

RESEARCH

Open Access



# Preoperative risk assessment and optimization integrating surgical and anesthetic principles and practices: a national survey for internists

Marc-Antoine Lepage<sup>1</sup>, Annie Lecavalier<sup>3</sup>, Gabriele Baldini<sup>1,4</sup>, Ning-Zi Sun<sup>1,2,5</sup> and Amal Bessissow<sup>1,2\*</sup>

## Abstract

**Background** The integration of procedure-specific risks into preoperative patient assessment and optimization are crucial aspects of perioperative care. However, data on internists' knowledge of surgical and anesthetic principles and practices are limited. We thus sought to identify internists' knowledge gaps in terms of surgical- and anesthetic-specific risk factors and characteristics.

**Methods** An open and voluntary e-survey was conducted via LimeSurvey between April and July 2021 to evaluate Canadian internists' knowledge of surgical and anesthetic principles and practices. The survey included the perceived importance and knowledge of several key surgical and anesthetic aspects, such as surgery duration, procedure-specific cardiac risk, bleeding risk, and thrombotic risk. It also assessed pre- and post-survey self-reported confidence levels in one's knowledge of these characteristics. Finally, we investigated how internists optimize some of the preoperative risks.

**Results** A total of 173 Canadian internists opened the survey link, and 121 completed it (completion rate 70%). While the majority of respondents considered surgical and anesthetic principles and practices as important, most identified knowledge gaps. Participants generally estimated surgery duration and procedure-specific cardiac risk adequately. However, they tended to underestimate procedure-specific bleeding risk for general (58%) and orthopedic (76%) surgeries and to overestimate procedure-specific thrombotic risk for vascular (63%) and genitourinary (60%) surgeries. Furthermore, there is a lack of consensus regarding the appropriate hemoglobin A1c target and 0% of respondents reported using the guideline-suggested hemoglobin threshold for investigation and intervention.

**Conclusions** Overall, our findings identify significant knowledge gaps among Canadian internists in preoperative assessment of procedure-specific risk factors and can be used to inform both the development of educational initiatives and future research to improve the quality of preoperative patient care.

**Keywords** Preoperative, Perioperative, Internal medicine, Survey

\*Correspondence:

Amal Bessissow

[amal.bessissow@mcgill.ca](mailto:amal.bessissow@mcgill.ca)

Full list of author information is available at the end of the article



© The Author(s) 2025. **Open Access** This article is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License, which permits any non-commercial use, sharing, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if you modified the licensed material. You do not have permission under this licence to share adapted material derived from this article or parts of it. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by-nc-nd/4.0/>.

## Background

Preoperative evaluation of patient-specific risk factors and their optimization are essential for ensuring the best possible surgical outcomes. Adequate glycemic control to limit postoperative infections (Dronge et al. 2006), reviewing and adjusting hypoglycemic agents to avoid hypoglycemia and ketoacidosis (Lui et al. 2012; Deuseberry et al. 2012), treating anemia and giving intravenous iron to help reduce blood product requirements (Richards et al. 2012; Muñoz et al. 2017), and assessing the need for thromboprophylaxis (Falck-Ytter et al. 2020; Gould et al. 2023) are just a few examples of perioperative optimization strategies.

In addition to performing a patient history, medication review, and focused physical examination to elicit potential patient-specific risk factors, it is critical to consider surgery- and anesthetic-specific factors that may impact the patient's perioperative course. For example, the type of anesthesia, patient position and surgical approach, may impact hemodynamics, cause atelectasis, affect postoperative analgesia requirements, cause local venous compression, etc. (Kunutsor et al. 2022; Thepsoparn et al. 2022; Massicotte et al. 2009; Ayatollahzade-Isfahani et al. 2013; Pei et al. 2022). These are procedure-specific risk factors.

