the strategies were directed toward mitigating the effect of perceived poor performance associated with learning, irrespective of the source of those emotions. Also, the intervention was directed at all residents and thus the small number of residents vulnerable to stereotype threat may be hidden in the larger group of residents. Finally, not all residents attended both sessions, possibly leading to dilution of the intervention. However, this strategy reflected the reality of most training programs in which residents attend educational opportunities intermittently based on clinical commitments and call schedules.

Conclusion

We found that residents experience low self-esteem following perceived poor performance, particularly at rounds. A simple orientation designed to reduce stereotype threat, however, was unsuccessful in reducing this threat overall. Future research will need to use other methods, such as qualitative research, to better understand residents’ experiences and to consider longer-term intervention as a possible strategy to reduce negative experiences at teaching rounds and in the OR.

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Contributors: J.G. Wright designed the study. E. Gomez acquired the data. Both authors analyzed the data, wrote and reviewed the article and approved the final version for publication.
References


Spine surgeons’ requirements for imaging at the time of referral: a survey of Canadian spine surgeons

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Background: Routine imaging of patients with spine-related complaints referred for surgical assessment may represent an inefficient use of technological resources. Our objective was to explore Canadian spine surgeons’ requirements with respect to imaging studies accompanying spine-related referrals.

Methods: We administered an 8-item survey to all 100 actively practising surgeon members of the Canadian Spine Society that inquired about demographic variables and imaging requirements for patients referred with spine-related complaints.

Results: Fifty-five spine surgeons completed our survey, for a response rate of 55%. Most respondents (43; 78%) required imaging studies to accompany all spine-related referrals. The type of imaging required was highly variable, with respondents endorsing 7 different combinations. Half (47%) required magnetic resonance imaging and 38% required plain radiographs either alone or in combination with other forms of imaging. Half of the respondents refused to see 20% or more of all patients referred for spine-related complaints.

Conclusion: Most Canadian spine surgeons require imaging studies to accompany spine-related referrals; however, the type and combination of studies is highly variable, and many patients who are referred are never seen (for a consultation). Standardization and optimization of imaging practices for patients with spine-related complaints referred for surgical assessment may be an important area for cost savings.

Contexte : Le recours systématique aux épreuves d’imagerie chez les patients qui se plaignent de maux de dos et qui sont référés pour consultation en chirurgie pourrait constituer une utilisation inefficace des ressources technologiques. Notre objectif était d’analyser les épreuves d’imagerie demandées par les chirurgiens canadiens spécialistes de la colonne vertébrale, suite aux demandes de consultation qui leur sont adressées pour des patients qui ont des problèmes de colonne vertébrale.

Méthodes : Nous avons administré un sondage en 8 questions aux 100 chirurgiens en pratique active qui forment la Canadian Spine Society; le questionnaire portait sur des variables démographiques et sur les demandes d’épreuves d’imagerie pour les patients qui leur sont référés pour des maux de dos.

Résultats : Cinquante-cinq chirurgiens de la colonne ont répondu à notre sondage, pour un taux de réponse de 55 %. La plupart des répondants (43; 78 %) ont dit demander des épreuves d’imagerie pour toutes les références qui leur sont adressées pour des problèmes de colonne vertébrale. Les types d’épreuves d’imagerie demandés variaient considérablement et les répondants ont mentionné 7 combinaisons d’épreuves différentes. La moitié d’entre eux (47 %) demandaient une imagerie par résonnance magnétique et 38 % demandaient des radiographies ordinaires, seules ou combinées à d’autres modalités d’imagerie. La moitié des répondants ont dit refuser de voir 20 % ou plus de tous les patients qui leur étaient référés pour des maux de dos.

Conclusion : La plupart des chirurgiens spécialistes de la colonne vertébrale au Canada demandent des épreuves d’imagerie pour tous les patients qui leur sont référés pour des problèmes de colonne vertébrale; toutefois, les types d’épreuves et leurs combinaisons sont très variables et de nombreux patients qui sont référés en consultation ne réussissent jamais à voir les spécialistes. La standardisation et l’optimisation des pratiques au chapitre de l’imagerie pour les patients qui souffrent de maux de dos et qui sont référés à un chirurgien représentent un poste budgétaire important où des économies pourraient être réalisées.
Spine-related complaints are common among adults, and patients whose symptoms fail to resolve in a timely manner or who present with neurologic involvement are often referred for surgical assessment. Anecdotally, surgeons often require imaging studies to accompany requests for consultation, but the extent and nature of this practice are unknown. Canada currently spends 10% of total outpatient expenditure on diagnostic imaging; and the actual costs are higher if one also considers the capital costs of equipment and the costs of downstream tests and interventions owing to imaging results.

Given fiscal pressures facing the Canadian government, there is a pressing need to find efficiencies in the use of diagnostic imaging technology. It is widely acknowledged that normal variants of the spine are common and that many of the changes that occur with aging are relatively benign, so clinical correlation is essential before assigning significance to lesions revealed by imaging. It has also been established that many spine-related referrals to surgeons in Canada are inappropriate and that the majority of patients seen in surgical consultation do not require surgery. As such, routine imaging of patients with spine-related complaints referred for surgical assessment may represent an inefficient use of resources. The aim of the present study was to survey Canadian spine surgeons about their requirements for imaging studies when receiving new referrals for patients with spine-related complaints.

**Methods**

**Questionnaire development**

With the assistance of clinical epidemiologists and content experts, we developed an 8-item, English language questionnaire to examine Canadian spinal surgeons’ use of spine-related imaging as part of the referral process. The final questionnaire framed response options with closed-ended questions, as a previous report has shown that this format results in fewer incomplete questionnaires than open-ended response options (see the Appendix, available at canjsurg.ca). We also included an option for surgeons to provide written comments regarding any other thoughts they may have on imaging for spine-related referrals. We pretested the final questionnaire on a group of 3 spine surgeons who also commented on its clarity and comprehensiveness and on the time required to complete it. No modifications were suggested by pretest participants.

**Questionnaire administration**

We used SurveyMonkey (www.surveymonkey.com/) to facilitate online completion of our questionnaire. We obtained permission from the Canadian Spine Society (CSS), an organization composed almost entirely of spine surgeons (www.spinecanada.ca/), to distribute our questionnaire to their members. Participants who logged on to the link were provided with a disclosure letter detailing the intent of the survey and explicit instructions that, should they choose not to complete the survey, they could convey their decision to us by email or fax. At 3 and 6 weeks after the initial email distribution, a CSS representative sent an email to all nonresponders who had not indicated that they did not wish to participate, requesting that they complete the questionnaire. The Canadian Memorial Chiropractic College Research Ethics Board approved our study.

**Data analysis**

We generated frequencies for all collected data. We acquired information on surgical training of respondents from a previous survey of the same population. One of us (J.W.B.) reviewed written comments in order to establish common themes.

We hypothesized a priori that surgeons would be more likely to refuse spine-related referrals if they required imaging to accompany all referrals, if they were older and if they spent a greater portion of their practices performing elective spine surgery. The dependent continuous variable was the proportion of spine-related referrals that were declined, as reported by spine surgeons. We planned to enter these variables into a linear regression model on the condition that we had sufficient data to ensure reliability of our model. We calculated that we would require at least 30 completed surveys to ensure reliability of our linear regression model (10 respondents for each independent variable considered).

We planned, but did not conduct, an analysis to explore the association between surgeons’ age and the proportion of their practices dedicated to elective spine surgery with requiring imaging to accompany spine-related referrals as our threshold for ensuring a reliable model was not met: 20 completed surveys in which surgeons reported they did or did not require imaging for spine-related referrals (whichever was the least common response).

All comparisons were 2-tailed, and we considered a variable to be significant if it had a \( p < 0.05 \) in the final multivariable model. For our linear regression model, we report the unstandardized regression coefficient and 95% confidence interval (CI) for each significant variable in the analysis. The value of the unstandardized regression coefficient represents the change in response score on the dependent variable, which was measured as a continuous variable on a 6-point Likert scale (<10%, 10%–20%, 21%–30%, 31%–50%, 51%–75% and >75%). We plotted residuals from the linear regression analysis to ensure that their distributions were reasonably normal, and multicollinearity
was deemed concerning if the variance inflation factor for any independent variable was greater than 5. We performed all analyses using PASW Statistics 18 statistical software (SPSS Inc.).

**RESULTS**

**Characteristics of respondents**

From August to September 2012, a representative from the CSS sent a link to our online survey to all 101 of their surgeon members. Fifty-six surgeons provided a completed survey, with 1 surgeon advising he maintained a nonsurgical practice, for an eligible response rate of 55% (55 of 100). Most respondents were men (98.2%), and approximately half (45.5%) had been in practice for more than 20 years (Table 1). Most respondents (65.4%) dedicated more than half their practices to elective spine surgery. The majority of respondents (43 of 55, 78.2%) required imaging studies to accompany all spine-related referrals; the types of imaging studies required were highly variable, with respondents endorsing 7 different types of imaging or imaging combinations (Fig. 1). Of the 11 surgeons who did not require imaging to accompany spine-related referrals, 4 indicated a preference for magnetic resonance imaging (MRI) scans with referrals.

Half of surgeons (27 of 55, 49.0%) either required \( n = 13 \) or preferred \( n = 14 \) MRI, alone or in combination with other forms of imaging studies, in order to consider a spine-related referral. Twenty-one surgeons (38%) required plain radiographs alone or in combination with other forms of imaging studies. None of our respondents reported that they acquired postoperative MRIs as part of routine practice after performing spine surgery.

**Factors associated with refusing spine-related surgical referrals**

Half of our respondents refused at least 20% of all spine-related referrals (without a consultation). In our adjusted model, only requiring imaging with spine-related referrals and surgical practices with greater dedication to elective spine surgery were associated with refusing spine-related referrals (Table 2). The unstandardized regression coefficients presented in Table 2 represent the impact of each baseline characteristic toward increasing the proportion of patients in a surgeon’s practice who are referred but not scheduled for consultation. For example, in our adjusted analysis surgeons who required imaging studies for all spine-related referrals demonstrated an average increase of 1.27 points on the 6-point scale associated with the question, “What is your estimate of the proportion of spine-related referrals you receive that do not result in a consultation?” (see the Appendix). Standardized
residual plots showed no violation of model assumptions. The variance inflation factor was less than 2 for each independent variable, suggesting no issues with multicollinearity. Our model explained approximately 13% of the variation (adjusted $R^2 = 0.13$) in the proportion of patients referred with spine-related complaints who our respondents refused to see.

**Written comments**

Written comments were provided by 23 respondents, and the most common themes were contradictory: imaging is an essential part of spine-related referrals, better triaging of referrals can reduce unnecessary imaging, and most spine-related referrals do not require imaging. For example, we received the following comments:

MRI is the gold-standard for imaging of the spine. We went through this same debate for [computed tomography] scans about 15 years ago. It is useless to resist. Patients want them. Referring physicians want them. Spine surgeons want them. It is only a matter of time before MRI will become the key to spine referrals anywhere it already hasn’t. Regulating or restricting it only makes the system less efficient.

We have a triage clinic now which doesn’t require an MRI. Patients get a phone call from a spine nurse, and if potentially surgical, get an MRI… We phoned about 700 patients last year, and less than 10% were surgical.

The vast majority of investigations are not indicated, or if indicated do not change management, resulting in inordinately long waiting times to obtain scan in those where they are indicated for management.

**DISCUSSION**

**Summary of findings**

Our survey found that the majority of Canadian spine surgeons require imaging studies to accompany all spine-related referrals; however, the type of imaging varies considerably and approximately 1 in 5 referrals are not scheduled for consultation. Requiring imaging as a condition of referral and spending a greater proportion of practice on elective spine surgery were associated with a higher rate of refusing referrals.

**Strengths and limitations**

The strengths of our study include a comprehensive sampling of Canadian spine surgeons from both academic and community practices, survey design and conduct consistent with best practices, and a high survey response rate for health care professionals (55% provided completed surveys) that is comparable with the mean physician response rate of 54% reported by Asch and colleagues in a systematic review of postal surveys.

Our study does have limitations. We did not explore the patient composition of surgeons’ practices, and it may be that some surgeons predominantly see the kinds of patients for whom most experts/guidelines suggest that imaging is appropriate at the time of referral; however, the wide variation in imaging types required, common use of multiple forms of imaging and the finding that 1 in 5 spine surgeons do not require imaging to consider spine-related referrals suggests that inefficiencies exist. Our results may have limited generalizability to non-Canadian spine surgeons. Our model exploring factors associated with spine surgeons’ refusal of spine-related referrals explained only 13% of the variation among respondents, suggesting that other variables that we did not assess are important in influencing this decision. Some potentially important factors that should be explored in future studies are surgeons’ referral volumes, surgeons’ operative wait times, the number of previous surgical consultations, factors suggesting that the patients are not surgical candidates (e.g., back-dominant pain with diffuse multilevel degenerative disc disease, established chronic pain syndrome in the absence of significant neurologic involvement) and ongoing litigation.

**Relevant literature**

Increases in use of diagnostic imaging in Canada have far exceeded population growth; between 1993/94 and 2003/04 there was a 300% increase in the number of computed tomography (CT) scans and a 600% increase in the number of MRI scans — more rapid growth than

| Table 2. Variables associated with a greater proportion of spine-related referrals to spine surgeons that do not result in a consultation, $n = 55$ |
|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| Variable                        | Univariable                     | Multivariable                   |                                |
|                                 | Unstandardized regression coefficient (95% CI) | $p$ value | Unstandardized regression coefficient (95% CI) | $p$ value |
| Surgeon age for each 10 year increment | 0.11 (−0.26 to 0.49) | 0.55 | 0.22 (−0.14 to 0.58) | 0.22 |
| Greater proportion of practice dedicated to elective lumbar spine surgery | 0.36 (−0.05 to 0.76) | 0.09 | 0.41 (0.02 to 0.80) | 0.041 |
| Require imaging studies for all lumbar spine referrals | 1.06 (0.08 to 2.04) | 0.034 | 1.27 (0.30 to 2.24) | 0.011 |

CI = confidence interval.
almost any other type of Canadian health service. Imaging of the lumbar spine accounts for approximately one-third of all MRIs in some provinces, such as Alberta where 25 000 lumbar spine MRIs were ordered in the fiscal year 2009/10 (Dr. Mauro Chies, Alberta Health Services, Edmonton, Alta.: personal communication, 2011). A recent study of Ontario patients with degenerative spine disease referred for surgical consultation found that 100% of CT scans and 60% of MRIs were unnecessary, resulting in an additional cost estimated at $24 million per year.15 Another recent study found that more than half of lumbar spine MRIs ordered in Edmonton and Ottawa were either inappropriate or of uncertain value.16

Reasons for high rates of inappropriate spine-related imaging are not clear; however, it appears to be a combination of patient demand owing to the persistent and often recurrent nature of degenerative spinal disorders17–21 as well as the limited confidence that many primary care physicians have in assessing and managing patients with chronic musculoskeletal complaints.22–24 This may drive referrals for both imaging and surgical consultation owing to concerns over further management needs or missing important findings. Spine surgeons faced with large numbers of (often nonsurgical) referrals may require imaging for consultation in an attempt to refuse clearly nonsurgical candidates and reduce wait times for patients who are likely to benefit from surgery.18 A potential solution to this problem may be an alternate mechanism for early standardized and skilled assessment during primary care of patients being considered for referral to a spine surgeon.

In their written comments, a number of respondents advocated the use of triaging systems to prescreen spine-related referrals, which reportedly reduced the proportion of unnecessary imaging. There has been very little formal research exploring the role of nonsurgeon clinicians for screening patients referred for surgical consultation secondary to spine-related complaints, but preliminary findings are promising.25–28 We have also found that the majority of Canadian spine surgeons would participate in this model of care.2 One of us (Y.R.R.) is currently leading a pilot study sponsored by the Ontario Ministry of Health and Long-Term Care to explore the feasibility and impact on health care utilization of an interprofessional shared-care model (primary care, allied health and specialist) that involves chiropractors and physical therapists assessing and educating patients with low-back pain or low back–related leg pain with persistent or recurrent symptoms beyond the acute phase (www.isaec.org/).

**Conclusion**

It is likely that requiring imaging to accompany all spine-related referrals for surgical consultation does not represent optimal use of technology or resources, and further research is required to better understand why most Canadian spine surgeons have adopted this approach. Clinical trials to formally evaluate models of care for patients with spine-related complaints that incorporate skilled nonsurgeons to provide advanced patient education and management, including appropriateness criteria for imaging and specialist referral in Canada, are urgently needed.

**Acknowledgments:** We thank Dr. Hamilton Hall and the Canadian Spine Society (CSS) Executive for allowing our survey to be sent to the CSS membership, and Ms. Jennifer Edwards, Assistant to the Director, CSS, for sending the link for our survey to CSS members.

**Competing interests:** None declared.

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**Contributors:** All authors designed the study. J. Busse and J. Riva acquired the data, which all authors analyzed. All authors wrote and reviewed the article and approved the final version for publication.

**References**


“iBIM” — Internet-based interactive modules: an easy and interesting learning tool for general surgery residents

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Background: The increased use of information technology supports a resident-centred educational approach that promotes autonomy, flexibility and time management and helps residents to assess their competence, promoting self-awareness. We established a web-based e-learning tool to introduce general surgery residents to bariatric surgery and evaluate them to determine the most appropriate implementation strategy for Internet-based interactive modules (iBIM) in surgical teaching.

Methods: Usernames and passwords were assigned to general surgery residents at the University of Alberta. They were directed to the Obesity101 website and prompted to complete a multiple-choice precourse test. Afterwards, they were able to access the interactive modules. Residents could review the course material as often as they wanted before completing a multiple-choice postcourse test and exit survey. We used paired t tests to assess the difference between pre- and postcourse scores.

Results: Out of 34 residents who agreed to participate in the project, 12 completed the project (35.3%). For these 12 residents, the precourse mean score was 50 ± 17.3 and the postcourse mean score was 67 ± 14 (p = 0.020).

Conclusion: Most residents who participated in this study recommended using the iBIMs as a study tool for bariatric surgery. Course evaluation scores suggest this novel approach was successful in transferring knowledge to surgical trainees. Further development of this tool and assessment of implementation strategies will determine how iBIM in bariatric surgery may be integrated into the curriculum.
he increased use of information technology (IT) supports a resident-centred educational approach that promotes resident autonomy and flexibility. Information technology has the potential to engender residents with a desire to manage their own learning, which is a valuable step toward lifelong learning. The resident dictates the time, duration, frequency, depth and direction of his or her interactive study. Information technology can also offer opportunities for the residents to assess their own competence, promoting self-awareness. Surgical educators must be proactive in embracing the Internet and other evolving technologies. A review of the literature shows that Internet-based training in bariatric surgery, compared with other specialties, is still in its infancy. Therefore, our objective was to establish a web-based e-learning concept demonstrating an introduction to bariatric surgery with interactive modules, including texts, graphics and animation along with audio and video components as study tools. As such, the study was designed to determine whether IT, specifically the Internet-based interactive modules (iBIMs) can be used to design and implement a system capable of delivering a constructive habit, enhanced by iconic imagery, to surgical teaching. Moreover, we attempted to evaluate the response of residents to the integration of such a system to the surgical curriculum.

Methods

An electronic version of written consent was emailed to general surgery residents at the University of Alberta. Those who agreed to participate in the study were assigned usernames and passwords and were directed to the website www.obesity101.ca, which housed the iBIM. To increase the number of participants, residents received a bimonthly reminder email to encourage them either to complete the project or to visit the website to read more about the project objectives, review module sample, and/or start the project.

Obesity101 is a web-based project that uses the Active Server Page (ASP.net) programming language and runs a Microsoft SQL database environment. In addition, the Action Script 3 language and Flash tools were used to design the interactive modules. First, after logging into the website, all participants completed a form, providing demographic information, including number of years in practice, levels of training and completion of any bariatric surgery rotations. No actual names or other identifying data were collected. Second, the residents were required to complete a precourse test assessing their basic knowledge of obesity and bariatric surgery. The test comprised 20 multiple-choice questions and took 20 minutes to complete. Third, residents who completed the demographic form as well as the precourse test were prompted to access the training modules. The modules included interactive animations and images (Fig. 1), videos and texts to introduce the bariatric surgery specialty, basic anatomy and physiology, preoperative assessment, intraoperative and postoperative issues as well as long-term follow-up and outcomes. Residents had the opportunity to review the course material as often as they wanted. The duration of the study was 6 months, beginning the first time the residents used their usernames and passwords to log in to the website. Finally, residents completed a postcourse test (multiple-choice questions) and a short postcourse (exit) survey. The test and the survey took approximately 25 minutes in total to complete. The precourse test, postcourse test and survey questions were validated by a focus group of experts in obesity and bariatric surgery from the Centre for the Advancement of Minimally Invasive Surgery at the University of Alberta.

Statistical analysis

Data were collected through multiple queries, and the results were exported directly to a Microsoft Excel file. The demographic and survey data were summarized as means ± standard deviations or as medians with ranges for continuous data and as percentages for categorical data. We used paired t tests to assess the differences between pre- and post-course scores for each participant. Personal data, such as usernames and email addresses, were not included in the analysis.

Results

Of the 52 general surgery residents at the University of Alberta, 34 agreed to participate in the project (65.4%); of those, 22 residents completed the precourse test (64.7%) and 12 residents completed the postcourse test (35.3%). With respect to the 12 residents who completed the project, the precourse test mean score was 50 ± 17.3 and the postcourse test mean score was 67 ± 14. We used a paired t test to compare groups (p = 0.020; Table 1).

Residents who completed the project were divided into 2 cohorts (junior trainees in postgraduate year 1 (PGY1) and PGY2, and senior trainees in PGY3–5). We used a paired t test to compare both the pre- and postcourse test results for both cohorts, and there was no significant difference between the groups (junior residents p = 0.14 v. senior residents p = 0.10).

Test scores were analyzed according to prior exposure to bariatric surgery. There was no significant difference between the pre- and postcourse test results for the cohort who didn’t have prior exposure to bariatric surgery (p = 0.70), whereas there was a significant difference between both scores for those who did have prior exposure (p = 0.011).

The precourse test scores for both junior and senior cohorts were analyzed, and there was no significant...
difference \((p > 0.99)\). Similarly, there was no significant difference regarding the postcourse test scores for both cohorts \((p = 0.67;\) Table 1).

Furthermore, as shown in Table 1, there was no statistical difference in the precourse test scores for residents without prior exposure to bariatric surgery and the scores of those who did have prior exposure \((p = 0.90)\). Likewise, there was no statistical difference regarding the postcourse test scores for these same groups \((p = 0.27)\).

**Postcourse survey**

Three of 10 residents who completed the survey found no difference between iBIM and standard study methods, whereas 7 residents thought that iBIMs are better than ordinary teaching and recommended their use in the surgery curriculum. Box 1 includes comments and suggestions from residents who completed the survey.

![Fig. 1](image)

*Incorrect match goes here. Please try again.*

**Table 1. Pre- and postcourse test results for all residents, residents grouped by postgraduate year and residents grouped by previous bariatric surgery exposure**

<table>
<thead>
<tr>
<th>Group</th>
<th>No.</th>
<th>Pre-course test results, mean ± SD</th>
<th>Post-course test results, mean ± SD</th>
<th>(p) value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junior residents (PGY1–2)</td>
<td>4</td>
<td>50.00 ± 8.16</td>
<td>70.00 ± 16.83</td>
<td>0.14</td>
</tr>
<tr>
<td>Senior residents (PGY3–5)</td>
<td>8</td>
<td>50.00 ± 21.04</td>
<td>65.63 ± 13.48</td>
<td>0.10</td>
</tr>
<tr>
<td>Previous bariatric surgery rotation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>9</td>
<td>49.44 ± 14.88</td>
<td>69.44 ± 14.88</td>
<td>0.011</td>
</tr>
<tr>
<td>No</td>
<td>3</td>
<td>51.67 ± 27.54</td>
<td>60.00 ± 10.00</td>
<td>0.70</td>
</tr>
<tr>
<td>All residents</td>
<td>12</td>
<td>50.00 ± 17.32</td>
<td>67.08 ± 14.05</td>
<td>0.020</td>
</tr>
</tbody>
</table>

PGY = postgraduate year; SD = standard deviation.

* Results of the junior versus senior residents for the pre- \((p > 0.99)\) and postcourse \((p = 0.67)\) tests.
† Results of residents who did not have previous rotations in bariatric surgery versus those of residents who did have previous experience for the pre- \((p = 0.90)\) and postcourse \((p = 0.27)\) tests.
discussion

The first use of computer-based medical training dates back to 1961. Since then, the rapid development and spread of personal computers and the Internet have caused an increase in the number and variety of software programs available for medical education. Several studies have shown that the interactive use of multimedia components and computer software can successfully be used in medical education to facilitate the learning process. There is already a large number of medical iBIMs available for the purposes of medical education as well as patient care, and more are being developed all the time. Examples of iBIMs are the medical calculator, adjuvant online and e-anatomy.

Gorman and colleagues have pointed out that “the future of medical education is no longer blood and guts, it is bits and bytes.” Further, they state that the old surgical paradigm of “see one, do one, teach one” is incompatible with today’s complex health care system. In turn, they advocate for the use of computer-based programs in surgical specialties. In light of these observations, our goal was to develop a comprehensive and constructive iBIM for obesity and bariatric surgery that would enable surgical residents to prepare for rotations and at the same time stimulate independent study habits. To accomplish this goal we used the obesity101 website to host interactive multimedia training modules that served as a basis for lectures as well as independent studying at home. This study confirms that the widespread use of iBIMs in our general surgery program could be easy, reliable and interesting. It is clear that this technology can change traditional medical education by providing rapid access to information and facilitating the introduction of residents to subspecialties like bariatric surgery efficiently and easily using a dynamic and interactive approach.

Consistent with our results were those of a study involving 116 nursing students starting a “medical-surgical nursing course (MSN)” at the University of Murcia in Spain. Students were divided into 2 randomly formed groups: an experimental group of 54 participants used a web-based tool and a control group of 62 participants received the same training but without using a web-based tool. The results revealed that the competitive e-learning method produced a significant increase in conceptual understanding and cognitive gains for the students in the experimental group.

The Department of Trauma Surgery at the Hannover Medical School has created a web-based multimedia training program with a central data management system that serves as an independent study program. A questionnaire was given to medical students who used the program, and 225 of 309 completed it. The majority of the surveyed students (79.6%) found the web-based program to be constructive and helpful. This study confirmed that web-based learning could play an important role in the future of academic medicine.

A criticism of iBIMs is that they may not be suitable for residents with negative attitudes toward IT, and residents’ preference for hard copy material over computer screen presentation has been reported. In addition, continuous use of IT may decrease our attention to the tasks at hand; some have even suggested that new technologies are changing the way that our brains process information, making us skin the surface for information instead of reading in depth.

limitations

This study was limited in 2 areas. First, sampling bias is likely. Sampling bias is a major problem in learning studies; research has found that individuals who are satisfied and have knowledge about the subject matter are more likely to participate in these educational inquiry studies than those who lack knowledge. Further, nonusers of the technology are less likely to respond to a study about IT and iBIMs.

Second, the participation rate was relatively low. For this study, nonresponders were contacted by email to obtain a response. Overall, the response rate to complete the full online project was 23% of all the general surgery residents and 35.3% of those who agreed to participate in the study, which made the study more qualitative than quantitative. Residents who agreed to participate in the Obesity101 model yet didn’t complete the project may have obtained some knowledge about obesity management. However, it is difficult to assess this knowledge in In-Training Evaluation Reports, as obesity management continues to be under-represented in our resident evaluations. One of the objectives of this study was to increase the awareness of obesity and incorporate this into our evaluations.
CONCLUSION

We found a significant difference between the pre- and postcourse test results of general surgery residents — especially those who had previous bariatric surgery experience — and this difference was deemed related to participation in our iBIM bariatric surgery course. However, this difference seemed unrelated to PGY. Furthermore, the majority of residents who completed the survey recommended using the iBIMs as an interesting, easy and effective study tool during their bariatric surgery rotations, which also could be integrated in the surgical curriculum. This is a pilot study to investigate the preference and effectiveness of the iBIM modules. Based on our data, the Bariatric Surgery department at the University of Alberta will design a new trial to further test if this approach is superior to the existing training approaches.

Competing interests: S. Karmali is a consultant for Ethicon EndoSurgery and Covidien, and has received speaker fees from Ethicon EndoSurgery. D.W. Birch is a consultant for and has received educational grants from Johnson & Johnson, Ethicon EndoSurgery and Covidien. No other competing interests declared.

Contributors: N. Azer, C. de Gara, S. Karmali and D.W. Birch designed the study. N. Azer and X. Shi acquired and analyzed the data, which C. de Gara, S. Karmali and D.W. Birch also analyzed. N. Azer wrote the article, which all authors reviewed and approved for publication.

References

The role of the laparoendoscopic single site totally extraperitoneal approach to inguinal hernia repairs: a review and meta-analysis of the literature

Background: Laparoendoscopic single site (LESS) surgery may have perceived benefits of reduced visible scarring compared to conventional laparoscopic (LAP) totally extraperitoneal (TEP) hernia repairs. We reviewed the literature to compare LESS TEP inguinal hernia repairs with LAP TEP repairs.

Methods: We searched electronic databases for research published between January 2008 and January 2012.

Results: A total of 13 studies reported on 325 patients. The duration of surgery was 40–98 minutes for unilateral hernia and 41–121 minutes for bilateral repairs. Three studies involving 287 patients compared LESS TEP (n = 128) with LAP TEP (n = 159). There were no significant differences in operative duration for unilateral hernias (p = 0.63) or bilateral repairs (p = 0.29), and there were no significant differences in hospital stay (p > 0.99), intraoperative complications (p = 0.82) or early recurrence rates (p = 0.82). There was a trend toward earlier return to activity in the LESS TEP group (p = 0.07).

Conclusion: Laparoendoscopic single site surgery TEP hernia repair is a relatively new technique and appears to be safe and effective. Advantages, such as less visible scarring, mean patients may opt for LESS TEP over LAP TEP. Further studies with clear definitions of outcome measures and robust follow-up to assess patient satisfaction, return to normal daily activities and recurrence are needed to strengthen the evidence.
Inguinal hernias are a common problem and concern in the population with more than 80,000 new diagnoses leading to more than 70,000 repairs between 2010 and 2011 in the UK; 20 million repairs are performed worldwide every year. Open inguinal hernia repairs are well-established procedures with good postoperative outcomes. Since the early 1990s laparoscopic techniques have become more popular. Some studies report an increase from 6% in 1992 to more than 40% in 2008 of hernias being repaired laparoscopically; this rapid rise in use may be because of less pain, faster recovery and better long-term outcomes. Furthermore, the minimally invasive procedures (typically the transperitoneal approach, but also the extraperitoneal approach if the midline raphe is crossed) offer the ability to examine the contralateral side, which may reveal an incipient or obvious hernia in up to 20% of patients. The proportion of laparoscopic repairs has increased markedly over the last 20 years. The 2 recognized types of laparoscopic approaches are totally extraperitoneal (TEPP) or transabdominal preperitoneal (TAPP). Although both techniques are safe and offer advantages, totally extraperitoneal (TEP) repairs may be associated with a lower incidence of port site hernias, bowel-related complications, less pain and greater patient satisfaction; conversely, TEP may be associated with an increased likelihood of conversion.

Greater patient education and demand for better cosmesis after surgical procedures have led to increased interest in laparoendoscopic single site surgery (LESS). Initially there was reluctance to adopt the technique owing to lack of technical facilitation; however, new or innovative port types and newer instruments have led to its application in a variety of surgical specialities. Laparoendoscopic single site TEP may be performed using conventional instruments, although articulating or curved instruments are in use. Although patients have good outcomes after conventional laparoscopic techniques, some authors suggest that there is a preference for LESS, which may be because of less postoperative pain or possible better cosmesis. Some have argued there is no advantage to single port surgery. We hypothesized that LESS TEP may be superior to conventional laparoscopic TEP (LAP TEP) because of fewer incisions, which may lead to less pain, and because the single incision in the umbilicus may result in a hidden scar with a better cosmetic appearance.

We reviewed the literature examining the role of LESS TEP for inguinal hernias. We aimed to compare LESS TEP with LAP TEP. Our main summative outcome measures were duration of surgery, hospital stay, cosmesis and return to activity.

METHODS

Searching and selection

We identified all studies examining the role of LESS TEP for hernia repairs or comparing LESS TEP with LAP TEP that were published between January 2008 and January 2012. We searched the Medline, Embase and CINAHL databases available through the National Health Service National Library of Health website, the Cochrane library and PubMed. A range of key words are available to describe LESS techniques, and we used these terms to search for relevant material. The main key words “single port,” “single site surgery,” “laparoendoscopic single site,” “single port access,” “single incision,” “multiport” and “totally extraperitoneal hernia repair” were used in combination with the medical subject headings “hernia” and “inguinal hernia.” Articles, reviews and meta-analyses that we considered irrelevant based on the titles and abstracts were excluded. Relevant articles referenced in these publications were obtained, and we searched the references of identified studies to identify any further studies. No language restriction was applied.

Quality assessment

Two authors (M.R.S.S. and M.K.) independently assessed the methodological quality of the trials included for meta-analysis using standardized reference tools.

Data extraction

Articles were included according to our review criteria (all noncomparative studies reporting on LESS TEP, all studies comparing LESS TEP with LAP TEP for groin hernias, all comparative or randomized studies, all elective cases, trials involving adults of any sex) and were reviewed by 2 researchers (M.R.S.S. and M.K.). This was performed independently, and if any conflict arose resolution was through discussion with the authors prior to analysis. Only papers examining the role of LESS TEP for hernias in adults and studies comparing LESS TEP with LAP TEP were included.

Our main outcome measures were duration of surgery for unilateral and bilateral hernias, hospital stay, complications, pain and concerns raised at follow up.

Statistical analysis

Statistical analyses were performed using Review Manager 5.0.23 (RevMan; Cochrane Collaboration). A value of $p < 0.05$ was chosen as the significance level for outcome measures. For continuous data (duration of surgery, hospital stay, return to activity), the inverse variance method was used for the combination of standardized mean differences (SMD). Binary data (intraoperative complications and recurrence) were summarized as risk ratios (RR) and combined using the Mantel–Haenszel method. Heterogeneity of the studies was assessed according to Q and $I^2$ statistics. We used a random-effects method if the heterogeneity was significant; otherwise a fixed-effects method was used. In a sensitivity analysis, I was added to each cell frequency for trials in which
REVUE

no event occurred, according to the method recommended by Deeks and colleagues.14 When standard deviations were not reported, we estimated them either from ranges or p values. Forest plots were used for the graphical display.

RESULTS

A total of 136 articles were screened for relevance. On further scrutiny, 16 articles15,19,22,35–47 were used in our literature review and 3 studies comparing LESS TEP with LAP TEP were found to have useful data for the summative outcome. One study commented on a previous report.27 Three studies22,40,45 compared LESS TEP with LAP TEP and were combined to produce a summative outcome. A flow chart of the literature search according to PRISMA guidelines48 is shown in Figure 1. Characteristics of each article are given in Tables 1 and 2.

Demographic characteristics of patients undergoing LESS TEP

Thirteen studies15,19,35–39,41–44,46,47 reported on 325 patients undergoing the LESS TEP procedure. The patient age range was 18–85 years,15,19,35–39,41–46 and 90% of patients were men.15,19,35–39,41–46

Surgical technique

Nine studies reported on the use of a balloon to create a preperitoneal space.15,19,37,44,46,47 Seven studies used a single port access device.15,19,36,38,39,41,43 Other techniques included the use of 3 ports through a single incision.15,37,42,44,46,47 A range of 0–45° cameras and straight, curved, articulating or manually bent instruments were used.15,37,42,44,46,47 Two studies36,43 did not report their mesh fixation method and 1 did not use any form of fixation.19

Outcomes after the LESS TEP approach

Perioperative data

The mean duration of surgery was 40–98 minutes for unilateral hernia repairs15,19,35–37,39,41,42,44,46,47 and 41–121 minutes for bilateral hernia repairs.15,16,19,36,39,41–44,46,47 Six patients required conversion, although no conversions were to a formal open procedure.15,16,41,42,46. "There were only 2 reported intraoperative complications involving bleeding or

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**Fig. 1.** Study selection. LAP = laparoscopic; LESS = laparoendoscopic single site surgery; TAPP = transabdominal preperitoneal; TEP = totally extraperitoneal.
### Table 1. Characteristics of studies included in our review and meta-analysis (part 1 of 2)

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>No. of patients</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>23</td>
<td>16</td>
<td>68</td>
<td>10</td>
<td>100</td>
<td>3</td>
<td>7</td>
<td>30</td>
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<tr>
<td>Age, yr (range)</td>
<td>60</td>
<td>NR</td>
<td>NR</td>
<td>48.4 (23–67)</td>
<td>65.5 (21–87)</td>
<td>44 (18–83)</td>
<td>43.7 (28–64)</td>
<td>48 (18–82)</td>
<td>64.6 (49–73)</td>
<td>46.5 (21–80)</td>
<td>NR</td>
</tr>
<tr>
<td>Sex, male:female</td>
<td>1:0</td>
<td>2:1</td>
<td>—</td>
<td>18.5</td>
<td>16.0</td>
<td>66.2</td>
<td>10.0</td>
<td>85.15</td>
<td>3.0</td>
<td>—</td>
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<td>Surgical technique</td>
<td>Balloon</td>
<td>Balloon</td>
<td>No balloon</td>
<td>Balloon</td>
<td>Balloon</td>
<td>Balloon</td>
<td>Balloon</td>
<td>Balloon</td>
<td>Balloon</td>
<td>Balloon</td>
<td>Balloon</td>
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<tr>
<td>Camera</td>
<td>—</td>
<td>45°</td>
<td>—</td>
<td>30°</td>
<td>—</td>
<td>30°</td>
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<td>30°</td>
<td>30°**</td>
<td>30°</td>
<td>30°</td>
</tr>
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<td>Instruments</td>
<td>Standard, straight</td>
<td>Standard, straight</td>
<td>Standard, straight</td>
<td>Articulating/standard</td>
<td>Standard, straight</td>
<td>Curved, standard</td>
<td>Standard, straight</td>
<td>Standard, straight</td>
<td>Standard, straight*</td>
<td>Curved, manually bent</td>
<td>Standard, straight</td>
</tr>
<tr>
<td>Incision length, cm (range)</td>
<td>2.5</td>
<td>2.5</td>
<td>Larger than standard TEP</td>
<td>2</td>
<td>3 (2.5–4.5)</td>
<td>2.5</td>
<td>2.8 (2.3–3.2)</td>
<td>2</td>
<td>2</td>
<td>1.5*</td>
<td>2</td>
</tr>
<tr>
<td>Fixed</td>
<td>Yes</td>
<td>Tacks</td>
<td>—</td>
<td>Tacks</td>
<td>Tacks</td>
<td>Tacks, glue</td>
<td>No fixation</td>
<td>Tacks</td>
<td>—</td>
<td>Tacks*</td>
<td>Tacks</td>
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<tr>
<td>Duration of surgery; n, min (range) or min ± SD</td>
<td>60 (52–66)</td>
<td>64.2 (40–175)</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Unilateral hernias</td>
<td>n = 1, 90</td>
<td>NA</td>
<td>n = 3</td>
<td>n = 19, 48.4 (32–62)</td>
<td>n = 13, 40 (25–75)</td>
<td>n = 36, 50 (35–90)</td>
<td>n = 10, 53.6 (45–65)</td>
<td>n = 83</td>
<td>NA</td>
<td>n = 24, 98.3 ± 26.7</td>
<td></td>
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<tr>
<td>Bilateral hernias</td>
<td>NA</td>
<td>n = 3, 79.3</td>
<td>n = 1</td>
<td>n = 4, 96.7 (95–120)</td>
<td>n = 3, 70 (60–75)</td>
<td>n = 32, 80 (40–125)</td>
<td>NA</td>
<td>n = 17</td>
<td>n = 3, 41 (26–65)</td>
<td>78.5 (52–110)</td>
<td>n = 6</td>
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<td>Hospital stay, d (range)</td>
<td>2</td>
<td>1, not recorded for 2 patients</td>
<td>—</td>
<td>1.17 (1–2)</td>
<td>&lt; 1</td>
<td>1 overnight patient</td>
<td>2</td>
<td>1.54 (1–11)</td>
<td>3</td>
<td>1.4</td>
<td>1.85</td>
</tr>
<tr>
<td>Conversion</td>
<td>0</td>
<td>0</td>
<td>1, bleeding; 1 extra port inserted</td>
<td>1, large hernia and adhesions; 2 extra ports inserted</td>
<td>0</td>
<td>1, unable to deploy port; 2 extra ports inserted</td>
<td>0</td>
<td>2, peritoneal tear and adhesions; LESS TAPP performed</td>
<td>0</td>
<td>0</td>
<td>0</td>
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Table 1. Characteristics of studies included in our review and meta-analysis (part 2 of 2)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Cugura et al.²²</th>
<th>Jacob et al.²⁶</th>
<th>Bucher et al.²⁶</th>
<th>Surgit et al.⁴¹</th>
<th>Agrawal et al.³⁰</th>
<th>Tran²⁶</th>
<th>Do et al.¹⁹</th>
<th>Chung et al.⁴²</th>
<th>He et al.²⁰</th>
<th>Tai et al.²⁵*</th>
<th>Shih et al.²⁷</th>
<th>Kim et al.²⁶</th>
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<tbody>
<tr>
<td><strong>Intraoperative complications, no.</strong></td>
<td>0</td>
<td>0</td>
<td>1, bleeding</td>
<td>0</td>
<td>0</td>
<td>—</td>
<td>0</td>
<td>1, peritoneal tear</td>
<td>—</td>
<td>No major complications</td>
<td>0</td>
<td>0</td>
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<tr>
<td><strong>Postoperative recovery</strong></td>
<td>Uneventful</td>
<td>Uneventful</td>
<td>Uneventful</td>
<td>Uneventful</td>
<td>Uneventful</td>
<td>Uneventful</td>
<td>Uneventful</td>
<td>2 had urinary retention</td>
<td>Uneventful</td>
<td>1 had ileus and seroma</td>
<td>2 had seroma</td>
<td>2: 1 had seroma, 1 had urinary retention</td>
</tr>
<tr>
<td><strong>Patient satisfaction (scale: 1–5)</strong></td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>None were dissatisfied</td>
<td>—</td>
<td>87.5% satisfied*</td>
<td>—</td>
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<tr>
<td><strong>Pain</strong></td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>n = 1, transient pain in testicle postoperatively</td>
<td>Most patients stopped analgesics within 48 h</td>
<td>No complaints of pain</td>
<td>5 patients had groin ache</td>
<td>Minimal pain at discharge</td>
<td>—</td>
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<td><strong>Return to activity, d</strong></td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>7–14</td>
<td>5.6 (1–30)</td>
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<tr>
<td><strong>Other follow-up</strong></td>
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<td>2 wk</td>
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<tr>
<td>1 mo</td>
<td>n = 1, no complications</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>1 wound infection, 1 wound dehiscence, 11 seroma/haematoma</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
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<tr>
<td>2–3 mo</td>
<td></td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>n = 2, minor wound complications</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
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<td>10–14 mo</td>
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<tr>
<td><strong>Recurrence, no.</strong></td>
<td></td>
<td>None at 2 wk</td>
<td>None at 14 wk</td>
<td>None at 1 mo</td>
<td>None at 2–3 mo</td>
<td>None at 1–10 mo</td>
<td>None at 1 mo</td>
<td>1 and 10 mo</td>
<td>None at 1 mo</td>
<td>None at 6 mo</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

NR = not reported; SD = standard deviation; TAPP = transabdominal preperitoneal; TEP = totally extraperitoneal.