The involvement of internists in the postoperative setting, especially in a co-management model and as part of a multidisciplinary team, has been studied and shown to decrease the length of stay, costs, and in-hospital mortality (Shaw et al. 2020; Rohatgi et al. 2016). On the other hand, the effects of internists' preoperative evaluations are not as well documented. While most non-RCTs, owing to their inherent selection bias, found that such preoperative evaluations are associated with neutral or worse patient outcomes (Pham et al. 1994; Katz et al. 2005), one retrospective analysis revealed decreased inpatient mortality (Vazirani et al. 2012). A reduced length of stay was also reported in one RCT (Macpherson and Lofgren 2017). Furthermore, in several health care models, including those used by Canadian institutions, the responsibility to elicit and optimize both patient- and procedure-specific risks often falls onto internists. As such, preoperative assessment of these risks is part of both the internal medicine and the general internal medicine core competencies required by the Royal College of Physicians and Surgeons of Canada. The Royal College of Physicians and Surgeons of Canada. 2018; Canada TRCo-PaSo. Internal Medicine Competencies 2018.

In this study, we aimed to assess the following: (1) Canadian internists' perceived importance of surgical- and anesthetic-specific risk factors, (2) their perceived knowledge of and confidence in assessing the surgical and anesthetic characteristics of commonly encountered surgeries, and (3) the appropriateness of

their recommendations for the optimization of common patient-specific risk factors.

## Methods

We conducted a bilingual (French and English), voluntary, and open cross-sectional e-survey of Canadian internists between April 26 and July 1, 2021. This 24-question survey targeted their preoperative procedure-specific risk assessment and recommendations for major elective noncardiac surgeries. It combined different sections and question structures: (1) sociodemographic information; (2) perceived importance of various surgical and anesthetic characteristics and self-reported knowledge and confidence levels in assessing these characteristics (Likert-scale questions, with pre- and postsurvey comparisons); (3) knowledge tests on procedure-specific cardiac, bleeding, and thrombotic risk assessments (multiple-choice questions (MCQs)); (4) use of nutrition screening tools (MCQs); (5) risk optimization (MCQs); and, finally, (6) preferred methods of learning (MCQs).

The survey (Additional File 1) was created through a literature review, discussions between investigators, and consultation with surgical and anesthesia experts at a tertiary university center in an iterative process. All authors reviewed and approved the survey. M. A. L., G. B., N. Z. S., and A. B. tested the survey features, and their answers were deleted prior to data collection. More details on survey characteristics are available in Additional File 1.

The protocol was approved by the local research ethics board (MUHC REB 2020–6320). Consent was obtained before the survey was administered. The information provided to participants is available in Additional File 2.

The LimeSurvey platform, which is compliant with Canadian privacy and accessibility standards, was used to collect answers. No identified data were obtained, and features to collect the date and time of completion as well as the IP address were disabled. No cookies or other means of creating a unique identifier were used.

We distributed the survey link electronically to internists through the Canadian Society of Internal Medicine's and the Association des spécialistes en médecine interne du Québec's respective newsletters as well as by emailing perioperative leaders in several Canadian centers and asking them to share the link with their colleagues (Additional File 2). No incentives were offered.

Answers from participants who opened the survey link and completed fewer than 50% of the questions were excluded. Answers were downloaded and analyzed via descriptive statistics with Microsoft® Excel. The CHERRIES checklist was used to report our findings (Additional File 3) (Eysenbach 2004).

**Table 1** Demographics

	N (%)
<b>Years of practice</b>	
Less than 5 years	35 (27)
5 to 10 years	24 (19)
11 to 20 years	29 (23)
More than 20 years	40 (31)
<b>Area of practice</b>	
Western Canada (British Columbia, Alberta)	6 (5)
Central Canada (Saskatchewan, Manitoba)	0 (0)
Eastern Canada (Ontario, Québec)	122 (95)
Atlantic Canada (N.B., P.E.I., N.S., N.L.)	0 (0)
<b>Time devoted to preoperative medicine</b>	
Less than 10%	59 (46)
10 to 25%	62 (48)
25 to 50%	7 (5)
More than 50%	0 (0)
<b>Types of practice</b>	
Academic/university center	71 (55)
Community center	66 (52)
Physician-owned practice	2 (2)
Private practice	5 (4)
<b>Surgeries for preoperative consultation</b>	
Abdominal (hepatopancreatobiliary, colorectal, gastric, appendix, adrenal, spleen)	125 (98)
Breast	84 (66)
Cardiac	24 (19)
Gynecological surgery	104 (81)
Head & neck surgery	95 (74)
Neurosurgery	45 (35)
Orthopedic surgery (including spine)	119 (93)
Thoracic	55 (43)
Urological	113 (88)
Vascular surgery	73 (57)
Other	8 (6)

N.B. New-Brunswick, P.E.I. Prince-Edward Island, N.S. Nova Scotia,  
N.L. Newfoundland Labrador

Correct answers to the knowledge-related survey questions were obtained from clinical guidelines when available; priority was given to North American over international guidelines (Dronge et al. 2006; Falck-Ytter et al. 2012; Gould et al. 2012; Doherty et al. 2017; Duceppe et al. 2017; Duggan et al. 2012; Fleisher et al. 2014; Kristensen et al. 2014; Munoz et al. 2017; National Blood Authority 2017; Thrombosis Canada and DOACS: Peri-Operative Management 2017; Thrombosis Canada. Thromboprophylaxis: Non-Orthopedic Surgery. 2018; Canada and Thromboprophylaxis: Orthopedic Surgery 2018; Wijesundera et al. 2019, 2019; Wischmeyer et al. 2020). When the literature could not provide a definitive

answer, local experts in surgery and anesthesia were consulted.

## Results

Of the 173 people who clicked on the survey link, 24 did not answer any questions, and 21 completed less than 50% of the survey and were therefore excluded. Seven people completed between 50 and 99% of the questions, and 121 finished the survey (completion rate 70%).

As shown in Table 1, there was a homogenous distribution across the number of years of practice. Most survey respondents were from Ontario or Québec (95%). They practised in academic and community centers and performed preoperative consultations across a wide range of surgical fields.

Table 2 shows that most survey participants thought that the duration of surgery, surgical approach, type of anesthesia, and type of analgesia were all important features of their preoperative assessment. However, only one-third reported their knowledge as highest in all domains.

Figure 1 shows how accurately participants predicted surgery duration and various operative risks. To facilitate visual representation, we grouped procedures by surgical specialties: general surgery (open hemicolectomy, laparoscopic cholecystectomy, inguinal herniorrhaphy), vascular surgery (carotid endarterectomy, endovascular aortic repair — EVAR), orthopedic surgery (total hip arthroplasty, total knee arthroplasty, laminectomy), thoracic surgery (open lung lobectomy), and genitourinary (transurethral resection of prostate — TURP, laparoscopic hysterectomy + bilateral salpingo-oophorectomy — TH-BSO). Most internists adequately estimated the surgery duration (53 to 84% depending on the surgery type). Most were also correct in their procedure-specific cardiac risk assessment, except for orthopedic surgeries, which were overestimated (63%). The procedure-specific bleeding risk was more frequently underestimated for general (58%) and orthopedic (76%) surgeries. The procedure-specific thrombotic risk tended to be overestimated by most respondents for vascular (63%) and genitourinary (60%) surgeries. Individual surgery data are available in Additional Tables 1, 2, 3, and 4.

In terms of preoperative patient nutritional optimization, Canadian internists mostly rely on their clinical judgment (71%). Fewer than one-third of the internists use one of the validated screening tools, and 28% do not screen for malnourishment. If malnourishment is identified, they often refer to a dietician or nutritionist (77%) and less commonly suggest high-protein oral supplements (35%), which are two adequate strategies.

The preferred preoperative hemoglobin A1c target in guidelines is  $\leq 7.0\%$ , which is used by only 35% of