*Results combined with TAPP hernia repairs.
a peritoneal tear. Hospital stay ranged from less than a day to 2.15 days. Postoperative recovery was uneventful all but 7 patients: seroma developed in 5 patients, 1 went into ileus and 1 experienced urinary retention.

**Follow-up**

Follow-up ranged from 2 weeks to 14 months. Patients reported only minimal discomfort or ache. There were only minor complications: epididymitis, wound infection, dehiscence and seroma/hematomas. Two studies reported on return to activities after a range of 5–14 days. There were no recurrences reported up to 14 months after the operation.

**Comparison with LAP TEP approach**

Three studies reported on a total of 128 patients in the LESS TEP group and 159 in the LAP TEP group.

**Duration of surgery**

**Unilateral hernia repairs**

Three studies contributed to a summative outcome. There was significant heterogeneity among trials (Q = 6.24, p = 0.040, I² = 68); therefore the fixed-effects model was inappropriate. There was no difference in duration of surgery between LESS TEP and LAP TEP (random-effects model: SMD = 0.16, 95% confidence interval [CI] –0.48 to 0.80, z = 0.49, p = 0.63; Fig. 2).

**Bilateral hernia repairs**

Three studies contributed to a summative outcome. There was no significant heterogeneity among trials (Q = 0.34, p = 0.84, I² = 0). There was no difference in duration of surgery between LESS TEP and LAP TEP (fixed-effects model: SMD = 0.18, 95% CI –0.16 to 0.52, z = 1.06, p = 0.29; Fig. 3).

**Hospital stay**

Three studies reported on hospital stay. There was no significant heterogeneity among trials (Q = 0.00, p > 0.99, I² = 0). There was no difference between groups (fixed-effects model: SMD = 0.00, 95% CI –0.23 to 0.23, z = 0.00, p > 0.99; Fig. 4).

**Intraoperative complications and conversions**

There was no significant heterogeneity among techniques according to the studies included (fixed-effects model: RR = 1.25, 95% CI 0.18–8.51, z = 0.23, p = 0.82). None of the patients required conversions.

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**Table 2. Characteristics of studies comparing LESS TEP with LAP TEP**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Shervinton et al.40</th>
<th>Tai et al.41</th>
<th>Cugura et al.30</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of patients</td>
<td>LAP TEP</td>
<td>LESS TEP</td>
<td>LAP TEP</td>
</tr>
<tr>
<td>Age, yr (range) or yr ± SD</td>
<td>52</td>
<td>52</td>
<td>22</td>
</tr>
<tr>
<td>Surgical technique</td>
<td>Preperitoneal space formed with balloon 1 × 11 mm, 2 × 6 mm ports (through single incision for LESS TEP), mesh fixed</td>
<td>Preperitoneal space formed with balloon 1 × 10 mm, 2 × 6 mm ports (through single incision via glove for LESS TEP), 30° camera and straight or curved instruments, mesh fixed</td>
<td>Preperitoneal space formed with balloon 1 × 10 mm, 2 × 6 mm ports (through single incision for LESS TEP), 0/30° camera and straight instruments, mesh fixed in majority of cases</td>
</tr>
<tr>
<td>Duration of surgery; n, min ± SD</td>
<td>33.7 ± 11.3</td>
<td>37.5 ± 11.9</td>
<td>58.5 (17–79)</td>
</tr>
<tr>
<td>Unilateral hernia</td>
<td>n = 39, 48.2 ± 10.8</td>
<td>n = 43, 51.7 ± 15.1</td>
<td>n = 19, 40 ± 21.6</td>
</tr>
<tr>
<td>Bilateral hernias</td>
<td>n = 13, 85.9 ± 8.2</td>
<td>n = 9, 86.8 ± 16.5</td>
<td>n = 3, 60 ± 15.3</td>
</tr>
<tr>
<td>Hospital stay, d ± SD</td>
<td>0.19 ± 0.07</td>
<td>0.19 ± 0.06</td>
<td>2.0 ± 1.6</td>
</tr>
<tr>
<td>Intraoperative complications, no.</td>
<td>—</td>
<td>—</td>
<td>0</td>
</tr>
<tr>
<td>Length of incision(s), cm (range)</td>
<td>—</td>
<td>—</td>
<td>3.5 (2.5–4.5)</td>
</tr>
<tr>
<td>Patient satisfaction, scale: 1–5 ± SD</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Pain</td>
<td>24 hr</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>1 wk</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Return to activity, d ± SD</td>
<td>11.88 ± 6.07</td>
<td>10.94 ± 5.7</td>
</tr>
<tr>
<td></td>
<td>Recurrence, no.</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

LAP = laparoscopic; LESS = laparoendoscopic single site; SD = standard deviation; TEP = totally extraperitoneal.
### Fig. 2. Duration of surgery for unilateral hernias. CI = confidence interval; IV = inverse variance; LAP = laparoscopic; LESS = laparoendoscopic single site surgery; SD = standard deviation; TEP = totally extraperitoneal.

### Fig. 3. Duration of surgery for bilateral hernias. CI = confidence interval; IV = inverse variance; LAP = laparoscopic; LESS = laparoendoscopic single site surgery; SD = standard deviation; TEP = totally extraperitoneal.

### Fig. 4. Hospital stay. CI = confidence interval; IV = inverse variance; LAP = laparoscopic; LESS = laparoendoscopic single site surgery; SD = standard deviation; TEP = totally extraperitoneal.

### Fig. 5. Return to activity. CI = confidence interval; IV = inverse variance; LAP = laparoscopic; LESS = laparoendoscopic single site surgery; SD = standard deviation; TEP = totally extraperitoneal.
**Cosmesis and follow-up**

The length of the incision in the umbilicus was similar in both techniques (1.5–2 cm); however, the total length of all incisions was slightly less in the LESS TEP group than the LAP TEP group (2 cm vs. 3.5 cm, respectively). This difference did not appear to translate into less satisfaction in the LAP TEP group. 

One study reported 5 and 6 minor complications in the LAP TEP and LESS TEP groups, respectively. There were 4 patients with seromas and 1 patient with bladder dysfunction after LAP TEP, and there were 3 patients with seromas and 3 with bladder dysfunction after LESS TEP.

**Pain**

Only 1 study reported on pain. After 24 hours, there appeared to be no difference between techniques; however, after 1 week patients who underwent LESS TEP had significantly less pain. One study reported on analgesic use, and although patients undergoing LESS TEP required painkillers for less time than those in the LAP TEP group, the difference was not significant.

**Return to activity**

Two studies reported on return to activity. There was no significant heterogeneity among trials (Q = 0.29, p = 0.59, I² = 0). Patients in the LESS TEP group restarted activity earlier, and this difference approached statistical significance (fixed-effects model: SMD = –0.49 to 0.02, z = 1.82, p = 0.07; Fig. 5).

**Recurrence**

There was no significant heterogeneity among trials (Q = 0.05, p = 0.82, I² = 0). There was no difference between techniques according to the studies included (fixed-effects model: RR = 1.25, 95% CI 0.18–8.51, z = 0.23, p = 0.82).

**Discussion**

The nature of surgery has led to developments in techniques to reduce the postoperative stress response and improvement in cosmesis. These include robotic laparoscopy, natural orifice transluminal endoscopic surgery (NOTES) and, increasingly, minimally invasive and LESS surgery. One of the main challenges to robotic surgery is cost; NOTES may be unacceptable to certain groups of patients, whereas LESS may be the most preferred approach.

**Main findings**

This paper examined the role of LESS TEP for inguinal hernia repairs and compared it with LAP TEP. Duration of surgery for unilateral and bilateral repairs showed a great variation but appeared comparable to conventional TEP performed by surgeons on different points of their learning curve. The conversion rate was low (0.02%) and no conversions were to a formal open technique; surgeons preferred to convert to TAPP or add further ports. Postoperative recovery was largely uneventful, and very few complications were noted. No recurrence was noted up to 14 months after surgery, and most patients returned to activity within 2 weeks.

Formal comparison with LAP TEP showed no significant difference in duration of surgery, hospital stay, intraoperative complications, conversions or recurrence. The LESS TEP procedure had a slightly smaller total incision length than LAP TEP. There are equivocal results in relation to pain and analgesic requirements. There was a trend for patients in the LESS TEP group to return to activity earlier, but the difference did not achieve statistical significance (p = 0.07); this result is consistent with the literature showing faster recovery in other settings.

**Importance**

The importance of these findings is that for patients with inguinal hernias, a range of safe and effective options is available and may be used to treat dual pathologies. Furthermore, the LESS technique may offer patients the ability to return to activity earlier, which may be especially important for those who are self-employed. This article also suggests that current evidence is strong enough to warrant further trials to establish the role of this technique. Although some articles suggest cosmesis may be better with LESS TEP, LAP TEP is an acceptable technique with good postoperative outcomes.

**Appraisal of evidence**

Owing to investment in newer or different instruments or ports, some suggest that LESS techniques are more expensive than conventional laparoscopic techniques; however, recent studies have shown comparability between the 2 techniques. There is a learning curve associated with LESS techniques; however, it may not be as steep as initially perceived and depends on a number of factors, including the type of port used for access. Nonetheless, experienced surgeons ought to perform or supervise these procedures to ensure adequate training. Furthermore, in the initial stages there may be a higher rate of postoperative complications until such time that the learning curve has reached a plateau. Technical challenges include access, poor triangulation and lack of space leading to instrument clash, which may be overcome by the use of 30° cameras. Instrument control may also be less intuitive. One disadvantage to LAP TEP is that if complications arise conversion to either LAP TAP or open surgery may be the only options, whereas with LESS TEP conversion to conventional LAP TEP is also an option.

Future advances include robotic surgery; however, recent studies have shown similar durations of surgery, and...
although remote operating is a definite advantage, costs may be prohibitive.11

From a patient perspective, single incision surgery is more appealing presumably owing to potential cosmetic benefits; however, this should be in the context of an appropriate safety profile.66 The cosmetic concern may be greater in children, with recent studies showing good outcomes.22,48 One factor regarding cosmesis is the position of the scar, with some reports suggesting an intramuscular or crescentic incision giving the best outcomes.22,48

Heterogeneity

The literature varied greatly in terms of specifics involved with the LESS TEP technique. In our literature review, some authors used a balloon11,19,35,38,41,42,44,47 to create the preperitoneal space, whereas others used blunt dissection.45 A range and combination of straight or curved and articulating instruments and 0°–45° cameras were used. Only 1 study reported no mesh fixation.19

In our pooled analysis comparing LESS TEP with LAP TEP, there was significant heterogeneity in the duration of surgery for unilateral repairs. This may be related to slightly different technique variations and differences in learning curve. This finding is in keeping with the lack of heterogeneity in duration of bilateral repair, reflecting progression in the number of procedures performed. However, most of the included studies did not state where the bilateral hernias were in relation to their learning curve. There was no significant heterogeneity in relation to hospital stay, recurrence, intraoperative complications or return to activity, which probably reflects similar clinical and follow-up protocols among the centres. Although there was no significant heterogeneity, there were some clinical differences in the type of technique used (Table 2). For example, some authors used a homemade port,19 some used different cameras and 1 group did not fix the mesh in all patients.22 Only 1 study reported the type of analgesics used and their discharge protocols.40 The activities to which patients returned were not clearly identified, and convalescence may have been very different depending on age, sex and type of employment.16 Other limitations to our study include the use of assessments of the papers according to set criteria. Although this may give an indication to the strength of the study, it may not highlight potential weaknesses, including detailed differences that were not documented in the studies, such as site of pain (umbilical v. pubic due to tacks) or sequelae of complications.

The degree of clinical heterogeneity means firm conclusions for practice need to be made with caution.

Quality assessment

We did not formally assess the quality of the studies included in our initial review. This was generally because of the small numbers in the series and because of the relative paucity of studies in the literature. In our early meta-analysis there was only 1 study12 that stated it was a randomized controlled trial of moderate quality; however, the study did not detail sample size calculations, allocation concealment or analysis based on intention to treat, which may lead to significant bias in reporting outcomes. Furthermore, this same trial did not specifically state it was double-blind. The remaining 2 studies were comparative studies, and 1 was a comparison with a historical cohort, which presents inherent weaknesses. One study12 did not report inclusion or exclusion criteria; the other study40 did not state clearly their diagnostic criteria or identify standardized outcome forms. It is too early to comment on publication bias.

Future studies

Further prospective randomized studies focusing on cosmesis, postoperative pain, analgesic requirements and return to activity are required to assess whether LESS TEP has an advantage over LAP TEP.40 Clear definitions of pain and return to activity should be given with examination of the type of job conducted, as it may be that LESS TEPP may benefit particular groups of workers. Studies should consider the learning curve of the surgeon to ensure appropriate comparisons with LAP TEP in relation to duration of surgery and hospital stay. Our review highlights the need for a multicentre randomized controlled trial with appropriate follow up.

Conclusion

The LESS TEP hernia repair is a relatively new technique and appears to be safe and effective. Advantages, such as less visible scarring, mean patients may opt for LESS TEP over LAP TEP. Further studies with clear definitions of outcome measures and robust follow up to assess patient satisfaction, return to normal daily activities and recurrence are required to strengthen the evidence.

Competing interests: None declared.

Contributors: M.R.S. Siddiqui, M. Kovzel, O. Priest, S.R. Preston and Y. Soon designed the study. M.R.S. Siddiqui and M. Kovzel acquired the data, which M.R.S. Siddiqui, M. Kovzel and S. Brennan analyzed. M.R.S. Siddiqui and M. Kovzel wrote the article, which all authors reviewed and approved for publication.

References


Transanal endoscopic microsurgery: a review

Rectal adenomas and cancers occur frequently. Small adenomas can be removed colonoscopically, whereas larger polyps are removed via conventional transanal excision. Owing to technical difficulties, adenomas of the mid- and upper rectum require radical resection. Transanal endoscopic microsurgery (TEM) was first designed as an alternative treatment for these lesions. However, since its development TEM has been also used for a variety of rectal lesions, including carcinoids, rectal prolapse and diverticula, early stage carcinomas and palliative resection of rectal cancers. The objective of this review is to describe the current status of TEM in the treatment of rectal lesions. Since the 1980s, TEM has advanced substantially. With low recurrence rates, it is the method of choice for resection of endoscopically unresectable adenomas. Some studies have shown benefits to its use in treating early T1 rectal cancers compared with radical surgery in select patients. However, for more advanced rectal cancers TEM should be considered palliative or experimental. This technique has also been shown to be safe for the treatment of other uncommon rectal tumours, such as carcinoids. Transanal endoscopic microsurgery may allow for new strategies in the treatment of rectal pathology where technical limitations of transanal techniques have limited endoluminal surgical innovations.

rectal adenomas and cancers are common. In 2007, 6721 new cases of rectal and rectosigmoid cancers were reported in Canada, representing an annual incidence of 20.4 per 100 000.1–3 In the United States, 40 000 new diagnoses of rectal cancer and 51 370 deaths from colon and rectal cancers were estimated for 2014.4 As premalignant lesions, adenomas are thought to transform into adenocarcinoma in 2.5% of patients after 1 year and in 8% after 5 years.5,6 In the lower rectum, small adenomatous polyps can be removed colonoscopically, whereas larger polyps are removed via conventional transanal excision (TAE) using anal retractors and diathermy. Adenomas of the mid- and upper rectum are much more difficult to visualize and remove transanally, thus requiring radical, transabdominal resection in most cases, including anastomosis where possible.

In the early 1980s, Buess and colleagues7 developed a transanal operating proc- toscope with modified laparoscopic instruments as an alternative treatment for these lesions using a technique known as transanal endoscopic microsurgery (TEM). Following animal model experiments,7 the group described the use of TEM to remove a rectal adenoma in a human in 1983.8 The method was conceptually designed to facilitate removal of endoscopically unresectable sessile polyps using a minimally invasive technique. After this early success with benign disease,
REVUE

the technique has been subsequently used to remove early stage carcinomas and carcinoids of the rectum, for palliative resection of advanced rectal cancers and to surgically correct rectal prolapse and rectal diverticular disease.9

The objective of this review is to describe the current status of TEM in the treatment of rectal lesions.

Technique

The TEM technique involves 3 main components: an operating proctoscope, a laparoscopic camera and modified laparoscopic instruments. The operating proctoscope is typically 4 cm in diameter and varies from 12 cm to 20 cm in length. The proctoscope maintains an airtight seal at the anus once inserted in the rectum and is held in place by the obligate articulating arm, which fixes the proctoscope to the operating table. The proctoscope has a port for inflow (typically CO2) and outflow, which facilitates smoke evacuation during cauterization. The faceplate on the proctoscope has 4 ports through which a camera and 3 modified laparoscopic instruments facilitate the full-thickness excision of rectal lesions up to 25 cm from the anal verge.10 In conventional laparoscopy, levering of the instruments is the primary strategy for dissection and retraction, but in the confines of the rectum while operating transanally the surgeon is restricted to more rotational movements; thus, the operating ends of the instruments are angulated to improve the operator’s range of motion (Fig. 1).

Learning curve

Owing to the technically challenging nature of TEM, limited indications for the procedure and cost of the equipment, the learning curve is steep.10,11 However, in hospitals where surgeons are experienced in minimally invasive operations, the technique is acquired more rapidly.12,13 Decreased complication rates, hospital stay, blood loss and duration of surgery after gaining experience with TEM have been reported in several studies.14,16 Koebrugge and colleagues17 investigated a learning curve effect for TEM in their series of 105 patients from 2002 to 2007. Dividing patients into 2 groups (2002–2004 and 2005–2007), they observed a significant decrease in duration of surgery, hospital stay and postoperative complications in the latter group. These findings are consistent with those of studies that examined the learning curve in laparoscopic colorectal procedures and laparoscopic cholecystectomy.12,18–20

Duration of surgery, length of stay and cost

In centres with more extensive TEM experience, average durations of surgery range from 45 to 113 minutes (Table 1), depending on the size and location of the lesion and the surgeon’s experience.14,17 Also, a number of studies have reported significantly decreased duration of surgery for TEM compared with radical resection, with reductions ranging from 46 to 140 minutes.21–24

![Fig. 1. Transanal endoscopic microsurgery (TEM) operating room set-up. (A) Camera, (B) light source, (C) lens clearing fluid, (D) insufflation tubing, (E) laparoscopy tower, (F) operating instruments, (G) suction, (H) ports, (I) operating anoscope, (J) TEM scope holding arm.](image-url)
Most patients who undergo TEM experience short hospital stay and early return to routine activities, even after resection of very large lesions, often with full thickness excision. Most TEM case series report mean postoperative hospital stays of 0–5 days.25–28 Shorter hospital stay and lower rate of postoperative complications after TEM also contribute to a considerable reduction in operation costs. In an American study by Cocilovo and colleagues,29 the cost-effectiveness of TEM compared with radical resection was analyzed. The average cost per patient (excluding device cost) for TEM was reported as $7775 compared with $34 018 for low anterior resection. These cost savings are mitigated by the relatively high initial cost of the instrumentation. However, in centres performing high volumes of TEM procedures, the per procedure costs are substantially reduced.29

**Functional outcomes**

Anorectal function after TEM has been addressed in several studies.10–14 As a result of the dilation of the anal canal by the proctoscope and possibly prolonged operations, it has been suggested that damage to the anal sphincter could cause postoperative fecal incontinence.15 Although manometric studies have shown decreased anal sphincter pressures and compliance after surgery, no remarkable detrimental long-term clinical impact on continence after TEM has been observed.15,36

Kreis and colleagues32 investigated functional outcomes after TEM in 42 patients using manometry and standardized interview scales. They observed decreased anal sphincter resting pressure 3 months and 1 year postoperatively (both \( p < 0.01 \)). However, the reduced squeezing pressure 3 months after surgery improved at 1 year. Kreis and colleagues suggested that these findings could be explained by the elderly group of patients undergoing TEM or by the direct effect of the tumour itself rather than the surgical technique. Similarly, in a prospective study of 41 patients Cataldo and colleagues33 found no deleterious consequences on fecal continence after TEM. They did not find any significant difference between pre- and postoperative mean Fecal Incontinence Severity Index (FISI) score (2.4 v. 2.4), mean Fecal Incontinence Quality of Life (FIQL) scores (lifestyle: 3.6 v. 3.5; coping: 3.7 v. 3.5, depression: 3.9 v. 3.8, embarrassment 3.6 v. 3.4), number of bowel movements per day (mean 2.4 v. 1.5) and ability to defer defecation. In a recent study of 50 patients Doornebosch and colleagues34 found significantly improved FISI and FIQL measures after 5 years of follow-up in 93 patients who underwent TEM. The authors assessed manometric and clinical values preoperatively and at 3, 12 and 60 months after surgery. Similarly to previous studies, manometric values, including anal resting pressure, rectal sensitivity threshold, maximum tolerated volume and urge to defecate threshold, declined at 3 months but returned to preoperative level at 12 months after surgery. Compared with preoperative levels, there were no significant changes in anal squeeze pressure after surgery. Wexner incontinence scores and general quality of life scores, which were increased in the early postoperative period, returned to preoperative levels at 5 years. They also reported that tumours larger than 4 cm caused a significant decline in rectal sensitivity, urge to defecate thresholds and maximum tolerated volume at 3 months (\( p = 0.008 \)). Tumor size was the only factor predicting postoperative urgency in this series. The best available evidence suggests that, independently, the TEM procedure seems to have no permanent deleterious effect on fecal continence.