**Table 2** Importance and knowledge of surgical and anesthetic characteristics in internist preoperative assessments

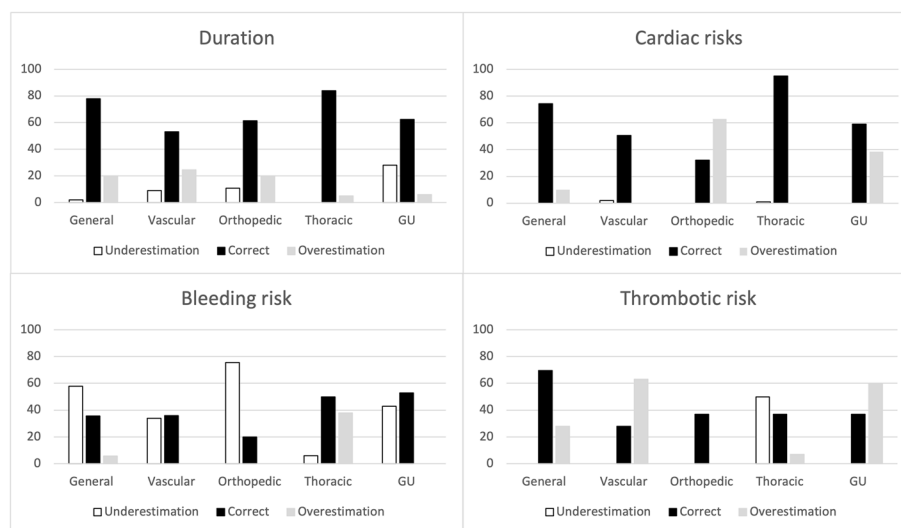
	Importance N (%)	Knowledge N (%)
<b>Duration of surgery</b>		
Important/knowledgeable	63 (49)	23 (18)
Moderately important/knowledgeable	52 (41)	64 (50)
Not important/knowledgeable	13 (10)	41 (32)
<b>Surgical approach (laparoscopy, laparotomy, etc.)</b>		
Important/knowledgeable	99 (78)	36 (28)
Moderately important/knowledgeable	24 (19)	73 (57)
Not important/knowledgeable	5 (4)	19 (15)
<b>Type of anesthesia used during surgery</b>		
Important/knowledgeable	92 (72)	31 (24)
Moderately important/knowledgeable	33 (26)	69 (54)
Not important/knowledgeable	3 (2)	28 (22)
<b>Perioperative analgesia used (i.e., epidural, patient-controlled analgesia, peripheral nerve block, PO narcotics)</b>		
Important/knowledgeable	72 (56)	26 (20)
Moderately important/knowledgeable	39 (30)	63 (49)
Not important/knowledgeable	17 (13)	39 (31)

internists. A total of 43% use a higher target, and 19% do not know what the best A1c target should be (Additional Table 5).

The suggested hemoglobin threshold in guidelines for investigation and intervention is < 130 g/L in all patients undergoing surgery in which significant blood loss (>500 mL) is anticipated, regardless of sex, which was

selected by 0% of internists, with most (38%) choosing a threshold of < 100 g/L (Additional Table 5).

A total of 94% of internists correctly identified the postoperative outcomes associated with impaired pre-operative functional capacity. However, only 18% recognized the Duke Activity Status Index (DASI) as its most objective measurement (Additional Table 5).



**Fig. 1** Survey answers for duration of surgery and surgical-specific risks. Top left corner: estimation of surgery duration. Top right corner: estimation of procedure-specific cardiac risk. Bottom left corner: estimation of procedure-specific bleeding risk. Bottom right corner: estimation of procedure-specific thrombotic risk. General surgery includes open hemicolectomy, laparoscopic cholecystectomy, and inguinal herniorrhaphy; vascular surgery includes carotid endarterectomy and endovascular aortic repair — EVAR; orthopedic surgery includes total hip arthroplasty, total knee arthroplasty, and laminectomy; thoracic surgery includes open lung lobectomy; and genitourinary (GU) surgery includes transurethral resection of prostate (TURP) and laparoscopic hysterectomy + bilateral salpingo-oophorectomy (TH-BSO)

When comparing responders' confidence pre- and postsurvey, shown in Fig. 2, there is a trend toward less confidence postsurvey in most areas.

Online learning activities, conferences, and meetings with surgeons and anesthesiologists were identified by participants as the preferred learning methods (Additional Table 2). Most responders currently have two or less continuing medical education activities a year in perioperative medicine. Furthermore, almost 70% of them perceive the need for additional information and training in surgical and anesthetic principles.

In the narrative section, one of the internists mentioned that documentation available prior to their preoperative assessment should include anticipated "duration of surgery, length of stay in hospital, general vs. regional vs. local, patient position." A few other internists spontaneously echoed a similar need for better communication between key actors in perioperative care.

## Discussion

With this survey, which was conducted among Canadian internists, we aimed to assess the importance they attributed to and their knowledge of surgical- and anesthetic-specific risk factors, as well as their perceived confidence in those topics. Additionally, we also assessed the adequacy of their optimization recommendations for common patient-specific risk factors compared with guideline recommendations. Our findings revealed important knowledge gaps that currently exist among Canadian internists pointing to unmet educational needs and providing insights into how to develop educational resources and improve perioperative care.

### Knowledge and importance of surgical- and anesthetic-specific risk factors

The responders self-identified knowledge gaps in surgical and anesthetic principles and practices despite perceiving these as being important to their preoperative assessments. Their level of confidence also decreased between the beginning and the end of the survey which suggests that they might not be fully aware of their knowledge gaps until they have been asked to explicitly reflect on these gaps. Eliciting these unperceived needs further supports the creation of more procedure-specific risk assessments and the optimization of educational resources.

### Risk assessment

Overall, procedure-specific cardiac risks were well estimated, possibly reflecting the broader body of evidence and the presence of Canadian guidelines (Duceppe et al. 2017). When internists misjudged cardiac risk, they tended to overestimate rather than underestimate the risk, particularly when dealing with orthopedic and

genitourinary surgeries. This may reflect the selection bias that internists are subjected to, as they are more likely to see patients at risk preoperatively (PausJenssen et al. 2008).

### Other procedure-specific risks were not as well assessed by internists

First, the bleeding risk was often underestimated. In the literature, the categorization of procedure-specific bleeding risk mostly relies on expert opinion (Doherty et al. 2017; Thrombosis Canada and DOACS: Peri-Operative Management 2017). It may also be influenced by local practices and the consequences to patients should they bleed. Internists may again be biased by their clinical exposure: bleeding tends to occur more intraoperatively or immediately postoperatively while the patient is still in the postanesthesia care unit and is usually dealt with by anesthesiologists and surgeons without internists' involvement.

Second, the thrombotic risk was overestimated for vascular, genitourinary, and, to a lesser extent, general surgeries. This overestimation may also be due to the preferential exposure that internists have to postoperative complications as thromboses tend to be managed by them.

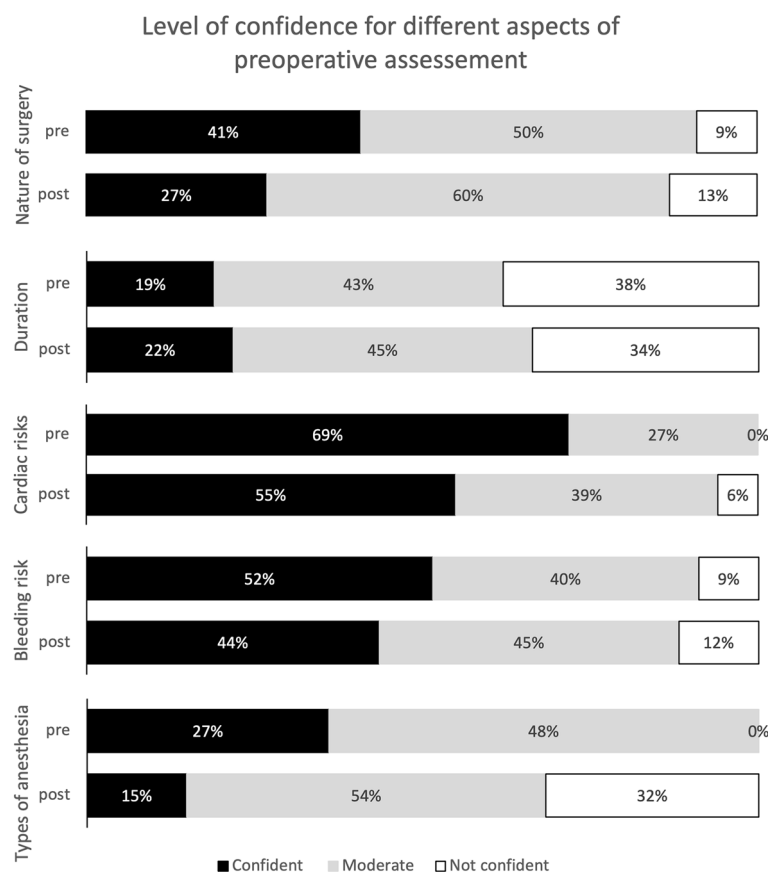
Despite these identified knowledge gaps, the PAUSE (Douketis et al. 2019) and BRIDGE (Douketis et al. 2015) trials have resulted in greater consensus on therapeutic anticoagulation management for most patients. Although both trials included a list of low- vs high-risk procedures in their supplementary appendix, more education may be warranted to promote awareness around the risk of bleeding. In contrast, the American Society of Regional Anesthesia and Pain Medicine guidelines (Horlocker et al. 2018; Narouze et al. 2018) are more conservative. How different trials and guidelines impact perioperative recommendations from different stakeholders could be pertinent future research questions.