**OUTCOMES AND COMPLICATIONS**

**Adenoma**

Since its introduction, TEM has been used primarily for resection of large adenomas of the rectum.25,26,39 Several studies in recent years have shown TEM to be a safe alternative to TAE in the treatment of rectal adenomas. Transanal endoscopic microsurgery excision of adenomas results in low adenoma recurrence rates. In the 2893 TEM procedures for adenomas reported in the literature, the reported local recurrence rates vary from 2% to 16% in individual series (Table 2).9,12,17,18,40–52 Several studies have compared local recurrence of adenomas treated by TEM and TAE. De Graaf and colleagues66 compared outcomes in 248 patients with rectal adenomas: 208 treated with TEM and 40 treated with TAE. They resected 216 adenomas in the TEM group and 43 adenomas in the TAE group. On pathology evaluation, patients who underwent TEM were significantly more likely

### Table 1. Duration of surgery for resection of rectal neoplasms using TEM

<table>
<thead>
<tr>
<th>Study</th>
<th>Time in OR, mean (range)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tsai et al.44</td>
<td>84 ± 4</td>
</tr>
<tr>
<td>Benign, mean (± SD) min</td>
<td>86 ± 4</td>
</tr>
<tr>
<td>Malignant, mean (± SD) min</td>
<td>75 (20–265)</td>
</tr>
<tr>
<td>Jeong et al.35</td>
<td>66 (15–240)</td>
</tr>
<tr>
<td>Allaix et al.37</td>
<td>90 (65–120)</td>
</tr>
<tr>
<td>Guerrieri et al.45</td>
<td>48 (10–110)</td>
</tr>
<tr>
<td>Whitehouse et al.32</td>
<td>81 (38–180)</td>
</tr>
<tr>
<td>Zacharakis et al.30</td>
<td>78 ± 15</td>
</tr>
<tr>
<td>Benign, mean (± SD) min</td>
<td>86 ± 10</td>
</tr>
<tr>
<td>Malignant, mean (± SD) min</td>
<td>90 (20–150)</td>
</tr>
<tr>
<td>Maslekar et al.34</td>
<td>45 (10–180)</td>
</tr>
<tr>
<td>Bretagnol et al.26</td>
<td>75 (20–385)</td>
</tr>
<tr>
<td>Smith et al.30</td>
<td>113</td>
</tr>
<tr>
<td>Steele et al.26</td>
<td>60 (20–240)</td>
</tr>
<tr>
<td>Winde et al.31</td>
<td>103</td>
</tr>
</tbody>
</table>

*Unless otherwise indicated.

OR = operating room; SD = standard deviation; TEM = transanal endoscopic microsurgery.
to have negative margins on the adenoma excision than those who underwent TAE (88% v. 50%, p < 0.001). The authors reported recurrence rates of 6.1% and 28.7% after TEM and TAE, respectively (p < 0.001). Similarly, in another study of 78 patients with adenoma treated with TEM (n = 40) or TAE (n = 38), Moore and colleagues\(^2\) reported more frequent negative margins (83% v. 61%, p = 0.030) and a lower recurrence rate in the TEM group (3% v. 32%, p = 0.003). The higher rate of negative margins achieved in adenoma resection using TEM seems to account for the lower rate of recurrence associated with this procedure. In a series of 117 patients Speake and colleagues\(^3\) used TEM to remove rectal adenomas in 80 patients. No recurrence developed in patients with negative margin resections. However, the authors reported a 10% recurrence for the positive margin specimens (p = 0.001). The importance of achieving negative margins in preventing local recurrence in patients undergoing TEM is highlighted in several studies. McCloud and colleagues\(^4\) investigated the predictors of early recurrence in patients with adenomas after TEM. They found significantly different recurrence rates between complete and incomplete excision groups after a median follow up of 31 months (4.3% v. 35.7%, p < 0.001). In subgroup analysis, their 75 patients were divided into 3 groups based on the largest tumour dimension: 0–50 mm (n = 45), 51–100 mm (n = 27) and 101 mm or larger (n = 3). Recurrence increased as tumour size increased (8.9% v. 25.9% v. 33.3%, p = 0.020). The authors surmised that large size of a polyp is likely related to an inability to completely excise with clear margins, thus leading to recurrence. Close monitoring of patients with positive margins or incomplete excision through endoscopic follow-up is highly recommended.

Complications after TEM for adenoma have been evaluated in several studies. Guerrieri and colleagues\(^5\) evaluated 588 patients with rectal adenoma at 6 centres in Italy. Overall, 81.1% of these patients experienced minor complications (e.g., suture site leakage, soiling and minor postoperative bleeding) and 1.2% experienced major complications (e.g., rectal hemorrhage requiring intervention, rectovaginal fistula requiring ileostomy, rectovesical fistula, suture site leakage treated with second TEM) within 30 days of surgery. Said and Stippel\(^6\) studied 280 patients with rectal adenoma, 3.4% of whom had postoperative complications including perforation, bleeding and fistula. They reported 1 (0.3%) postoperative death due to a recurrent thromboembolic event. In another study, Whitehouse and colleagues\(^7\) performed 146 TEMs in 143 patients. Six (4.1%) patients had postoperative bleeding and received transfusions. Two of them had repeat TEM to stop the bleeding. The authors reported 1 procedure-related death due to intraperitoneal perforation and leakage. They also found nonsignificant radiologic leaks in 3 patients (2%) who were managed nonoperatively.

In summary, for adenomas TEM has shown excellent results, low recurrence rates and a remarkably favourable complication profile compared with TAE\(^8-11\) and radical resection.\(^12-13\) The evidence supports TEM as the preferred approach to rectal adenoma resection when colonoscopic removal is not possible.

### Adenocarcinoma

#### Early rectal adenocarcinomas

Transanal adenoma excision for early rectal cancer is controversial. Recent data from well-designed observational studies have suggested high local recurrence rates and worse survival in patients treated with TAE compared to those treated with radical resection (Table 3).\(^14-20\) Bentrem and colleagues\(^21\) completed a study of 319 patients who were treated for T1 rectal adenocarcinomas by either TAE (n = 151) or radical resection (n = 168) over a 17-year period. The authors compared local and distant recurrence, disease-free survival and overall survival between the 2 groups. Survival analysis was based on a follow-up period of 51 months. Their results indicated significantly lower 5-year local and overall recurrence rates in the radical resection group. Nonetheless, they observed similar outcomes in terms of disease-free and overall survival between the 2 procedures. While these data are concerning, it is possible that high local recurrence rates associated with TAE may be partially related to the technical challenges of the procedure. Comparative studies of TEM and TAE for early rectal cancers demonstrated fewer resections with positive margins and lower local recurrence rates with TEM. In a study of patients with early rectal cancers, Christoforidis and colleagues\(^22\) found a lower local recurrence rate in patients undergoing TEM than in those who had TAE, although the difference was not significant (12% v. 22%, p = 0.37). They also found better tumour resection in patients who underwent TEM, with fewer positive margins in these patients than in those who underwent TAE (37% v. 19%, p = 0.001). Langer and colleagues\(^23\) also confirmed that TEM is superior to TAE with respect to resection margin results, with higher R1 and Rx resections in patients who underwent TAE (37% v. 16% v. 19% and 5%, respectively, p = 0.001). Furthermore, conventional TAE is usually limited to resection of the rectal wall, whereas TEM facilitates excision of some mesorectal, fat and perirectal lymph nodes, which can be retrieved and sampled with the specimen.

For rectal cancer, the gold standard therapy is radical resection. In the Dutch total mesorectal excision (TME) trial\(^24\), patients with T1 cancer treated with TME alone had 1.7% local recurrence at 2 year follow-up. Use of TEM in patients with early rectal adenocarcinomas is usually limited to patients with low-risk T1 rectal adenocarcinomas that are small (< 4 cm); well differentiated; have no lymphatic, vascular or perineural involvement; and are located within 15 cm of the anal verge. Early rectal cancer is defined as invasive adenocarcinoma confined to the submucosal layer. Once the cancer spreads beyond the mucosal layer, it is possible for it to metastasize to local lymph nodes or even distant organs. Kudo\(^25\) proposed a submucosal (sm) classification (sm1 refers to...
infiltration into the upper third, sm2 into the middle third and sm3 into the lower third of the submucosal layer) that describes the level of penetration of the tumour into the submucosa. It has been used previously to predict lymph node metastasis and to select the proper treatment approach in patients with early rectal cancer.\textsuperscript{86-89} Studies report that the risk of lymph node involvement correlates with the depth of tumour invasion into the submucosa.\textsuperscript{90-93} Kikuchi and colleagues\textsuperscript{86} reported that the overall incidence of lymph node metastasis was 5\% in patients with sm2 and 25\% in those with sm3 tumours. However, they found that none of their patients with sm1 and pedunculated sm2 tumours had lymph node metastasis. For pedunculated polyps, sm1 classification is similar to Haggit level 1 classification, and sm2 includes node metastasis. For pedunculated polyps, sm1 classification is used in patients with sm1 and pedunculated sm2 submucosal rectal cancers, these tumours could be removed by local excision. However, if margins are positive, radical options are more favourable in this group of patients. In cases of greater submucosal invasion (sm3), an sm2 sessile tumour or when vessels are involved, radical resection or adjuvant therapy after local resection should be considered. On the other hand, more recently, in a retrospective study, Choi and colleagues\textsuperscript{94} reported a higher incidence of lymph node metastasis in patients with sm2 and sm3 rectal cancers (21.3\% and 38.5\%, respectively). They also reported that 4 patients with sm1 invasion showed evidence of lymph node metastasis (4.2\%). The authors suggest that even in the case of sm1 invasion, local resection should be reserved for meticulously selected patients. In any event, precise preoperative staging is critical in the selection of appropriate patients to optimize outcomes.\textsuperscript{95}

With the advancement of magnetic resonance imaging (MRI), the accuracy in staging rectal cancer has increased significantly. Studies report MRI accuracy of 65\%–100\% in the staging of rectal cancer.\textsuperscript{96-99} This variability might cause difficulty, especially when staging borderline tumours. The role of MRI in the staging of early rectal cancer is not yet evident owing to its limited ability to distinguish between mucosal and submucosal layers of the rectal wall.\textsuperscript{100} However, MRI has been shown to be effective in the evaluation of mesorectal fat and fascia, which are important features in treatment planning, especially for patients with more advanced cancers. Endorectal ultrasonography (ERUS) is usually used to assess T stage and has been reported to have an accuracy of up to 94\%.\textsuperscript{101,102} However, ERUS is not reliable in assessing lymph node positivity.\textsuperscript{103-105} Nonetheless, the combination of digital rectal examination, ERUS and flexible sigmoidoscopy with biopsy is the recommended preoperative staging and tumour assessment strategy when considering TEM. In otherwise appropriate candidates who have an ERUS suggestive of T2 or T3 disease but in whom there is clinical suspicion of early cancer, TEM can still be used to confirm T stage in patients who are reluctant to undergo radical resection; early salvage surgery can still be performed postoperatively if advanced rectal cancer is identified.\textsuperscript{106} Moreover, there are a number of reports that immediate reoperation after local excision of rectal carcinomas demonstrates oncologic results comparable to primary radical resection.\textsuperscript{107-109}

Several groups have reported their experience with TEM in patients with early rectal cancers (Table 4).\textsuperscript{110-119} Baartrup and colleagues\textsuperscript{110} retrospectively studied 72 patients

| Table 2. Local recurrence in patients undergoing TEM for resection of rectal adenoma |
|----------------------------------|----------------|----------------|--------------------|
| Study                           | Patients, no. | Recurrence, % | Follow-up, mean (range)* |
| de Graaf et al.\textsuperscript{12} | 208           | 6.1           | 32 (0.4–95)         |
| Tsai et al.\textsuperscript{14}   | 156           | 5.0           | 24.5 (6–128)        |
| Guerrieri et al.\textsuperscript{14} | 402           | 4.0           | 84 (1–190)          |
| van den Broek.\textsuperscript{17} | 248           | 9.3           | 13 (0–48)           |
| Ramirez et al.\textsuperscript{17} | 149           | 5.4           | 43 (12–112)         |
| de Graaf et al.\textsuperscript{14} | 309           | 6.6           | 27 (0–123)          |
| Moore et al., mean (± SD) mo     | 40            | 3.0           | 20 ± 16             |
| Speake et al.\textsuperscript{17} | 80            | 12.5          | 12 (3–84)           |
| Guerrieri et al.\textsuperscript{14} | 598           | 4.3           | 44 (15–74)          |
| McCloud et al.\textsuperscript{80} | 75            | 16.0          | 31 (6–80)           |
| Whitehouse et al.\textsuperscript{58} | 143           | 4.8           | 39 (4–89)           |
| Endreseth et al.\textsuperscript{41} | 64            | 13.0          | 24 (1–95)           |
| Platell et al., mean (± SD) mo   | 62            | 2.4           | 18 ± 0.9            |
| Palma et al.\textsuperscript{100} | 71            | 5.6           | 30 (6–54)           |
| Said et al.\textsuperscript{44}   | 260           | 6.5           | 38.3 (3–129.6)      |
| *SD = standard deviation; TEM = transanal endoscopic microsurgery. | | | |

| Table 3. Studies comparing transanal excision versus radical resection in treatment of rectal cancers |
|----------------------------------|----------------|----------------|--------------------|
| Study                           | Patients, no. | Recurrence, % | 5-year survival, % |
| Nash et al.\textsuperscript{30} | 137           | 13.2*         | 87* 79*            |
| RR                             | 146           | 2.7*          | 96* 90*            |
| Endreseth et al.\textsuperscript{41} | 29            | 12*           | 64* 70*            |
| RR                             | 256           | 6*            | 77* 80*            |
| Bentrem et al.\textsuperscript{30} | 151           | 15*           | 93 89             |
| RR                             | 168           | 3*            | 6* 97 93           |
| Nascimbeni et al.\textsuperscript{87} | 70            | 6.6           | 89 72.4*          |
| RR                             | 74            | 2.8           | 90.4*              |
| Meilgren et al.\textsuperscript{82} | 69            | 18*           | 95 72             |
| RR                             | 30            | 58*           | 9 95 80            |

*RR = radical resection; TAE = transanal excision. Statistically significant.\textsuperscript{120-122}
### Table 4. Transanal endoscopic microsurgery outcomes in rectal adenocarcinoma

<table>
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<tr>
<th>Study</th>
<th>Tumour stage</th>
<th>Patients, no.</th>
<th>Local recurrence, %</th>
<th>Follow-up, mean (range) or ± SD mo</th>
<th>Hospital stay, mean (range) or ± SD d</th>
<th>Disease-specific 5-year survival, %</th>
<th>Overall 5-year survival, %</th>
<th>Positive resection margin, %</th>
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fu = follow-up; SD = standard deviation.
with pT1 cancers. They reported a recurrence rate of 13% (9 of 72), 5-year cancer-specific mortality of 6% (4 of 72) and 5-year total survival of 76%. Allaix and colleagues studied 300 patients with rectal neoplasms treated with TEM between 1993 and 2007. Three of 38 patients with pT1 cancers received postoperative radiotherapy. The authors observed no recurrence; the overall and disease-free survival rates were 100% at a mean follow-up of 60 months in this group of highly selected patients.

Four studies have compared oncologic results of TEM and radical surgery exclusively in patients with T1 rectal cancers (Table 5). Only 1 was a prospective randomized study. In this study, Winde and colleagues found no difference in oncologic outcomes between the treatment groups. Similarly the other 3 studies reported no difference in 5-year cancer-free and overall survival rates. De Graaf and colleagues reported a significantly lower local recurrence rate in the radical resection group (24% in the TEM group vs. 0% in the TME group, p < 0.001). Positive margin rates were shown to be higher with TEM than radical resection by Palma and colleagues and Heintz and colleagues; however, they observed similar local recurrence rates in both the TEM and radical resection groups. All of these studies suggest that patients treated with TEM had significantly shorter duration of surgery, less blood loss, shorter hospital stay, lower angesic demand and lower morbidity.

As such, the available evidence suggests that TEM alone seems to be a reasonable alternative to radical resection in patients with low-risk T1 adenocarcinomas. However, further therapeutic steps (salvage surgery or chemoradiation [CRT]) should be considered in patients with positive margins, as suggested in the literature. Furthermore, scrutinous preoperative patient selection and disclosure of the limited evidence to the patient is critical.

**Advanced rectal adenocarcinomas**

The limited role of TEM in the treatment of more locally advanced tumours is more defined. Lymph node involvement ranges from 12% to 28% in patients with T2 tumours and from 36% to 66% in those with T3 tumours. High rates of local recurrence for T2 (up to 50%) and T3 tumours (up to 100%) with conventional local excision alone have been reported.

Transanal endoscopic microsurgery alone is not a reasonable treatment for fit patients who have rectal cancer that is local stage T2 or deeper. There is recent data to guide the use of TEM in patients with T2 and T3 rectal cancers. Borschitz and colleagues found reduced local recurrence in patients with T2 rectal carcino mas who underwent immediate reoperation after TEM as opposed to those who had TEM alone (12% vs. 35%, p value not reported). Similarly Tsai and colleagues reported their results of TEM resection of rectal cancer in a retrospective series of 269 patients (111 patients with adenocarcinomas: 58 with T1, 26 with T2 and 11 with T3 tumours). Patients with less than 6 months of follow-up, those who had previous resection, patients with metastases at the time of presentation and those who underwent radical surgery after TEM were excluded from the recurrence analysis. The mean follow-up was 42.8 (range 9–116) months for patients with T2 and 44.7 (range 8–73) months for those with T3 tumours. The authors reported a local recurrence rate of 23.5% (4 of 17) and 100% (4 of 4) for patients with pT2 and pT3 adenocarcinomas, respectively. Two of 4 patients with recurrent T2 tumours underwent abdominoperineal resection.

### Table 5. Studies comparing TEM and radical resection in the treatment of early rectal cancers (T1)

<table>
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<tr>
<th>Study</th>
<th>Patients, no.</th>
<th>Follow-up, mean ± SD mo*</th>
<th>Recurrence, %</th>
<th>5-year survival, %</th>
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<td>TEM</td>
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<td>8</td>
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<td>Palma et al., no. of mo</td>
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<td>TEM</td>
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RR = radical resection; SD = standard deviation; TAE = transanal excision; TEM = transanal endoscopic microsurgery; TME = total mesorectal excision.

*Unless otherwise indicated.

†Tumours in 3 patients were resected with a Park retractor owing to their proximity to the anal verge.

‡Statistically significant.
Transanal endoscopic microsurgery after neoadjuvant therapy for downstaging of advanced tumours is being investigated and has demonstrated promising results. Lozano and colleagues randomly assigned 70 patients with T2N0 rectal cancer to TEM and laparoscopic resection (LR) procedures after CRT. Patients were restaged after neoadjuvant therapy. Those in the TEM group had significantly better results in terms of hospital stay, blood loss and duration of surgery than those in the LR group, although there was no difference in complication rates between the groups. Oncologic results after TEM and LR were comparable in terms of local (5.7% vs. 2.8%) and distant (both 2.8%) recurrence rates (combined local and distant recurrences 9% vs. 6%) and probability of disease-free survival (both 94%). However, lower morbidity, shorter hospital stay and faster return to normal activities in the TEM group may suggest that this technique is favourable for selected patients with T2 disease without nodal involvement or distant metastasis, though more evidence is required. Guerrieri and colleagues studied 137 patients with rectal adenocarcinoma treated with TEM. Fifty-four patients with T2 and 46 with T3 disease underwent neoadjuvant radiotherapy. Twenty-eight patients with T1 disease who had favourable differentiation did not receive neoadjuvant radiation. Likewise, 9 patients with T2 and T3 disease did not receive neoadjuvant radiotherapy owing to bleeding, treatment refusal and preoperative diagnosis of adenoma. Among those who received pre-TEM radiation, 2 patients with T2 (3.7%) and 2 patients with T3 disease (4.3%) had local recurrence at a mean of 46 (range 6–113) months follow-up. This is compared with 3 local recurrences (33%) in patients who did not have radiation preoperatively. Eighteen patients preoperatively staged as having T2 (n = 12) and T3 (n = 6) disease who received radiotherapy before the operation had no residual malignancy (pT0) in the final pathology assessment.

In a recent prospective, multi-institutional phase II trial, Garcia-Aguilar and colleagues reported the preliminary results of the American College of Surgeons Oncology Group (ACOSOG) in patients with T2N0 rectal cancer. Seventy-seven patients, completed neoadjuvant CRT followed by local excision within 4–8 weeks. Following CRT 56% of the patients showed a complete clinical response defined as “complete disappearance of tumour on proctoscopic exam.” A positive resection margin was observed in 1 patient (1%), and 1 patient with pT3 disease who underwent TME following LE was shown to have lymph node metastasis after CRT. In 49 patients (64%) tumours were down-staged to pT0–1. Pathologic complete response was observed in 22 patients (44%) and complete clinical response reached a sensitivity of 85% and specificity of 67% in prediction of pathologic complete response in this study. Perioperative complications occurred in 45 (58%) patients, with rectal pain being the most common. Overall this study demonstrates the effectiveness of CRT in the nonradical approach to rectal cancer in selected patients; however, further adjustments need
to be made to CRT protocols to reduce the relatively high rate of adverse effects associated with CRT.

Carcinoids

Mentges and colleagues\textsuperscript{15} were the first to report the use of TEM in the resection of rectal carcinoid tumours. Subsequently, several authors presented their experience with TEM and carcinoids.\textsuperscript{117–121} Carcinoids eligible for local excision are typically smaller and less technically challenging than rectal adenocarcinomas.\textsuperscript{118} Kinoshita and colleagues\textsuperscript{117} reported their results in 27 patients with carcinoid tumours treated with TEM. Fourteen patients had TEM for primary excision, and the remaining 13 underwent TEM for excision of prior incomplete endoscopic resection of rectal carcinoids. Duration of surgery, blood loss and histopathologic results did not differ between these 2 groups. The authors reported no positive margins in their specimens, and there was no local recurrence or carcinoid-specific mortality after a follow-up period of 70.6 months. Araki and colleagues\textsuperscript{118} reported on 12 patients with rectal carcinoid treated by TEM. Ten of these patients’ submucosal tumours were less than 10 mm in size; the pathology demonstrated negative resection margins, and there were no local recurrences. Two patients in whom pathology showed lymphatic involvement were treated with subsequent LAR. Ishikawa and colleagues\textsuperscript{119} compared the results of carcinoid removal between conventional excision (n = 11) and TEM (n = 17). After a mean follow-up of 23.8 (range 6–49) months for the TAE group and 47.1 (range 12–96) months for the TEM group, the authors reported no local or distant recurrence.

Despite limited data in the literature, it appears that TEM is a safe and effective way to remove small rectal carcinoids either primarily or after incomplete endoscopic removal. However, further study is still needed.