### Risk optimization

In addition to the gaps and heterogeneity in the literature on risk assessment, several gray areas exist in risk optimization.

First, although a stricter A1c control preoperatively is associated with fewer infections (Dronge et al. 2006), whether a rapid improvement toward the target following preoperative assessment can improve postoperative outcomes remains unclear. This may be why there was so much heterogeneity in the participants' answers.

Second, variability was also observed in the internists' approach to preoperative optimization of baseline anemia. More recently, the PREVENTT trial (Richards et al.



**Fig. 2** Levels of confidence for different aspects of the preoperative assessment. From top to bottom: nature of surgery, duration of surgery, procedure-specific cardiac risk, procedure-specific bleeding risk, and types of anaesthesia

2020) failed to show benefits on mortality or transfusion requirements when anemia was identified and treated 10–42 days before elective abdominal surgery despite guideline recommendations to do so (Munoz et al. 2017). As more studies are conducted and published, we hope to see guideline with stronger recommendations and a more homogenous approach emerging in internists' pre-operative management plans.

Finally, while internists generally chose adequate nutrition optimization strategies on the survey, they reported rarely engaging in malnourishment screening. This may, in part, be due to the small amount of nutritional training in the medical schools' curriculum (Crowley et al. 2019).

### Communication

Although this was not a survey objective, communication between the different stakeholders in perioperative care was identified by some responders as a component to work on. This also seems to be an issue identified in

the literature by different actors involved in perioperative care.

A Canadian chart audit revealed that only 55% of pre-operative consult notes had all the recommendations followed (Flemons et al. 2022). Following the audit, the authors conducted interviews to identify barriers to recommendations implementation. From the surgical team's perspective, the barriers included the absence of a clearly defined stakeholder responsible for reviewing the pre-operative consult and the lack of comfort with the execution of the recommendations. From the internists' perspective, trying to predict all possible postoperative outcomes was a barrier to providing suggestions (Flemons et al. ). Given that procedure-specific risks may influence pre-operative recommendations, optimizing communication between all consultants seems key to maximize their impact.



### Potential implications

Several ideas to improve communication between the different teams involved in the perioperative care of complex patients could be explored in the future. For example, structured multidisciplinary rounds, like those at the University of Saskatchewan, could be implemented across institutions (Canadian Resident Matching Service (CaRMS) 2024). Cross-pollination between training programs could also lead to more comfort and a better understanding of realities across specialties. Canadian internal medicine (3+1 years stream) and general internal medicine (3+2 years stream) programs already have training in perioperative medicine, most through a single 4-week mandatory rotation, which could be adapted (Canadian Resident Matching Service (CaRMS) ). As explored at the end of our survey, educational resources for practising internists would also be essential and could be delivered via different instructional methods, as suggested by responders: online modules and videos, conferences, and meetings with surgeons and anesthesiologists. System-level solutions could also be explored such as the inclusion of procedure-specific risks on preoperative consultation requests, along with clinical support decision tools developed collaboratively to incorporate them in patient's overall perioperative risk estimation to guide preoperative optimization. The development of clear care pathways for recommendations to be implemented preoperatively could be imbedded within electronic medical software, and artificial intelligence could even 1 day assist physicians with risks assessment and optimization.

### Limitations

#### *Our study has some limitations*

Local surgical and anesthetic expertise may vary and affect the level of complexity in the surgeries performed (for example, between a tertiary and a community center). This may impact procedure-specific risks and thus influence how internists answered. Although we used the best evidence currently available to define correct answers, many areas of uncertainty remain in perioperative medicine, which is a relatively new field of study, further increasing heterogeneity in answers. Surgery duration was the only survey component for which we needed to consult with local experts to define correct answers. This was however the most successful section: it should not affect our conclusions.