Role of TEM in other diseases

The application of TEM for a variety of other rectal lesions has been described in case series and case reports. Serra Aracil and colleagues\textsuperscript{122} and Zoller and colleagues\textsuperscript{123} reported 4 cases of retrorectal cysts excised using TEM. They reported no significant complications and complete excision of the cysts. Other reported, albeit rare, indications for TEM include excision of gastrointestinal stromal tumours,\textsuperscript{124} repair of colorectal anastomotic strictures\textsuperscript{125–127} and rectovaginal or rectourethral fistula closure.\textsuperscript{128,129}

Future directions of TEM

Use of TEM as a portal for natural orifice transluminal surgery (NOTES) has been discussed widely.\textsuperscript{110–112} However, most of the studies in this field are still in preclinical and experimental phases. One of the main concerns about the transanal or transcolonic access is the risk of fecal spillage into the abdominal cavity. Extensive experience from TEM studies suggests that full-thickness excision of rectal tumours and peritoneal entry is not associated with postoperative complications.\textsuperscript{113,114} Theoretically, TEM should be a safe platform for a transanal NOTES procedure.

A number of feasibility studies have shown successful completion of transrectal NOTES on porcine and human cadavers using TEM.\textsuperscript{115,116} Nonetheless, as TEM instruments were developed for intraluminal resection, technical difficulties, such as inadequate length of instruments to reach the mid and upper abdominal structures, inability to effectively mobilize intra-abdominal organs and safely fashion anastomoses, are the barriers to clinical implementation of transanal NOTES procedures using TEM. To address these technical issues, in an experimental bovine model Bhattacharjee and colleagues\textsuperscript{17} demonstrated a redesigned TEM instrument that is longer and more manoeuvrable. Using the modified instruments, they achieved easier dissection of mesenteric vasculature and colonic mobilization.

The first clinical human studies were performed as hybrid laparoscopically assisted ‘TEM’ NOTES procedures.\textsuperscript{118,119} These studies have been shown to be promising in terms of ease of access, feasibility of the technique, postoperative course, lymph node retrieval and achieving clear margins. However, it is crucial to follow up the long-term outcomes to better evaluate the safety and efficacy of this approach in comparison to open or laparoscopic colorectal procedures.

Overall, TEM provides an ideal access portal for NOTES. It offers a stable platform, capability to safely close the enterotomy and maintenance of adequate pneumoperitoneum. Further modification of the instruments, however, is required to overcome its technical challenges.

Conclusion

Transanal endoscopic microsurgery is a technological advance that has been refined and improved significantly since its introduction in the mid-1980s. For rectal adenomas, TEM is the preferred method of removing lesions that are not amenable to colonoscopic excision and has resulted in low recurrence and complication rates. In patients with early (T1) rectal cancers, the use of TEM is controversial. However, small studies comparing TEM to radical resection suggest that there is a role for TEM in select patients. For those with T2 and T3 lesions, TEM should be considered palliative (in patients with prohibitive medical risks for radical resection) or experimental. Patients with T2 or deeper lesions should be treated only with TEM in the context of a clinical trial if they are fit and willing to have radical resection. For the treatment of other uncommon rectal tumours, such as carcinoids, TEM should be used where previously conventional transanal excision was the preferred treatment strategy. Finally, TEM may allow for new strategies in the treatment of rectal pathology where technical limitations of transanal techniques have limited endoluminal surgical innovations.
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References


Obesity is an epidemic that is known to play a role in the development of gastroesophageal reflux disease (GERD). Studies have shown that increasing body mass index plays a role in the incompetence of the gastroesophageal junction and that weight loss and lifestyle modifications reduce the symptoms of GERD. As a method of producing effective and sustainable weight loss, bariatric surgery plays a major role in the treatment of obesity. We reviewed the literature on the effects of different types of bariatric surgery on the symptomatic relief of GERD and its complications. Roux-en-Y gastric bypass was considered an effective method to alleviate symptoms of GERD, whereas laparoscopic sleeve gastrectomy appeared to increase the incidence of the disease. Adjustable gastric banding was seen to initially improve the symptoms of GERD; however, a subset of patients experienced a new onset of GERD symptoms during long-term follow-up. The literature suggests that different surgeries have different impacts on the symptomatology of GERD and that careful assessment may be needed before performing bariatric surgery in patients with GERD.

Obesity, defined by the World Health Organization as a body mass index (BMI) greater than 30, is an epidemic issue that has major implications on health. It is estimated that more than 200 million men and 500 million women around the world — more than 10% of the world’s population — are obese. Associated with obesity are health conditions that carry significant morbidity and mortality, including cardiovascular disease, osteoarthritis, diabetes, some cancer (breast, colon, endometrial) and gastroesophageal reflux disease. In addition, more than 20% of the worldwide population is overweight (BMI > 25). It is estimated that in the next 20 years, more than 2.16 billion people will be overweight and that 1.12 billion will be obese — statistics with large implications for health care systems. In Canada, 60% of the population is considered overweight, and 24.1% is considered obese.
**Bariatric surgery**

Bariatric surgery has been shown to be the most effective and efficient means of achieving significant and sustainable weight loss in severely obese individuals. Bariatric surgery is classified as either primarily restrictive or primarily malabsorptive. With respect to the effect of bariatric surgery on gastroesophageal reflux disease (GERD), it is important to break down the different types of procedures, as anatomy and physiology is altered differently with different procedures. The common restrictive procedures often mentioned are laparoscopic adjustable gastric banding (LAGB) and laparoscopic sleeve gastrectomy (LSG). An LAGB is a procedure that restricts the amount of food entering the stomach by attaching a band around the fundus that can be restricted over time with saline injections. An LSG is an innovative procedure in which a vertical division is made at the larger curvature of the stomach, making the stomach pouch smaller and more restrictive. In addition to its restrictive properties, LSG has an endocrinologic mechanism in that the levels of the hormone ghrelin (an appetite-stimulating hormone) is reduced. The pyloric sphincter remains intact in both these restrictive procedures, and intestinal absorption is undisturbed.

Malabsorptive procedures include Roux-en-Y gastric bypass (RYGB) and biliopancreatic diversion (BPD). The RYGB, which is the more common of these 2 procedures, has been shown to produce substantial weight loss in morbidly obese patients. It involves creation of a gastric pouch with the pouch drained by a roux limb from the proximal jejunum. In a controlled clinical trial by Hofso and colleagues, patients who underwent RYGB were compared with those who underwent lifestyle modifications, and weight loss was found to be 22% greater in the RYGB group. A BPD involves a sleeve gastrectomy and the creation of 2 enteric limbs: a gastric limb that transports undigested food and a biliopancreatic limb that is attached distally in the small bowel, which creates malabsorption.

**Gastroesophageal reflux disease**

Gastroesophageal reflux disease is a common comorbid condition in bariatric patients. It pertains to the exposure of the esophagus to stomach content, leading to esophageal mucosal damage. The etiology is not completely understood but may include a mixture of hereditary and functional factors with a role of abnormal relaxation of the lower esophageal sphincter (LES), increased frequency of transient sphincter relaxation, or from increased pressure from the stomach secondary to a hiatus hernia or increased intra-abdominal pressure. This can lead to symptoms including heartburn, regurgitation, dysphagia, odynophagia, increased salivation and chest pain. Long-standing GERD can lead to reflux esophagitis in which the epithelial layer of mucosa in the esophagus is irritated, causing necrosis and ulcers to the esophagus. In addition, reflux-induced inflammation can lead to esophageal strictures. Barret esophagus is a condition in which there is intestinal columnar cell epithelium replacing the squamous epithelium usually found in the esophagus. This abnormal metaplasia can eventually lead to adenocarcinoma of the esophagus. It is estimated in 10% of patients with Barret esophagus the condition will eventually transform into adenocarcinoma of the esophagus.

Of important consideration with respect to GERD and its associated symptoms is the difficulty of objectively assessing the severity of symptoms. Because GERD is a subjective clinical entity, actual documentation of the severity of the disease process is difficult to assess in terms of properly correlating subjective symptoms with actual disease process. A recent study by Chan and colleagues demonstrated the difficulty between self-reported symptoms and their correspondence to pathologic gastroesophageal reflux. In their study, the authors asked 336 individuals to complete a self-reported Mayo-GERD questionnaire and referred them to 24-hour esophageal pH monitoring. Using an esophageal pH of less than 4 at the distal esophagus or a DeMeester score greater than 14.7 to demonstrate pathologic GERD, the authors identified questions that were associated with GERD using univariate and multivariate analysis. They found that of the 336 patients who underwent this study, 51% of those who stated that they had severe GERD symptoms did not actually have pathologic GERD based on objective testing. In addition, the authors found that male respondents and patients who claimed to have a prolonged history of GERD-like symptoms, nocturnal heartburn and a history of hiatus hernia were more likely to have an abnormal 24-hour pH measure; however, these factors lacked a clinical utility to predict pathologic GERD. The authors concluded that subjective claims of GERD and its associated symptoms were difficult to correlate objectively, making studies based on subjective claims difficult to analyze.

Obesity is an independent risk factor for GERD. Hamps and colleagues conducted a meta-analysis and described the effect of obesity and the risk for GERD and its associated complications. In 9 studies assessing the effect of obesity on GERD, 6 studies found significant associations between obesity and the prevalence of GERD. Six of 7 studies found associations between obesity and erosive esophagitis, 6 of 7 found an association with adenocarcinoma of the esophagus, and 4 of 6 found associations between obesity and gastric cardia. It was also found that increasing BMI netted a progressive risk for GERD and its associated complications. In a cross-sectional study, El-Serag and colleagues found an association between BMI and GERD in volunteers who were asked to fill out questionnaires, some of whom had undergone endoscopic analysis. The authors found a positive correlation with BMI and the development of GERD and its associated complications.
In 2006, Pandilfino and colleagues\textsuperscript{16} used high-resolution manometry and simultaneous intraesophageal and intragastric transnasal pressure sensors on 285 patients to further analyze the effect of increasing BMI on the gastroesophageal junction. They found a significant correlation between BMI and waist circumference with intragastric pressure ($p < 0.001$) and gastroesophageal pressure gradient ($p < 0.001$). Using multivariate analysis adjusting for age, sex and patient type did not alter the direction or magnitude of this association. The authors also found that obesity was associated with separation of the esophagogastric junction (EGJ) pressure components ($p < 0.001$). The result of this study demonstrated that obesity augments the flow of gastric juice into the esophagus, leading to symptoms consistent with GERD. The study was aimed at the mechanical aspect of how obesity could lead to EGJ incompetence and adversely affect physiologic function.

**Effect of bariatric surgery on GERD**

Table 1 lists studies that have examined the effect of bariatric surgery on GERD. Although weight loss and lifestyle modifications are important in reducing the symptoms of GERD, different bariatric surgeries have provided varying degrees of symptom alleviation.\textsuperscript{17} De Groote and colleagues\textsuperscript{17} performed a systematic review of bariatric surgery and GERD and compared the data with lifestyle modification. They found that lifestyle modification led to a decrease in GERD symptoms in 4 of 7 studies. They compared various bariatric procedures and found that RYGB was associated with a notable decrease in GERD symptoms. With vertical band gastroplasty, however, there was either no change in GERD symptoms or an increase in incidence of GERD. They were unable to determine whether gastric bands improved or worsened GERD symptoms. Comparing the RYGB with the lifestyle modification group, it appeared that the patients who underwent RYGB had a better alleviation of GERD symptoms.

**Sleeve gastrectomy**

Chiu and colleagues\textsuperscript{18} performed a systematic review on GERD and its effects following LSG. Analysis showed that 4 studies demonstrated an increase in prevalence and 7 studies showed a reduced prevalence of GERD following LSG. The understanding is that LSG may promote GERD by reducing LES pressure (possibly from division of ligaments and blunting of the angle of His). It was also discussed that the remnant gastric pouch, being much more restrictive, may increase gastric pressure by reducing gastric compliance and emptying, and decreasing volume and dispensability. As for LSG reducing GERD, factors that may contribute to this effect include accelerated gastric emptying and increased weight loss, which decrease abdominal pressure. It was also suggested that long-term resolution of GERD could be explained by increase in compliance and restoration at the angle of His, which occurs about 3 years postoperatively.

In a retrospective review of 28 patients undergoing LSG, Howard and colleagues\textsuperscript{19} performed pre- and postoperative upper gastrointestinal radiographic swallow studies to assess for GERD in these patients. The patients had an average excess weight loss (EWL) of 40%, with a mean follow-up time of 32 weeks. Of these patients, 18% were found to have new onset GERD on their postoperative upper GI swallow test after having the LSG procedure. In addition, patients were given follow-up questionnaires, which yielded a 64% response rate; 22% of patients reported having symptoms of GERD. The authors postulated that LSG procedures might in fact increase the prevalence of GERD despite satisfactory weight loss.

In summary, LSG appears to increase the incidence of GERD in patients who undergo the procedure, possibly relating to increased intragastric pressure and changes in the angle of His. However, with increased gastric compliance in the long term there may be an alleviation of symptoms relating to GERD.

### Table 1. Effect of bariatric surgery on gastroesophageal reflux disease

<table>
<thead>
<tr>
<th>Study</th>
<th>Type of bariatric surgery</th>
<th>No. of patients*, EWL</th>
<th>Type of assessment or study</th>
<th>Follow-up, mo</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Howard et al.\textsuperscript{16} (2011)</td>
<td>LSG</td>
<td>28</td>
<td>40</td>
<td>Upper GI swallow, clinical symptoms</td>
<td>8</td>
</tr>
<tr>
<td>Chiu et al.\textsuperscript{18} (2009)</td>
<td>LSG</td>
<td>15</td>
<td>NA</td>
<td>Systematic review</td>
<td>NA</td>
</tr>
<tr>
<td>Woodman et al.\textsuperscript{21} (2012)</td>
<td>LAGB</td>
<td>122</td>
<td>49.8</td>
<td>Quality of life questionnaire</td>
<td>24</td>
</tr>
<tr>
<td>de Jong et al.\textsuperscript{17} (2010)</td>
<td>LAGB</td>
<td>3307</td>
<td>NA</td>
<td>Systematic review</td>
<td>NA</td>
</tr>
<tr>
<td>Frezza et al.\textsuperscript{22} (2002)</td>
<td>LRYGB</td>
<td>152</td>
<td>64</td>
<td>Questionnaire of symptoms</td>
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</tr>
<tr>
<td>Perry et al.\textsuperscript{23} (2004)</td>
<td>LRYGB</td>
<td>57</td>
<td>NA</td>
<td>Follow-up questionnaire</td>
<td>18</td>
</tr>
</tbody>
</table>

EWL = excess weight loss; GERD = gastroesophageal reflux disease; GI = gastrointestinal; LAGB = laparoscopic adjustable banding; LRYGB = laparoscopic Roux-en-Y bypass; LSG = laparoscopic sleeve gastrectomy; NA = not available.

\*Unless otherwise indicated.
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### Gastric banding

In a recent study, Woodman and colleagues used the Obesity and Weight-Loss Quality of Life Instrument (OWLQOL-17) to assess the effect of adjustable gastric banding on GERD symptoms. They followed up with 122 patients 2 years postoperatively and found a resolution of GERD symptoms in 80% of the patients questioned. Of the remaining participants, 11% reported an improvement of symptoms, 7% experienced no change in symptoms and 2% reported worsening of symptoms. However, the authors were not able to find a clear correlation between amount of weight lost and reduction in symptom severity. They postulated that the suppression of GERD following the gastric banding procedure could be explained by a combination of weight loss or by reducing intragastric pressure and the frequency of transient LES relaxation as well as anatomic augmentation of the gastro-esophageal sphincter.

Other studies have been inconsistent with short- and long-term follow-up. A systematic review by de Jong and colleagues involving 20 studies with a total of 3307 patients who underwent gastric banding found a significant reduction in symptoms associated with GERD. They found that the prevalence of reflux symptoms decreased postoperatively from 33.3% to 7.7% and medication use decreased from 27.5% to 9.5%. The prevalence of esophagitis was also reduced postoperatively from 33.3% to 27.5%. There was a reduction of pathologic reflux from 55.8% preoperatively to 29.4% postoperatively. The authors did find, however, a subset of patients who experienced a new onset of reflux symptoms (15%) and a new onset of esophagitis (29.4%). In addition, they found that gastric banding LES pressures increased from 12.9 mm Hg to 16.9 mm Hg, LES relaxation decreased from 100% to 79.7%, and the percentage of dysmotility increased from 3.5% to 12%. The authors postulated that with initial weight loss, there was short-term alleviation of GERD and its complications; however, with longer-term follow-up, there is a subset of patients who experience a new onset of reflux and its complications.

Of important consideration when it comes to patients who underwent gastric banding is the difficulty of ascertaining whether symptoms are a result of a prior or a postoperative GERD pathologic process or of a complication relating to their gastric banding surgery. In a prospective review of 257 patients who underwent gastric banding between January 2002 and December 2006, Arias and colleagues tried to measure the incidence of megaesophagus. Impaired esophageal peristalsis can cause a lack of relaxation of the LES, which in turn can cause esophageal dilatation and megaesophagus following secondary and tertiary peristalsis, leading to symptoms similar to that of GERD. The authors used symptoms, signs and gastrointestinal series findings to verify the presence of mega-esophagus and found that of the 257 patients, 5 developed megaesophagus even though 4 of the 5 had previously normal manometry findings before their adjustable band placement and 1 had a nonspecific motility disorder. In all patients, however, band removal was recommended.

In summary, gastric banding appears to provide short-term improvement of reflux symptoms, esophagitis and normalized pH monitoring results. There is, however, a subset of patients who experience a new onset of reflux symptoms and esophagitis in the long term, although it is difficult to ascertain whether these are a result of pathologic GERD or complications from gastric banding.

### Roux-en-Y gastric bypass

Several studies have shown consistent alleviation of GERD symptoms in patients undergoing RYGB. In 2002, Frezza and colleagues assessed changes in GERD symptoms following LRYGB. Of 152 patients who participated in the study, follow-up revealed an EWL of 64% and a significant reduction in GERD symptoms at 12-month follow-up (heartburn: 87%–22%, \( p < 0.001 \); water brash: 18%–7%, \( p < 0.05 \); wheezing: 40%–5%, \( p < 0.001 \); aspiration: 14%–2%; use of proton pump inhibitors: 44%–9%, \( p < 0.001 \); and use of H2 blockers: 60%–10%, \( p < 0.01 \)).

In 2004, Perry and colleagues assessed 57 patients who underwent a Roux-en-Y gastric bypass pre- and postoperatively. Hiatal hernias or esophagitis was present in 48 patients and Barrett esophagus was present in 2 patients preoperatively. Patients were followed up at a mean of 18 (range 3–30) months, and they attained a mean weight loss of 40 kg. In follow-up all patients reported improvement or no symptoms of GERD.

It is also important to note that some studies have assessed the use of LRYGB as revision surgeries to laparoscopic Nissen fundoplication procedures that have failed to alleviate GERD symptoms. Previous studies have shown equal effectiveness between Nissen fundoplications and LRYGB in alleviating symptoms of GERD in morbidly obese patients. Raffoupolous and colleagues assessed 7 patients with previous Nissen fundoplications who were undergoing revision LRYGB using the Gastro-esophageal Reflux Disease–Health Related Quality of Life (GERD-HRQL) scale. Postoperative reassessment with the GERD-HRQL scales showed a significant reduction in GERD scores (\( p = 0.006 \)). Other studies have reported similar results with respect to LRYGB as revision to antireflux surgeries.

Another important consideration when assessing the effect of bariatric surgery on GERD symptoms is the presence of hiatal hernias. As mentioned by Orlando, hiatal hernias are considered to directly impact LES incompetence. It has been noted that the size of the hiatal hernia inversely affects LES pressure and directly increases...
impairment in esophagogastric junction barrier function, thus increasing the amount of GERD-like symptoms. Since the incidence of both GERD and hiatal hernias increases as BMI increases, there has been a recent trend toward bariatric surgeons attempting to combine bariatric surgeries with repair of hiatal hernias. A recent retrospective analysis by Kothari and colleagues compared the results of LRYGB and LRYGB combined with laparoscopic hiatal hernia repair (LHHR). Their study involved 3 groups of patients: the first group (n = 33 717) did not have hiatal hernias and underwent LRYGB alone, the second group (n = 644) had hiatal hernias and underwent both LRYGB and LHHR, and the final group (n = 1589) had hiatal hernias but did not undergo LHHR. Most patients with hiatal hernias did not undergo hernia repair during their LRYGB, as most surgeons considered the procedure unnecessary owing to the alleviation of GERD symptoms after significant weight loss. As there is a direct correlation between hiatal hernias and the presence of GERD symptoms, it is important to take this trend of concurrent RYGB and hernia repair into account in order to fully assess the alleviation of GERD symptoms following LRYGB.

In summary, RYGB is an effective procedure for alleviating the symptoms of GERD as it plays a role in significant weight loss without altering the anatomy of the LES and increasing intragastric pressure; however, careful consideration of concurrent RYGB and hernia repair is warranted.

**CONCLUSION**

Obesity is an important risk factor in the development of GERD and its associated complications. Weight loss following lifestyle modification has been shown to significantly alleviate GERD symptoms. With regards to bariatric surgery and its effect on GERD, studies have shown inconsistencies with different types of bariatric surgery. Laparoscopic sleeve gastrectomy has been associated with an increased incidence of GERD following the procedure; explanations have included the postoperative angle of His and increase in intragastric pressure. Gastric banding has been shown to improve the symptoms of GERD in the short-term; however, a small subset of patients experience new reflux symptoms and esophagitis in the long-term. The most effective bariatric procedure in the alleviation of GERD appears to be RYGB, which has been reported to have a similar efficiency as that of Nissen fundoplication. As bariatric surgeries affect anatomy and physiology of the gastrointestinal tract in different ways, it is important to assess patients’ comorbidities when considering the different types of bariatric surgeries. Based on the studies we discussed, it appears that RYGB provides the best alleviation of symptoms associated with GERD and its comorbidities.

**Competing interests:** S. Karmali is a consultant for Ethicon Endo-Surgery and Covidien. D.W. Birch is a consultant for Johnson & Johnson, Ethicon Endo-Surgery and Covidien, and he has received speaker fees and educational grants from Johnson & Johnson, Ethicon Endo-Surgery, Covidien and Stryker. No other competing interests declared.

**Contributors:** D.W. Birch, R.S. Gill and S. Karmali designed the study. M. El-Madi acquired and analyzed the data, which D.W. Birch and S. Karmali also analyzed. All authors wrote the article and reviewed and approved the final version for publication.

**References**


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Current management of penetrating torso trauma: nontherapeutic is not good enough anymore

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A highly organized approach to the evaluation and treatment of penetrating torso injuries based on regional anatomy provides rapid diagnostic and therapeutic consistency. It also minimizes delays in diagnosis, missed injuries and nontherapeutic laparotomies. This review discusses an optimal sequence of structured rapid assessments that allow the clinician to rapidly proceed to gold standard therapies with a minimal risk of associated morbidity.

Over the past century, the management of penetrating torso trauma has engaged in repeated cycles involving both operative and nonoperative algorithms. In part, this sequence has been based on alterations in hospital resources, advances in diagnostic imaging and period-specific beliefs of well-known thought leaders.

Since the introduction of firearms at the 1346 Battle of Crecy, the management of penetrating abdominal wounds has been debated. In 1834, a French military surgeon (Dr. Baudens) completed the first reported exploratory laparotomy for a penetrating abdominal injury. She commented that one must “introduce a finger or small sponge into the wound to determine the presence of blood, feces or bubbles of gas, and therefore proceed to laparotomy.” On a practical note, however, this viewpoint was stunted by the rudimentary delivery of “anesthesia” until 1846. Despite a subsequent 1887 American Surgical Association statement mandating operative exploration (laparotomy) for all civilian abdominal gunshot wounds, widespread adoption of this approach was not immediately successful either. In the Anglo-Boer War (1899–1902), for example, Sir William McCormick dictated a policy of no exploration. This contrasted Princess Von Gedroit’s experience in the Russian–Japanese War (1904–1905) with mandatory operative exploration of all abdominal gunshot wounds. It was not until midway through World War I (1915) that a substantial improvement in mortality was noted with a policy of frequent laparotomy. Routine exploration then remained the standard of care for decades and is partially responsible for the observed decrease in mortality from World War I (53%) to World War II (24%), the Korean conflict (12%) and the Vietnam War (9%). Routine exploration was also popularized throughout the United States as these surgeon-soldiers returned home to work in civilian centres.

In the 1960s, Shaftan (United States), Nance and Cohn (United States) and Stein and Lissos (South Africa) reintroduced the concept of nonoperative management of selected penetrating abdominal wounds. This was
primarily a response to the overwhelming increase in patient volumes associated with the proliferation of handguns in urban America. There was also an epiphany that civilian weapons were much less powerful than the military-grade guns to which surgeons had become accustomed. Over the past decade, this approach (“selective conservatism”) has become increasingly popular for both stab and gunshot wounds of the abdomen.16–19

It must also be stated at the outset that despite the transformational impact of cross-sectional imaging on the care of modern trauma patients, penetrating scenarios often render this ubiquitous test unhelpful. Although a policy of liberal computed tomography (CT) for severely injured blunt trauma patients has clearly become the standard of care, anatomic and algorithmic approaches to stab and gunshot wounds differentiate the experienced and efficient clinician from the uncomfortable one. As a result, the aim of this review is to discuss a logical and systematic approach to the diagnosis and management of patients with penetrating torso trauma.

CHALLENGES WITH PENETRATING TORSO TRAUMA

Penetrating trauma presents considerable difficulties for the clinician. Potential challenges include the use of external wounds as markers of internal injuries; injury patterns that are not always predictable; multiple wounds; single wounds that traverse multiple anatomic areas (i.e., chest and abdomen); hemodynamic instability; major vascular injuries, which are much more common than in blunt trauma; and a substantially worse reliability of the physical examination for detecting peritonitis in the context of a rapid increase in morbid obesity. Common traps include, but are not limited to, missing additional wounds and therefore missiles, assuming a straight line of trajectory, assuming “entry” versus “exit” wounds, relying on “probing” a wound, missing cavitary penetration, relying on initial hemodynamic stability and not recognizing missile and/or air embolization.

INITIAL ASSESSMENT AND RESUSCITATION

Rapid prehospital transport of patients with penetrating injuries to a trauma centre is paramount.6-11 The time interval from injury to control of hemorrhage is the dominant variable defining patient survival.6,12-13 As a result, urban centres with advanced prehospital systems and experienced trauma surgeons (i.e., rapid decision-making) often show impressive survival characteristics despite major vascular injuries.14-19 Given that patients with penetrating torso injuries behave much differently than those with blunt trauma, they should also be assessed using unique approaches.6 More specifically, all patients must be thoroughly and immediately inspected for penetrating wounds (i.e., axilla, groin, perianal, perineum). Palpation of the actual penetrating wound is extremely tender to the patient and therefore unhelpful. Missing wounds is a common source of preventable morbidity.

The clinician should initiate the diagnostic search for injuries of relevance with the tests that will prompt transfer to the operating theatre if found to be positive. All wounds should also be rapidly marked (radio-opaque marker) to improve the interpretation of subsequent radiographs. Both anterior–posterior and cross-table lateral radiographs are essential early in the resuscitation to provide data on possible injuries and trajectories. In general, the number of holes added to the number of missiles should provide an even number. This rule is rarely broken. Plain radiographs also prompt intervention in scenarios of hemothorax, pneumothorax and/or free intraperitoneal air. Although the clinician’s goal should be to avoid missing any injuries, a complete diagnosis of all injuries is not mandatory before operative intervention in hypotensive patients nearing physiologic exhaustion. In addition, a nontherapeutic laparotomy remains a preventable form of significant morbidity that can be avoided using an organized approach to penetrating injuries.5-10 More specifically, complications occur in up to 41% of all patients,20-23 leading to a substantially increased length of stay in hospital23,24 and significant costs.24-26

Early focused assessment with sonography for trauma (FAST) examination is mandatory for detection of a possible pericardial hemorrhage (i.e., cardiac injury).27-30 Although it is also helpful in detecting the presence of fluid within the peritoneal cavity, this should not directly alter a clinician’s management in the absence of hypotension, diffuse peritonitis or evisceration.8-10,27-30 As a result, the dominant utility of FAST in penetrating scenarios is to rule out pericardial tamponade and evaluate patients with multisystem injuries.

The remaining approach to the initial assessment of patients with penetrating torso trauma relies on a combination of many basic advanced trauma life support (ATLS) principles (e.g., adequate intravenous access, prevention of hypothermia) with the addition of very early transition to blood products as per damage control resuscitation principles in hemodynamically unstable patients.12-16 This includes an immediate transfer to the operating theatre for hemorrhage control as the dominant guiding principle for improving the patient’s probability of survival. The apparent success of “hypotensive resuscitation” in both the civilian and military contexts is also crucial.17,36 More specifically, elevation of a patient’s systolic blood pressure greater than 80 mm Hg before obtaining definitive hemorrhage control has clear and repeatable consequences with regard to increased bleeding.17-39 This is a direct result of intraluminal clot ejection and reversal of vascular spasm in completely transected vessels.
The indications for emergency department (ED) thoracotomy (EDT) remain controversial. Patients with penetrating cardiac trauma and loss of signs of life within the trauma bay continue to benefit most from EDT. As the time without vital signs increases, so does the unlikeliness of functional neurologic salvage in a moribund patient. There remains no role for ED laparotomy. Despite initial enthusiasm in the 1970s, it is clear that EDT for the purpose of reducing hemorrhage within the peritoneal cavity (i.e., major abdominal vascular injury) is widely unhelpful. Back bleeding from the large blood volume below the aortic clamp remains a standard source of exsanguination. As a result, penetrating torso wounds also mandate central venous access (if needed) through subclavian or internal jugular lines (i.e., above the diaphragm). Resuscitation through a femoral central line is unhelpful in the context of an injury to the right iliac phragm). Resuscitation through a femoral central line is unhelpful in the context of an injury to the right iliac vein, inferior vena cava, liver or hepatic veins. It should also be noted that despite highly debated discussions of absolute indications for EDT dating back nearly 40 years, patients with narrow complex pulseless electrical activity (PEA) are generally good candidates for EDT. Patients who arrive in asystole represent the opposite end of the spectrum and are almost uniformly nonsalvagable. Patients who arrive in wide complex PEA represent a transition toward cardiac death and, as a result, are very rarely salvaged with functional neurologic outcomes despite the usual 1–3 hours of attempted resuscitation and operative intervention. Caution must be used before initiating EDT in these patients.

The presence of blood, feces, urine and/or succus in nasogastric tubes or blood in a Foley catheter should alert the clinician to potential organs of injury. Finally, a detailed discussion of damage control indications and procedures is beyond the scope of this review, but it must be remembered that candidates for damage control surgery (including open abdomens) are only those patients with continued and progressive decompensation with regard to intraoperative physiology despite ongoing massive resuscitation.

**Evaluation by Regional Anatomy (Zones and Boxes)**

The human torso can be divided into various zones and boxes of regional anatomy. Because the treatment of penetrating injuries is based on anatomy and physiology, this template provides the clinician with a structured approach to diagnosing and treating all wounds. More specifically, a systematic evaluation of each zone using known regional anatomy and external markers of trauma is crucial (Box 1). In general, this approach minimizes missed injuries as well as any delays in diagnosis. It also provides a consistent and predictable approach to all injuries and therefore avoids unnecessary laparotomies and associated resource implications.

It must be noted that both the thoracoabdominal and abdominopelvic regions are unique because penetrating wounds to these zones may cause injuries in either body cavity/area. Particularly in the case of gunshot injuries, trajectories can also extend across 3 or more anatomic regions (pelvis–abdomen–thorax–neck). The thoracoabdominal region is marked by the fourth intercostal space superiorly (nipple level) and the costal margin inferiorly around the entire torso. This region changes with each cycle of breathing given the continuous movement of the diaphragm. The cardiac box is restricted by the nipple lines laterally, sternal notch superiorly and xiphoid process inferiorly. This box is clearly a crucial region for evaluation given the risk of cardiac tamponade and rapid death. The pelvis is limited superiorly by the iliac crest (posterior) and pubic crest (anterior), as well as inferiorly by the gluteal fold (posterior) and base of the testes (anterior). The anterior abdomen is marked posteriorly by the mid-axillary line, inferiorly by the pubic crest, superiorly by the xiphoid process and costal margins and bilaterally by the iliac crests. The flank and back region is limited anteriorly by the mid-axillary line, superiorly by the level of the scapula tips and inferiorly by the iliac crests.

**Abdominal Stab Wounds**

Stab wounds represent an injury with significantly less kinetic energy than gunshot wounds. This reality results in a substantially lower chance of injury requiring repair and therefore should parlay into a lower intervention rate. Among all patients with stab wounds, approximately 55% arrive at a trauma centre with hypotension (i.e.,

<table>
<thead>
<tr>
<th>Box 1. Organs of potential concern within anatomical zones and boxes</th>
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<tbody>
<tr>
<td><strong>Right thorax</strong></td>
</tr>
<tr>
<td>• Lung</td>
</tr>
<tr>
<td>• Superior vena cava</td>
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<tr>
<td><strong>Left thorax</strong></td>
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<tr>
<td>• Lung</td>
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<td>• Aorta</td>
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<tr>
<td><strong>Transmediastinal</strong></td>
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<tr>
<td>• Anterior mediastinum</td>
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<td>• Heart</td>
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<td>• Trachea</td>
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<tr>
<td>• Great vessels</td>
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<tr>
<td>• Posterior mediastinum</td>
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<tr>
<td>• Aorta</td>
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<tr>
<td>• Esophagus</td>
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<tr>
<td>• Spine</td>
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<tr>
<td><strong>Anterior abdomen</strong></td>
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<tr>
<td>• Stomach</td>
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<tr>
<td>• Small bowel</td>
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<tr>
<td>• Transverse colon</td>
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<tr>
<td>• Mesentary</td>
</tr>
<tr>
<td>• Liver/porta hepatitis</td>
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<tr>
<td>• Spleen</td>
</tr>
<tr>
<td><strong>Back and flank</strong></td>
</tr>
<tr>
<td>• Retroperitoneal colon</td>
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<tr>
<td>• Kidneys</td>
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<tr>
<td>• Ureters</td>
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<td>• Pancreas</td>
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<td>• Aorta</td>
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<td>• Inferior vena cava</td>
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<tr>
<td>• Spine</td>
</tr>
<tr>
<td><strong>True pelvis</strong></td>
</tr>
<tr>
<td>• Iliac arteries and veins</td>
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<tr>
<td>• Bladder</td>
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<tr>
<td>• Urethra</td>
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<tr>
<td>• Ureters</td>
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<tr>
<td>• Rectum</td>
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<tr>
<td>• Vagina</td>
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<tr>
<td>• Uterus</td>
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<tr>
<td><strong>Cardiac box</strong></td>
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<td>• Heart</td>
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hemodynamic alterations), diffuse peritonitis and/or evisceration. Regardless of anatomic zone, these represent absolute indications for emergent operative intervention in most centres.

Flank and back

The remaining 45% of patients present with hemodynamic stability, no evisceration and an absence of significant torso tenderness remote to the actual wound site. Management of these stable patients is based on the site of the wound. In those with flank and/or back wounds, cross-sectional imaging is a common option after completion of the initial assessment. If selected, this should generally involve triple-phase (oral, intravenous and rectal) contrast CT of the entire torso. When the clinician’s aim is to detect retroperitoneal contrast leakage from potential colonic injuries, adequate distention with rectal contrast is critical. If the colonic site of interest is not well opacified (i.e., right flank stab but insufficient rectal contrast), then the study is generally considered inadequate. To ensure optimal results, detailed communication with both the radiology technician and patient is essential. If patients with stab wounds to the flank and back undergo a policy of routine laparotomy/exploration, the associated nontherapeutic rate will approximate 85%.

Anterior abdomen

Management of the patient with an anterior abdominal stab wound offers substantially more diagnostic options and discussion. These options include, but are not limited to, routine laparotomy, local wound exploration, screening laparoscopy, CT, diagnostic peritoneal lavage (DPL) and observation. It should be noted that CT in these patients is much less useful than in the context of gunshot wounds because it is the high kinetic energy of a bullet and entrainment of air that provides the clinician with an excellent visual trajectory/tract. The deepest extent of a knife trajectory, however, is typically very difficult to delineate and is often misleading. As a result of these observations, in addition to the clear inadequacies of CT for confirming injuries to the diaphragm or bowel, most high-volume centres do not routinely image anterior abdominal stab wounds with CT.

Although the literature is filled with individual case series describing extreme examples, a policy of routine laparotomy for anterior abdominal stab wounds will result in a nontherapeutic laparotomy rate of nearly 60%. With the addition of a local wound exploration (LWE), this rate can be decreased to less than 50%. It must be noted, however, that the definition of an LWE is a surgical procedure performed with appropriate sterile technique and instruments that define either the base of the wound or the most superficial fascial level (whichever is encountered first). If the wound proceeds beyond the fascia, the LWE is considered positive. Progression to deeper layers of the abdominal wall is frowned upon given the increase in local morbidity as well as the associated high rate of known penetration of the peritoneum when the anterior fascial layer is violated. As a result, the LWE fundamentally differs from “probing” the wound with a finger or instrument. Probing is notoriously unreliable and therefore cannot be recommended in any scenario with the exception of confirming a completely tangential torso wound in a stable patient. The dominant utility of the LWE is that patients who are found to be “negative” can undergo tissue closure and be discharged from the hospital. It should be noted, however, that if a patient is admitted for serial observation following a positive LWE, the subsequent physical examinations can be complicated by pain associated with the LWE itself.

Proceeding in an anatomic fashion, another diagnostic option is laparoscopy. This procedure can be divided into 3 distinct entities: laparoscopy defined as “positive” when penetration of the peritoneum has occurred (screening laparoscopy); laparoscopy that includes a full inspection of all intraperitoneal and retroperitoneal structures (diagnostic laparoscopy), including the lesser sac, gastroesophageal junction and pelvis; and laparoscopy with active repair of injured structures (therapeutic laparoscopy). Secondary to its ease of completion and therefore extrapolation to most trauma surgeons, screening laparoscopy has become the most common of these entities. If a positive screening laparoscopy is used as a trigger for a subsequent laparotomy, the nontherapeutic laparotomy rate decreases slightly to 40% of all patients. It should also be noted that presumably owing to variable skill levels, the published missed injury rate associated with diagnostic laparoscopy ranges from 0% to 82%. Despite this wide range, larger studies cluster at 9%–18%. One recent and novel idea to address this recurrent issue is to combine laparoscopy with DPL. Once the laparoscopy is complete, a standard DPL is performed through any port. This combined approach may also limit the dominant problem with stand-alone DPL. More specifically, using DPL alone as an indication (> 10 000 RBC/mm³) for subsequent laparotomy in patients with anterior abdominal stab wounds is overly sensitive and results in an unacceptably high rate of nontherapeutic explorations.

An alternate and increasingly popular option to manage patients with an anterior abdominal stab wound in the absence of hypotension, diffuse peritonitis and evisceration is admission and observation with serial clinical examinations. Selective nonoperative management (SNOM; formally termed “selective conservatism”) can now arguably be considered the standard of care for stab wounds in numerous centres of varying resources and cultures. While opponents of this philosophy often erroneously cite the presence of...
highly specialized observation wards in high-volume centres, it is undeniable that if serial clinical examinations by a physician (including trainees) are not available, SNOM is not safely possible. Exclusion of patients with concurrent traumatic brain or spinal cord injuries or intoxication as well as those undergoing nonabdominal operative procedures who are unable to cooperate in serial clinical examinations is also crucial. The physical examination must be reliable when applied to any patient. It must also be stated that patients undergoing SNOM should receive little narcotic analgesics, which can mask clinical findings, and must be monitored for changes in vital signs and laboratory tests (white blood cell count and hemoglobin). Isolated omental eversion is not an absolute contraindication to SNOM.66,72

There is no evidence of increased morbidity or length of stay in hospital in patients who undergo SNOM.8,10,59–65 Most visceral injuries requiring repair after anterior abdominal stab wounds will transition to a positive clinical examination within 12 hours.64 This duration is extended to 18 hours for flank and back wounds.65

THORACOABDOMINAL STAB WOUNDS

Historically, patients who require a laparotomy for the abdominal component of their injury complex require a concurrent tube thoracostomy and thoracotomy in two-thirds and one-third of cases, respectively.8 It is essential, however, that all patients with left upper quadrant anterior abdominal stab wounds undergo a diagnostic laparoscopy for an associated diaphragm injury before discharge.9,10,66,67 This modality is excellent at both detection and repair in up to one-third of patients who have an associated diaphragm injury.15,66,67 The time frame of performing laparoscopy is debated. While some clinicians prefer to perform this intervention earlier, waiting 12–24 hours after admission may benefit the patient by lowering the risk of missing associated injuries.80 More specifically, patients with concurrent injuries requiring repair will evolve with regard to peritonitis before the scheduled laparoscopy and will therefore be candidates for a combined repair (either laparoscopy or laparotomy).

Debate also exists over the utility of laparoscopy in patients with right upper quadrant stab wounds given the substantial coverage of the diaphragm in this hemitorsi by the liver.90–92 Despite this anatomic advantage, hepatic herniation and lacerations of the diaphragm anterior to the liver are not entirely uncommon. It should also be noted that a standard upright/supine chest radiograph is notoriously insensitive to small diaphragm injuries and must not be relied on to rule out diaphragm trauma.66

Cardiac box

Concern over potential cardiac injuries should be uncommon upon completion of the pericardial window during the FAST examination. This test is incredibly sensitive for detecting cardiac trauma.27–29 The isolated exception (i.e., false negative) occurs in a patient with a right-sided (low pressure) cardiac injury and a concurrent hole in the pericardium leading to a recurrent low-volume hemothorax despite tube thoracostomy.64 As a result, any patient with a residual hemothorax in the context of adequate thoracic drainage and a potential cardiac trajectory must undergo an urgent pericardial window.64 “This procedure can be completed with local or general anesthetic. The patient must be prepared and draped for a sternotomy before induction with any general anesthetic, however, given the risk of concurrent cardiac arrest due to alterations in cardiac physiology. A pericardial window may also be indicated in select patients with associated subcutaneous emphysema and/or morbid obesity that prevent adequate ultrasound visualization.27–29 If positive, a patient with a stab wound should undergo a median sternotomy, as opposed to a patient who sustains a gunshot wound (lateral or bilateral thoracotomy may be preferred over a median sternotomy).

ABDOMINAL GUNSHOT WOUNDS

Given the higher kinetic energy associated with gunshot wounds, the incidence of injury and therefore laparotomy, is significantly higher than with stab wounds.8–10 As a result, a policy of routine laparotomy in patients with gunshot wounds to the torso will result in a nontherapeutic laparotomy rate of up to 20%.9,10,44,69–71 If the missile can be proven to have entered the peritoneal cavity remote from isolated solid organ injuries, the rate of nontherapeutic laparotomy is likely as low as 2%–4%.9,10,44,69–71 This discrepancy is clearly impacted by the increasing prevalence of obesity in our society. As a result, tangential extraperitoneal wounds are becoming more common. The even higher complication risk associated with morbidly obese patients makes excluding those patients who do not need operative interventions that much more crucial.

Based on these high risks of injury requiring operative therapy, SNOM of gunshot wounds must be limited to patients with high-fidelity, cross-sectional imaging and careful selection. Computed tomography scans are absolutely critical in plotting missile trajectory and risk stratifying potential consequences of direct and kinetic trauma. In the past decade, SNOM of patients with gunshot injuries to solid organs, such as the liver and kidneys, is increasingly common and successful.9,10,44,69,72–74 This concept relies on receipt of a normotensive patient without peritonitis. The published series of patients with high-grade hepatic and renal gunshot injuries who are safely managed without a laparotomy are increasingly impressive.9,10,44,69,72–74 These include patients who may require...
Angioembolization for moderate arterial hemorrhage and/or pseudoaneurysms. It must be clear though that when missile trajectory and hollow viscous structures intersect or when free fluid/air is adjacent to a hollow viscous structure laparotomy is indicated. It must also be noted that high-grade hepatic injuries with significant spillage of intraperitoneal blood and/or bile may require a delayed laparoscopic washout and drainage. If bilious drainage persists, an endoscopically placed intrabiliary intravascular shunts represent excellent methods of achieving vascular control, technical details are beyond the scope of this review.

**Pelvic gunshot wounds**

Transpelvic gunshot wounds are particularly challenging given the high number of anatomic structures at risk, as well as the potential involvement of multiple zones (anterior abdomen, back/flank, true pelvis). As a result, 85% of all transpelvic trajectories will cause injury to an internal organ. As noted above, a clinician’s diagnostic workup should begin with whichever test has the highest likelihood of mandating operative intervention. These tests include bedside rigid sigmoidoscopy (presence of blood and/or bone), cystography, lower extremity distal pulse quality and presence (femoral, popliteal) and ankle-brachial indices (ABI). Loss of distal pulses and/or an ABI less than 0.9 mandates immediate investigation. This may include angiography and/or operative exploration for iliac arterial injuries (particularly for a sustained ABI < 0.8). In experienced hands, concurrent diagnosis and repair may be most efficient within the operating theatre (although preoperative CT-angiography represents a reasonable alternative). Finally, it should also be noted that although balloon catheters and temporary intravascular shunts represent excellent methods of achieving vascular control, technical details are beyond the scope of this review.

**Conclusion**

An organized approach to the evaluation and treatment of penetrating torso injuries based on regional anatomy provides diagnostic and therapeutic consistency for the clinician. It also minimizes both delays in diagnosis and missed injuries. In addition, this approach prevents the significant morbidity associated with nontherapeutic laparotomies while concurrently conserving hospital and societal resources. This framework allows the clinician to answer the questions, “Did the projectile/injury enter the peritoneal, retroperitoneal or pelvic cavity?” and “Is it an injury that will require a laparotomy to repair?”.

**Competing interests:** None declared.

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Prognostic factors for morbidity and mortality in elderly patients undergoing acute gastrointestinal surgery: a systematic review

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Background: Elderly patients undergoing acute gastrointestinal (GI) surgery experience increased morbidity and mortality compared with younger and elective patients. Prognostic factors can be used to counsel patients of these risks and, if modifiable, to minimize them. We reviewed the literature on prognostic factors for adverse outcomes in elderly patients undergoing acute GI surgery.

Methods: We searched PubMed and Embase using a strategy developed in collaboration with an expert librarian. Studies examining independent associations between prognostic factors and morbidity or mortality in patients aged 65 and older undergoing acute GI surgery were selected. We extracted data using a standardized form and assessed study quality using the QUIPS tool.

Results: Nine cohort studies representing 2958 patients satisfied our selection criteria. All studies focused on postoperative mortality. Thirty-four prognostic factors were examined, with significant variability across studies. There was limited or conflicting evidence for most prognostic factors. Meta-analysis was only possible for the American Society of Anesthesiologists (ASA) score, which was found to be associated with mortality in 4 studies (pooled odds ratio 2.77, 95% confidence interval 0.92–8.41).

Conclusion: While acute GI surgery in elderly patients is becoming increasingly common, the literature on prognostic factors for morbidity and mortality in this patient population lags behind. Further research is needed to help guide patient care and potentially improve outcomes.

Contexte : On constate une morbidité et une mortalité accrues chez les patients âgés soumis à une chirurgie gastro-intestinale (GI) urgente, comparativement aux patients plus jeunes et ceux qui subissent une intervention non urgente. Certains facteurs pronostiques peuvent servir à conseiller les patients au sujet des risques et, s’ils sont modifiables, au sujet de leur atténuation. Nous avons passé en revue la littérature sur les facteurs pronostiques qui sous-tendent l’issue négative d’une chirurgie GI urgente chez des patients âgés.

Méthodes : Nous avons interrogé les bases de données PubMed et Embase à l’aide d’une stratégie mise au point en collaboration avec un expert bibliothécaire. Nous avons sélectionné les études portant sur les liens indépendants entre facteurs pronostiques et morbidité ou mortalité chez les patients de 65 ans et plus soumis à une chirurgie GI urgente. Nous avons extrait les données à l’aide d’un formulaire standardisé et évalué la qualité des études au moyen de l’outil QUIPS.

Résultats : Neuf études de cohorte regroupant 2958 patients répondaient à nos critères de sélection. Toutes les études faisaient état de la mortalité postopératoire. Trente-quatre facteurs pronostiques ont été analysés et la variabilité entre les études était significative. Les preuves se sont révélées limitées ou divergentes pour la plupart des facteurs pronostiques. Il n’a été possible d’effectuer une méta-analyse que pour le score ASA (American Society of Anesthesiologists), qui s’est révélé associé à la mortalité dans 4 études (rapport des cotes regroupées 2,77, intervalle de confiance de 95 % 0,92–8,41).

Conclusion : La chirurgie GI urgente est de plus en plus courante chez les patients âgés, mais la littérature sur les facteurs pronostiques de morbidité et de mortalité chez cette population de patients a pris du retard. Il faudra approfondir la recherche pour orienter le soins des patients et améliorer les résultats.
Elderly patients (age ≥ 65) are the fastest growing subset of the population in industrialized countries. This has had an impact on the health care system as the proportion of discharged patients older than 65 has increased from 10% in 1970 to 37% in 2007. This trend will likely continue, as 25% of North Americans are expected to be older than 65 by 2040. This changing demographic will impact the delivery of health care, including surgical care, in many ways. Of particular concern to the field of general surgery is that 40% of gastrointestinal (GI) surgeries in elderly patients occur on an acute (urgent or emergent) basis. Nonelective surgery in older adults is associated with a 10- to 15-fold increase in morbidity and a 3- to 5-fold increase in mortality compared to elective surgery in this age group. Furthermore, nonelective surgery in this cohort is also associated with increased morbidity (28% v. 10%) and mortality (15.2% v. 2.5%) compared with younger cohorts. This high potential for poor outcomes has implications for patient care and autonomy as well as cost and resource planning.

Prognostic factors for perioperative morbidity and mortality are useful to clinicians and patients in several ways. At the most basic level, prognostic factors can inform care and convey the probability of expected risks to the patients and their families. Once identified, factors associated with adverse outcomes can potentially be modified. Finally, prognostic factors can be used to inform the development of risk prediction models in order to more accurately assess risk for individual patients. To our knowledge, no previous review articles have explored prognostic factors for morbidity and mortality in this patient population. With these views in mind, the purpose of our study was to systematically review and synthesize the available evidence on prognostic factors associated with morbidity and mortality in elderly patients undergoing acute GI surgery.

**METHODS**

**Literature search**

We used a strategy developed in collaboration with an expert librarian (see the Appendix, available at canjsurg.ca) to search PubMed and Embase (all years through June 11, 2012). Search terms (medical subject headings, Emtree headings and free text words) related to acute GI surgery, elderly patients, postoperative outcomes, risk prediction and prognosis were used with Boolean logic to identify all potentially relevant articles. No language restrictions were applied.

Search results were combined using Ref Works software version 2.0 (ProQuest), and duplicates were removed. One of us (J.S.) initially screened titles for potential relevance, and citations were excluded if they did not pertain to the study population of interest. Abstracts were independently screened for relevance by 2 of 3 reviewers (P.D., J.S., and J.B.). Full text review was then performed by 2 reviewers (J.S. and P.D.). At this stage articles were limited to those published in English or French. When there was disagreement about study selection, an attempt at consensus was made. In the rare instance that consensus could not be reached, adjudication was done by the third reviewer (J.B.). Reference lists of all included studies were searched for additional studies of potential relevance. If relevant information was unclear or missing, up to 3 attempts were made to contact the primary author and obtain the pertinent information.

**Study selection**

**Study population**

Patients aged 65 years and older who were undergoing acute GI surgery constituted the population of interest. In order to be consistent with current North American models of acute care surgery, at least 90% of the included cohorts had to have undergone GI surgery, with at least 75% of these surgeries being acute. The definition of acute surgery was any unscheduled or unplanned surgery.

**Outcomes of interest**

The primary outcomes of interest were postoperative morbidity and mortality. Postoperative mortality was defined as in-hospital or 30-day mortality. Morbidity was defined as any deviation from the normal postoperative course, using the classification scheme proposed by Dindo and colleagues. Major complications (Clavien III–IV) were defined as those requiring surgical, endoscopic or radiologic intervention and/or those requiring intensive care. Minor complications (Clavien I–II) were defined as any complication that was not major, including ileus, wound infection, the need for blood transfusion, systemic infection not requiring intensive care unit (ICU) intervention, cardiac arrhythmia or the need for parenteral nutrition. Secondary outcomes of interest were length of stay (LOS) in hospital and discharge to an institution (rehabilitation hospital, assisted living situation or nursing home).

**Prognostic factors**

All prognostic factors evaluated in previous studies were considered in this systematic review. Prognostic factors were classified into 3 groups for synthesis and clear presentation: patient factors, disease factors and perioperative factors. Patient factors were any underlying condition or demographic characteristic present before the acute illness (e.g., age, sex, comorbidities). Disease factors were
any prognostic feature related to the acute illness (e.g., laboratory values, presence of sepsis, peritonitis, obstruction, malignancy). Perioperative factors were aspects related to the surgical admission (e.g., postoperative complications, time to surgery, need for blood transfusion, type of surgery).

**Study designs**

Clinical cohort studies were included if there was a longitudinal component between prognostic factor measurement and outcomes of interest, including cohort studies or randomized controlled trials (if analyzed to identify important prognostic variables). Study data could be collected prospectively or retrospectively. Selection of studies was limited to those that included multivariate analysis (studies that reported only univariate, or crude analysis were excluded).

**Critical appraisal of included studies**

Prognostic factor studies were categorized into 3 groups based on phase of investigation. Phase one studies were exploratory studies in which associations between prognostic factors and outcomes were sought out. Phase 2 studies were exploratory studies based on prior hypotheses to test the association between prognostic factors and outcomes of interest. Finally, phase 3 studies were those that aimed to explain how relationships between prognostic factors influence the outcome.

Risk of bias (ROB) was assessed by 2 reviewers (J.B. and P.D.) using the Quality in Prognostic Studies (QUIPS) tool. The QUIPS tool examines ROB in 6 domains: study participation, study attrition, prognostic factor measurement, outcome measurement, study confounding, and statistical analysis and presentation. Cohen’s κ was used to assess inter-observer reliability for agreement on all 6 domains. Where there was disagreement about assessment of individual items and judgment about domain risk of bias, reviewers attempted to reach consensus through discussion. In the rare instance that consensus was not achieved, adjudication was done by a third reviewer (J.S.).

**Data extraction**

Data extraction was performed with consensus by 2 independent reviewers (P.D. and J.S.), using a standardized data extraction form (see the Appendix, available at canjsurg.ca). Extracted information included study characteristics (type of study, number of patients, type of surgery, outcomes of interest), patient characteristics (age, sex, body mass index, and comorbid conditions), and strength of association (odds ratios [OR], relative risks [RR] and hazard ratios [HR]) between prognostic factors and outcomes of interest.

**Data synthesis**

When data were available, multivariate associations between prognostic factors and postoperative outcomes were synthesized. For clarity, associations were recalculated to be in the same direction, as necessary, with associations above 1 indicating a worse prognosis. Where 3 or more studies reported an association between a prognostic factor and outcome of interest, we performed random-effects generic inverse variance meta-analysis using Review Manager version 5.1 (Cochrane Collaboration). We calculated standard errors (SEs) from confidence intervals (CIs) and appropriately transformed the individual study association and SE to their natural logarithms to normalize their distributions. Heterogeneity among studies was assessed using a χ² test and the I² statistic. Heterogeneity was considered significant when the χ² test had a p < 0.10 or if I² was greater than 50%.

When meta-analysis was not possible, qualitative synthesis of studies was used to explore heterogeneity due to population source and setting, definitions of prognostic factor and outcomes. Strength of association was defined based on effect size as weak (OR < 1.5), moderate (OR 1.5–2.9) or strong (OR ≥ 3). Consistency of findings was assessed using the following schema.

- **Strong evidence:** consistent findings (defined as > 75% of studies showing the same direction of effect) in multiple high-quality (defined as low ROB in all domains) studies.
- **Moderate evidence:** consistent findings in multiple low-quality (moderate to high ROB in 4 of 6 domains) studies and/or 1 high-quality study.
- **Limited evidence:** 1 study.
- **Conflicting evidence:** inconsistent findings across studies.
- **No evidence:** lack of association between the prognostic factor and outcome of interest.

**RESULTS**

Nine studies met all of our selection criteria (Fig. 1). Sixteen papers (8 Russian, 3 Japanese, 2 German, 1 Chinese, 1 Bulgarian and 1 Norwegian) were excluded as per protocol; most were published in the late 1970s and early 1980s and did not contain a multivariate analysis. Two additional studies were identified through bibliographic review of included studies; neither was included in the review because they did not include multivariate analyses.

**Study characteristics**

Table 1 summarizes the characteristics of the 9 included studies representing a total of 2958 patients. Four studies focused exclusively on acute...
8801 Embase references

5273 PubMed references

10,370 titles screened

1175 abstracts screened

5273 PubMed references

178 full-text pages

2 articles added from bibliographic review

9 studies included for analysis

9195 not relevant to study population

Excluded n = 997
- 397: age cutoff < 65 yr
- 253: wrong outcome
- 196: less than 90% nonelective GI surgery
- 122: case study/series
- 28: reviews
- 3: duplicate

Excluded n = 169
- 70: no multivariate analysis
- 56: age cutoff < 65 yr
- 16: foreign language
- 16: less than 95% nonelective
- 9: conference abstracts
- 2: editorials

9195 not relevant

Fig. 1. Overview of literature review and study selection. GI = gastrointestinal.

Table 1. Study and patient characteristics of included studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Location</th>
<th>No. of patients</th>
<th>Age cut-off, yr</th>
<th>Type of surgery</th>
<th>Outcomes of interest</th>
<th>Average age, yr or median (range)</th>
<th>Sex, % male</th>
<th>Average LOS, d or median (range)</th>
<th>Mortality, %</th>
<th>Morbidity, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arenal et al.²⁰</td>
<td>Valladolid, Spain</td>
<td>710</td>
<td>≥ 70</td>
<td>GI surgery</td>
<td>In-hospital mortality</td>
<td>79.4 (46.8)</td>
<td>NR</td>
<td>21.5 (58.3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cook et al.⁹</td>
<td>Bristol, UK</td>
<td>107</td>
<td>≥ 65</td>
<td>GI surgery</td>
<td>In-hospital mortality</td>
<td>80.2 (50.4)</td>
<td>NR</td>
<td>43.9 (NR)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fukuda et al.²¹</td>
<td>Kawasaki, Japan</td>
<td>94</td>
<td>≥ 80</td>
<td>GI surgery</td>
<td>30-day mortality</td>
<td>85.6 (38.3)</td>
<td>NR</td>
<td>16.0 (43.6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kwok et al.²³</td>
<td>Boston, USA</td>
<td>1358</td>
<td>≥ 80</td>
<td>Colorectal</td>
<td>30-day mortality</td>
<td>85.3 (34.3)</td>
<td>NR</td>
<td>28.9 (26.9)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leong et al.²²</td>
<td>Singapore</td>
<td>58</td>
<td>≥ 80</td>
<td>Colorectal</td>
<td>30-day morbidity/mortality</td>
<td>83 (80–96)</td>
<td>41.4 (17.5)</td>
<td>27.6 (3–108)</td>
<td>81.0 (30–97)</td>
<td></td>
</tr>
<tr>
<td>McGillicuddy et al.²⁴</td>
<td>New Haven, USA</td>
<td>292</td>
<td>≥ 65</td>
<td>Colorectal</td>
<td>In-hospital morbidity/mortality</td>
<td>78.1</td>
<td>41</td>
<td>20.9</td>
<td>15.0 (34.6)</td>
<td></td>
</tr>
<tr>
<td>Modini et al.²⁵</td>
<td>Rome, Italy</td>
<td>215</td>
<td>&gt; 65</td>
<td>Colorectal</td>
<td>30-day mortality</td>
<td>78 (47)</td>
<td>NR</td>
<td>16.3 (17.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Okubo et al.²⁶</td>
<td>Niigata, Japan</td>
<td>36</td>
<td>≥ 80</td>
<td>GI surgery</td>
<td>In-hospital mortality</td>
<td>84 (80–97)</td>
<td>44.4 (38 (2–150))</td>
<td>27.8 (83.3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vaughan-Shaw et al.²⁷</td>
<td>Southampton, UK</td>
<td>88</td>
<td>≥ 80</td>
<td>GI surgery</td>
<td>30-day mortality</td>
<td>84 (80–96)</td>
<td>51.1 (15 (8–72))</td>
<td>33.0 (NR)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

COPD = chronic obstructive pulmonary disease; CRF = chronic renal failure; DM = diabetes mellitus; GI = gastrointestinal; IHD = ischemic heart disease; LOS = length of stay; NR = not reported.

*Major morbidity reported.

Table 2. Risk of bias assessment for included studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Data acquisition</th>
<th>Study participation</th>
<th>Study attrition</th>
<th>Prognostic factor measurement</th>
<th>Outcome measurement</th>
<th>Study confounding</th>
<th>Statistical analysis and presentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arenal et al.²⁰</td>
<td>Retrospective</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>Cook et al.⁹</td>
<td>Prospective</td>
<td>Low</td>
<td>Low</td>
<td>Moderate</td>
<td>Low</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>Fukuda et al.²¹</td>
<td>Retrospective</td>
<td>Moderate</td>
<td>Low</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>Kwok et al.²³</td>
<td>Prospective</td>
<td>Moderate</td>
<td>Low</td>
<td>Moderate</td>
<td>Low</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Leong et al.²²</td>
<td>Retrospective</td>
<td>Low</td>
<td>Low</td>
<td>Moderate</td>
<td>Moderate</td>
<td>High</td>
<td>Moderate</td>
</tr>
<tr>
<td>McGillicuddy et al.²⁴</td>
<td>Retrospective</td>
<td>Low</td>
<td>Low</td>
<td>Moderate</td>
<td>Low</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>Modini et al.²⁵</td>
<td>Retrospective</td>
<td>Low</td>
<td>Low</td>
<td>Moderate</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Okubo et al.²⁶</td>
<td>Retrospective</td>
<td>Low</td>
<td>Low</td>
<td>Moderate</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Vaughan-Shaw et al.²⁷</td>
<td>Retrospective</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>
colorectal surgery, while 5 studies\textsuperscript{9,20,21,24,27} focused on acute GI surgery. All of these studies included mortality as the primary outcome of interest. Two studies\textsuperscript{22,24} examined prognostic factors for morbidity using multivariate analysis. No included study examined the association between prognostic factors, LOS or discharge to institution.

**Study designs**

Table 2 summarizes the ROB assessment for all included studies. Inter-rater reliability was good (κ = 0.76, 95% CI 0.59–0.92). Two studies\textsuperscript{9,23} were prospective cohorts and the rest were retrospective. All studies were exploratory, phase 1, investigations. Most studies were of low to moderate quality. The main issues with study quality were related to prognostic factor measurement, study confounding and statistical analysis. The ROB was reported as moderate in 7 studies\textsuperscript{9,20–25} owing to incomplete reporting on how prognostic factors were measured and in 5 studies\textsuperscript{9,20,21,24,25} owing to partial reporting on confounder measurement. One study\textsuperscript{22} was rated as having a ROB owing to partial reporting of confounder measurement and partial reporting on how adjustment was made. Finally, with respect to statistical analysis, most studies were considered to have a moderate ROB, as step-wise regression was used. One study received a high ROB rating as, in addition to using step-wise regression, model presentation was incomplete.\textsuperscript{24}

**Prognostic factors associated with perioperative mortality**

Patient factors associated with postoperative mortality are summarized in Table 3. Nine patient factors were investigated across studies. There is limited evidence of an association between a history of chronic obstructive pulmonary disease,\textsuperscript{2,23} a history of congestive heart failure,\textsuperscript{2,23} dependent functional status\textsuperscript{2,23} and mortality. All studies examined age as a prognostic factor. Evidence for an association between age and mortality was conflicting, as only 4 studies\textsuperscript{9,23–25} found an association on multivariate analysis (5 studies reported negative/neutral associations with outcome). The American Society of Anesthesiologists (ASA) score was considered in 7 of 9 studies,\textsuperscript{9,20,22,24–27} and results were also inconsistent. Three studies treated the ASA score as an ordinal variable; a pooled analysis is summarized in Fig. 2 (pooled OR 2.77, 95% CI 0.92–8.41). An additional 3 studies\textsuperscript{21,24,27} treated the ASA Score as an ordinal variable; however, they used stepwise regression and the ASA score was removed during modelling. The remaining study treated the ASA score as dichotomous, showing an association between an ASA of 3 or greater and mortality.\textsuperscript{22} Contradictory evidence also existed for sex\textsuperscript{9} and history of neurologic disease.\textsuperscript{2,23} There is no evidence of an association between the Eastern Cooperative Oncology Group physical status and mortality.

Disease factors associated with postoperative mortality are summarized in Table 4. A total of 11 disease factors were analyzed. There was limited evidence of an association between the physiologic component of the Physiologic and

| Table 3. Patient factors associated with postoperative mortality, OR (95% CI) |
|-------------------------------------------------------------|-----------------|-----------------|-----------------|-----------------|
| Patient factor                                              | Arenal et al.\textsuperscript{20} | Cook et al.\textsuperscript{9} | Fukuda et al.\textsuperscript{21} | Kwock et al.\textsuperscript{23} | Leong et al.\textsuperscript{22} | McGillicuddy et al.\textsuperscript{24} | Modini et al.\textsuperscript{25} | Okubo et al.\textsuperscript{26} | Vaughan-Shaw et al.\textsuperscript{27} |
| Age                                                         | OR 1.03 (0.97–1.09) | OR 1.15 (1.04–1.27)* | NS              | NS              | NS              | p = 0.001†        | OR 3.77 (1.32–10.7)* | NS              | NS              |
| Sex, male                                                   | OR 1.05 (0.99–1.11) | OR 0.21 (0.19–0.23)* | NS              | NS              | NS              | NS              | NS              | NS              | NS              |
| ASA score                                                   | OR 1.15 (1.11–1.19)* | OR 5.88 (2.40–14.43)* | NS              | NS              | ASA ≥ 3 OR 10.41 (1.48–73.19)* | NS              | OR 3.87 (2.05–7.93)* | NS              | NS              |
| Presence of comorbidities                                   | NS              | NS              | NS              | NS              | NS              | NS              | NS              | NS              | NS              |
| Hx of COPD                                                   | NS              | NS              | NS              | NS              | OR 1.79 (1.28–2.50)* | NS              | NS              | NS              | NS              |
| History of CHF                                              | NS              | NS              | OR 1.87 (1.21–2.90)* | NS              | NS              | NS              | NS              | NS              | NS              |
| History of neurologic disease                               | NS              | NS              | OR 4.47 (1.73–11.41)* | NS              | NS              | NS              | NS              | NS              | NS              |
| ECOG physical status                                        | NS              | NS              | NS              | NS              | NS              | NS              | NS              | NS              | NS              |
| Totally dependent functional status                         | OR 2.54 (1.88–3.43)* | NS              | NS              | NS              | NS              | NS              | NS              | NS              | NS              |

ASA = American Society of Anesthesiologists; CHF = congestive heart failure; CI = confidence interval; COPD = chronic obstructive pulmonary disease; ECOG = Eastern Cooperative Oncology Group; NS = not significant; OR = odds ratio.

* p < 0.05.
† Data treated as continuous and no OR produced.
Operative Severity Score for the enumeration of Mortality and Morbidity (POSSUM) score, the neutrophil to lymphocyte ratio, presence of 2 or more failing organs and mortality. Conflicting evidence for an association between mortality and serum creatinine, mesenteric ischemia, the presence of the systemic inflammatory response (SIRS) or sepsis, and metastatic disease was shown. There was no evidence of an association between the Acute Physiology and Chronic Health Evaluation-II (APACHE-II) score, the operative severity component of the POSSUM score, the presence of GI bleeding, intestinal obstruction, the presence of peritonitis or mortality.

Perioperative factors associated with patient mortality are summarized in Table 5. A total of 14 perioperative factors were considered across studies. There was moderate evidence of an association between duration of symptoms before admission and mortality. There was limited evidence for an association between mortality and palliative resection, nontherapeutic laparotomy, need for invasive monitoring, need for ICU admission and midline laparotomy. Conflicting evidence for an association between time from admission to surgery, postoperative complications, preoperative steroid use and estimated blood loss was shown. There was no evidence of an association between the American Society of Anesthesiologists (ASA) score as a prognostic factor for postoperative mortality.

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>log, OR</th>
<th>SEM</th>
<th>Weight, %</th>
<th>OR, IV, Random, 95% CI</th>
<th>OR, IV, Random, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modini et al.25</td>
<td>0.142</td>
<td>0.142</td>
<td>37.3</td>
<td>1.15 (1.11, 1.19)</td>
<td>0.15 (1.11, 1.19)</td>
</tr>
<tr>
<td>Cook and Day9</td>
<td>1.75</td>
<td>0.458</td>
<td>32.0</td>
<td>5.76 (2.35, 14.12)</td>
<td>5.76 (2.35, 14.12)</td>
</tr>
<tr>
<td>Arenal et al.20</td>
<td>1.353</td>
<td>0.345</td>
<td>32.8</td>
<td>3.87 (1.97, 7.61)</td>
<td>3.87 (1.97, 7.61)</td>
</tr>
<tr>
<td>Total (95% CI)</td>
<td>100.0</td>
<td></td>
<td></td>
<td>2.77 (0.92, 8.41)</td>
<td>2.77 (0.92, 8.41)</td>
</tr>
</tbody>
</table>

**Table 4. Disease factors associated with postoperative mortality, OR (95% CI)**

<table>
<thead>
<tr>
<th>Disease factor</th>
<th>Arenal et al.20</th>
<th>Cook et al.9</th>
<th>Fukuda et al.21</th>
<th>Kwok et al.23</th>
<th>McGillicuddy et al.24</th>
<th>Modini et al.25</th>
<th>Okubo et al.26</th>
<th>Vaughan-Shaw et al.27</th>
</tr>
</thead>
<tbody>
<tr>
<td>APACHE-II score</td>
<td>—</td>
<td>—</td>
<td>OR 1.13</td>
<td>(0.92–1.38)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>POSSUM score</td>
<td>—</td>
<td>—</td>
<td>PS: OR 1.20</td>
<td>(1.03–1.42)*</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>OECD: OR 1.02</td>
<td>(0.85–1.23)</td>
<td></td>
<td></td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Presence of intestinal obstruction</td>
<td>OR 1.04</td>
<td>(0.97–1.12)</td>
<td>NS</td>
<td>—</td>
<td>NS</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Presence of creatinine &gt; 1.5 mg/dL</td>
<td>—</td>
<td>—</td>
<td>OR 2.57</td>
<td>(1.97–3.36)*</td>
<td>NS</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Presence of N/L ratio</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>≥ 2 failing organs</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>OR 1.03</td>
<td>(1.01–1.06)*</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Presence of GI bleeding</td>
<td>OR 1.12</td>
<td>(0.96–1.30)</td>
<td>NS</td>
<td>—</td>
<td>NS</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Presence of mesenteric ischemia</td>
<td>OR 1.29</td>
<td>(1.08–1.53)*</td>
<td>NS</td>
<td>—</td>
<td>OR 4.33</td>
<td>(0.89–21.11)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Presence of SIRS/sepsis</td>
<td>—</td>
<td>NS</td>
<td>—</td>
<td>OR 2.13</td>
<td>(1.60–2.82)*</td>
<td>OR 5.26</td>
<td>(1.21–22.5)*</td>
<td>—</td>
</tr>
<tr>
<td>Presence of peritonitis</td>
<td>OR 1.04</td>
<td>(0.96–1.13)</td>
<td>—</td>
<td>—</td>
<td>NS</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Metastatic disease</td>
<td>OR 1.03</td>
<td>(0.91–1.17)</td>
<td>—</td>
<td>OR 2.00</td>
<td>(1.08–3.71)*</td>
<td>NS</td>
<td>NS</td>
<td>—</td>
</tr>
</tbody>
</table>

**Fig. 2.** Pooled analysis for American Society of Anesthesiologists (ASA) score as a prognostic factor for postoperative mortality. CI = confidence interval; IV = inverse variance; OR = odds ratio; SEM = standard error of the mean.

**Table 4. Disease factors associated with postoperative mortality, OR (95% CI)**

APACHE-II = Acute Physiology and Chronic Health Evaluation II; CI = confidence interval; GI = gastrointestinal; N/L = neutrophil/lymphocyte; NS: not significant; OR = odds ratio; OSS = operative severity score; POSSUM = Physiologic and Operative Severity Score for the enUmeration of Mortality and Morbidity; PS = physiologic score; SIRS = systemic inflammatory response syndrome.

Prognostic factor not considered in analysis.

*p < 0.05.
with GI resection, \(^9,^{20,22,23}\) suture repair of perforation, \(^{20,22}\) time from symptom onset to surgery, \(^{20}\) or adequate resuscitation\(^9\) and mortality.

**Prognostic factors associated with postoperative complications**

Only 2 exploratory studies\(^{19,21}\) examined potential prognostic factors for postoperative morbidity. One study\(^{22}\) evaluated the association between patient age, sex, surgeons’ expertise, ASA grade, hemoglobin on admission, the need for blood transfusion, duration of the operation and type of operation and postoperative morbidity. On multivariate analysis only high ASA score (\(\geq 3\)) was associated with postoperative morbidity (OR 37.29; 2.31–602.60). A second study\(^{24}\) examined the association between 17 prognostic factors and the development of any postoperative complication (including pneumonia, respiratory failure, myocardial infarction, deep venous thrombosis, pulmonary embolus and stroke). The authors used a stepwise regression model and found wound contamination (OR 3.22, 95% CI 1.55–6.67, \(p < 0.001\)), shock (OR 2.23, 95% CI 1.05–4.88, \(p = 0.04\)), chronic renal insufficiency (OR 1.47, 95% CI 1.06–2.04, \(p = 0.02\)) and time in the operating room (no OR reported as data continuous, \(p = 0.01\)) to be associated with postoperative complications.

Taken together, these studies provide limited evidence of an association between an ASA score of 3 or greater, wound contamination, shock, chronic renal insufficiency, time in the operating room and postoperative morbidity in this patient population.

**Discussion**

As the population ages, issues related to the surgical care of elderly patients are becoming increasingly common.\(^{2,7,10,28}\)

---

### Table 5. Perioperative factors associated with postoperative mortality, OR (95% CI)

<table>
<thead>
<tr>
<th>Perioperative factor</th>
<th>Arenal et al.(^9)</th>
<th>Cook et al.(^3)</th>
<th>Fukuda et al.(^21)</th>
<th>Kwok et al.(^23)</th>
<th>Leong et al.(^22)</th>
<th>McGillicuddy et al.(^26)</th>
<th>Modini et al.(^25)</th>
<th>Okubo et al.(^26)</th>
<th>Vaughan-Shaw et al.(^27)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration of Symptoms before admission, h</td>
<td>OR 1.10 (1.03–1.18)*</td>
<td>—</td>
<td>&gt; 24 h of symptoms</td>
<td>OR 9.60 (1.02–50.80)*</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Time from admission to operating room, h</td>
<td>OR 1.05 (0.98–1.12)</td>
<td>—</td>
<td>—</td>
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<tr>
<td>Time from symptom onset to operating room, h</td>
<td>OR 0.97 (0.89–1.05)</td>
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<td>Patient adequately resuscitated</td>
<td>NS</td>
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<td>EBL</td>
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<tr>
<td>Preoperative steroid use</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>OR 0.61 (1.06–2.45)*</td>
<td>—</td>
<td>NS</td>
<td>—</td>
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<tr>
<td>Postoperative complications</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>NS</td>
<td>OR 36.17 (11.48–113.9)*</td>
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<tr>
<td>GI resection</td>
<td>OR 1.04 (0.97–1.12)</td>
<td>NS</td>
<td>—</td>
<td>—</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
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<td>NS</td>
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<tr>
<td>Suture closure of GI perforation</td>
<td>OR 1.08 (0.96–1.21)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>NS</td>
<td>—</td>
<td>NS</td>
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<tr>
<td>Palliative procedure</td>
<td>OR 1.18 (1.06–1.31)*</td>
<td>—</td>
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<tr>
<td>Nontherapeutic laparotomy</td>
<td>OR 1.26 (1.11–1.43)*</td>
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<tr>
<td>Need for invasive monitoring</td>
<td>—</td>
<td>OR 6.25 (1.59–24.55)*</td>
<td>—</td>
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<tr>
<td>Need for ICU admission</td>
<td>—</td>
<td>OR 11.11 (1.95–64.21)*</td>
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<tr>
<td>Midline laparotomy</td>
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<td>OR 8.86 (1.20–68.46)*</td>
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</table>

CI = confidence interval; EBL = estimated blood loss; GI = gastrointestinal; ICU = intensive care unit; NS: not significant; OR = odds ratio.

\(^* p < 0.05.\)

\(^{†}\)Data treated as continuous and no OR produced.

Prognostic factor not considered in analysis.
Elderly patients may differ from younger patients in several ways, including the number and severity of comorbid conditions they have, the types of surgical problems that develop and the treatments that are offered to them. Accordingly, there has been considerable interest in risk assessment specifically for elderly patients undergoing abdominal surgery. However, currently available preoperative risk assessment tools lack sufficient accuracy and reliability and often are not applicable in the acute clinical setting in this patient population. Thus surgeons are left with very little in their armamentarium to counsel patients regarding postoperative risks and must rely on clinical judgment.

Better risk prediction models are needed to guide the care of older patients, particularly in areas associated with high morbidity and mortality.

To our knowledge, this is the first systematic review on prognostic factors associated with mortality among elderly patients undergoing acute GI surgery. A total of 34 potential prognostic factors were analyzed, and there was significant variability with regards to which factors were examined in each study. The majority of evidence suggesting an association between prognostic factors and mortality was limited or conflicting. Only age at the time of surgery, the ASA score, the presence of SIRS/sepsis, duration of symptoms before admission and postoperative complications were shown to be associated with mortality in more than 1 study. Quantitative meta-analysis was only possible for the ASA score, and there was significant heterogeneity in effect size ($I^2 = 92\%$).

Although there was an association between increased ASA score and postoperative mortality in elderly patients undergoing acute abdominal surgery, 3 studies, not incorporated in the quantitative meta-analysis, did not show an association between ASA score and mortality. Given the limited number of studies available, sensitivity analysis was not possible, and the reasons for this variation are unclear. As the covariates examined across studies are not dissimilar, a possible explanation for this discrepancy is related to the study design. As all 3 studies used step-wise regression, it is possible that the results differ due to the statistical method used, as step-wise regression techniques are very sensitive to small changes in the data and the results are highly dependent on the cohort make-up. Therefore, the true association between the ASA score and mortality in elderly patients is unclear and further research is required.

The present systematic review highlights the lack of quality research for potential prognostic factors for morbidity and mortality in this high-risk population. Importantly, none of the studies examined variables associated with postoperative LOS, postoperative quality of life, loss of independence or the need for nursing home placement. Given that many elderly patients consider quality of life to be more important than quantity of life, research that addresses these patient-centred outcomes is needed. This issue was highlighted in a recent quality improvement guideline for optimal preoperative assessment of geriatric surgical patients. Future research evaluating prognostic factors for perioperative outcomes in elderly patients should also include frailty, which has been associated with postoperative morbidity, postoperative LOS and loss of independence among elderly patients undergoing elective GI surgery.

Identification of prognostic factors that can be used to create predictive models may help surgeons counsel patients regarding their postoperative risks. In addition it may help to identify strategies to improve outcomes in this patient population. While factors such as patient age and comorbidities are not modifiable, other factors, such as postoperative complications, might be. In addition, in trying to improve outcomes associated with emergency procedures, the potential to decrease the need for emergency surgery should be examined. Older patients with chronic conditions, such as incisional hernias or biliary tract disease, who are often managed expectantly with the hope that they might not need therapy, could be the group who benefit the most from elective surgery. With the increasing proportion of elderly patients, a better understanding of the risks and the benefits associated with elective versus emergency surgery is needed for common existing conditions that can lead to acute events requiring urgent surgery.

**Conclusion**

The literature on prognostic factors for postoperative morbidity and mortality in elderly patients undergoing nonelective GI surgery is very limited. At present, there are no established models that can assist in predicting adverse outcomes in this group. The majority of available studies are exploratory, most evidence is of limited quality and the results are conflicting. Given the aging population and associated future need for emergency surgery in elderly patients, there is a need for high-quality research in this area.

**Competing interests:** None declared.

**Contributors:** P. Davis, J. Hayden and P. Johnson designed the study. P. Davis, J. Springer and J. Bailey acquired the data, which P. Davis, J. Hayden and P. Johnson analyzed. P. Davis wrote the article, which all authors reviewed and approved for publication.

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MASSIVE PANNICULECTOMY: A NOVEL METHOD OF TREATMENT OF POSTLAPAROTOMY WOUND DEHISCENCE IN MORBID OBESITY

It was with interest that we read the article “High-concentration oxygen and surgical site infections in abdominal surgery: a meta-analysis.”1 Massive liposuction and body contouring procedures are no longer primary therapeutic options for the treatment of morbid obesity owing to their complications and suboptimal results. The obvious paradigm shift has been noted to favor bariatric procedures since the advent of laparoscopic approaches over last 2 decades. Panniculectomy is a cosmetic procedure that involves the removal of excess skin and fat from the affected organ.

We performed massive panniculectomy for the treatment of postlaparotomy wound dehiscence in a morbidly obese patient. A 60-year-old woman with body mass index (BMI) of 41.7 underwent a total abdominal hysterectomy for dysfunctional uterine bleeding. A surgical site infection and dehiscence involving skin and subcutaneous layers across the complete length of incision developed in the immediate postoperative period. The initial treatment at the primary centre involved drainage, debridement and regular dressings.

The patient was referred to our centre for further management in postoperative week 4. Upon clinical examination, we observed that the abdomen skin fold was thick and large, and it was difficult to examine the dehiscence suture line in the recumbent position (Fig. 1A). The bacteriological study of culture and sensitivity from the abdominal wound was unremarkable; blood work was essentially normal. After counselling the patient and her relatives, a decision was made to repair the wound with massive panniculectomy to remove excessive skin and subcutaneous tissue from the abdomen. The excessive abdominal skin complex incorporating the suture line and the umbilicus was removed (weighing 8.5 kg) and the procedure was completed. The duration of the surgery was 180 minutes; blood loss was minimal (100 mL). The postoperative period was uneventful and the wound healed well, with no excessive abdominal fold. The patient was able to resume her normal activities 14 days after the procedure (Fig. 1B).

Management of morbid obesity involves a trial of strict diet and exercise, followed, if unsuccessful, by one of the various bariatric surgical procedures. Plastic surgical intervention usually comprises massive liposuction and body contouring with or without lumpectomies after achieving weight loss.

Panniculectomy is a procedure that involves the removal of excess skin and fat from any part of the body. This procedure is different from abdominoplasty, which involves tightening of the muscles. Panniculectomy is done routinely after massive weight loss (e.g., after bariatric surgeries), where excessive skin and subcutaneous fat are removed to enhance appearance and improve confidence. When more than 10 lbs of tissue is removed, the procedure is known as massive panniculectomy.2

Abdominal wall hernia repair is treated with mesh repairs, component separation technique and pedicled fascia lata flap. In our case, excessive bulk of the abdominal wall mass was dragging in multiple directions, thereby stretching the operative wound and preventing it from closing. During the procedure, the previous vertical wound was excised en masse with the excess abdominal apron and umbilicus using a supra pubic Pfannensteil incision; the postexcision wound was closed transversely corresponding to the relaxed skin tension lines. Therefore, a reduced abdominal wall mass and a new suture line along the relaxed skin tension lines enabled us to have good wound healing and increased patient satisfaction.

We conclude that panniculectomy, which is primarily a cosmetic method of excess skin and fatty tissue removal, can be used to treat postsurgical wound dehiscence in morbidly obese patients.

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ANCILLARY TESTS TO IMPROVE THE ACCURACY OF LAPAROSCOPY IN THE DIAGNOSIS OF TUBERCULOUS PERITONITIS

It has been suggested in your journal that laparoscopy and biopsy should be deployed to diagnose tuberculous peritonitis.1 In 1993, the World Health Organization took an unprecedented step and declared tuberculosis (TB) a global emergency.2 The prevalence of extrapulmonary TB is rising, possibly related to co-infection with HIV. In patients with extrapulmonary TB, the abdomen is involved in 11% of patients.3 Tuberculous peritonitis is believed to exhibit a female predominance; other causes of abdominal pain may delay diagnosis.

Over a 2-year period, we carried out a prospective study of 92 patients admitted to the Government Medical College, Srinagar, India with the clinical suspicion of abdominal TB. Of these patients, 50 were subsequently proven by biopsy to have peritoneal TB.

All the patients underwent the following diagnostic tests after a thorough clinical examination: erythrocyte sedimentation rate (ESR); Mantoux test; ascitic fluid analysis for adenosine deaminase (ADA) levels, Ziehl–Neelsen staining and culture of mycobacterium tuberculosis bacilli (MTB); and contrast enhanced computed tomography (CT) of the abdomen. We then undertook diagnostic laparoscopy. Features of a positive laparoscopy included thickened peritoneum, adhesions and peritoneal tubercles, which were biopsied (Fig. 1). Our patients were mainly young adults from rural areas, with a slight female predominance. Patients presented with fever (50%), weight loss (40%), anorexia (74%), malaise/pain (80%), diarrhea (10%), vomiting (40%) and constipation (25%). Physical signs were palor (74%), tender abdomen (70%), abdominal distension (50%), abdominal mass (20%), ascites (15%) and lymphadenopathy (8%). The Mantoux test was positive in 23 patients (46%). Anaemia was present in 84% of patients and the ESR was high in 90%.

Diagnostic laparoscopy was positive in 46 of 50 patients with biopsy-proven peritoneal TB, with a sensitivity of 92%. Contrast enhanced CT of the abdomen detected 30 of 50 cases of abdominal TB with a specificity of 60% and specificity of 71.42%. Ziehl–Neelsen staining for MTB of ascitic fluid was positive in only 2 patients (4%) and culture for MTB was positive in 8 cases (16%), whereas ascitic fluid polymerase chain reaction (PCR) for TB increased the sensitivity to 83.33%. Ascitic fluid analysis for ADA (> 33 U/L) showed a sensitivity and specificity of 100% and 96%, respectively. Diagnostic laparoscopy was falsely positive in 10 of 42 patients who did not have TB peritonitis.

Difficulties in the diagnosis of TB peritonitis owe to its nonspecific associated clinical features, unhelpful laboratory tests and a high level of false-negative tests (i.e., Mantoux test, Ziehl–Neelsen staining and culture of ascitic fluid and false-negative imaging). High levels of ascitic ADA is associated with TB peritonitis.4 Ascitic fluid was found clinically in only 15% of our patients, but may be available at the time of operation. Histopathology of peritoneal lesions is appropriate for diagnosing TB and to rule out other diseases, such as cancer. In the past, this required laparotomy4 even though the potential for laparoscopy was known before the advent of video laparoscopy.2

We agree with the previous report1 on the value of laparoscopy, but we found a false-positive rate of 18%. We suggest that the laparoscopic diagnosis of TB peritonitis be confirmed by histopathology of peritoneal lesions or ascitic fluid analysis for ADA greater than 33 U/L, depending on the local availability of these tests.

References


Fig. 1. Adhesions between the colon and the parietal peritoneum in a patient with tuberculous peritonitis.
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