Most responders were from Québec or Ontario which may reflect that survey announcements through associations' newsletters are not as effective as direct solicitation. This potentially decreases our ability to extrapolate our findings to internists working in other Canadian provinces. The COVID-19 pandemic may have also

induced some degree of survey fatigue and affected completion and response rates (Koning et al. 2021).

Surveys can also be subject to selection bias, and internists with an interest in perioperative care may have been more inclined to answer our survey. However, despite this, we were nonetheless able to capture several knowledge gaps and opportunities for future research and educational development.

### Conclusions

In conclusion, our survey results suggest that internists have knowledge gaps related to surgical and anesthetic considerations. There is a need for the development of more perioperative care educational resources for procedure-specific risk assessment and optimization for internists, and our results may help inform the choice of content and focus for such resources.

### Abbreviations

CHERRIES	Checklist for Reporting Results of Internet E-Surveys
COVID-19	Coronavirus disease 2019
DASI	Duke Activity Status Index
EVAR	Endovascular aortic repair
GU	Genitourinary
IP	Internet Protocol
MCQs	Multiple-choice questions
MUHC	McGill University Health Centre
N.B.	New-Brunswick
N.S.	Nova Scotia
N.L.	Newfoundland Labrador
P.E.I.	Prince-Edward Island
REB	Research Ethics Board
RCT	Randomized control trial
TURP	Transurethral resection of prostate
TH-BSO	Laparoscopic hysterectomy + bilateral salpingo-oophorectomy

### Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s13741-024-00489-2>.

Additional file 1. English version of the survey.

Additional file 2. Additional File 2. CSIM and ASMIQ announcements.

Additional File 3. CHERRIES checklist.

Additional file 4: Additional tables: Additional Table 1. Estimation of surgery duration. Additional Table 2. Estimation of surgery-specific cardiac risk. Additional Table 3. Estimation of surgery-specific bleeding risk. Additional Table 4. Estimation of surgery-specific thrombotic risk. Additional Table 5. Risk optimization. Additional Table 6. Preferred method(s) of learning. Additional Table 7. Interdisciplinary disagreements, CME, and perceived need for additional training.

### Acknowledgements

1. Contributors. None. 2. Funders. The authors received no financial support for the research, authorship, and/or publication of this article. 3. Prior presentations. None

### Authors' contributions

MAL: conceptualization, methodology, analysis, writing – original draft, visualization. AL: conceptualization, methodology, writing – review & editing. GB: conceptualization, methodology, writing – review & editing. NZS: conceptualization, methodology, writing – review & editing, supervision. AB:

conceptualization, methodology, writing – review & editing, supervision, project administration.

### Funding

This work was not supported by any funding.

### Data availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

### Declarations

#### Ethics approval and consent to participate

The protocol was approved by the local research ethics board (MUHC REB 2020–6320). Consent was obtained before administration of the survey. The information provided to participants is available in the Additional File 2.

#### Consent for publication

N/A.

#### Competing interests

The authors declare no competing interests.

#### Author details

<sup>1</sup>Faculty of Medicine and Health Sciences, McGill University, Montreal, Canada. <sup>2</sup>Division of General Internal Medicine, Department of Medicine, McGill University Health Centre, Montreal, Canada. <sup>3</sup>Centre Intégré de Santé Et de Services Sociaux de Laval, Laval, Canada. <sup>4</sup>Department of Anaesthesia, McGill University Health Centre, Montreal, Canada. <sup>5</sup>Institute of Health Sciences Education, McGill University, Montreal, Canada.

Received: 5 October 2024 Accepted: 28 December 2024

Published online: 13 January 2025

### References

- Ayatollahzade-Isfahani F, Pashang M, Omran AS, Saadat S, Shirani S, Fathollahi MS. Comparing the impact of supine and leg elevation positions during coronary artery bypass graft on deep vein thrombosis occurrence: a randomized clinical trial study. *J Vasc Nurs*. 2013;31(2):64–7.
- Canada TRCoPaSo. Internal medicine competencies. 2018. Available from: <https://www.royalcollege.ca/>.
- Canadian Resident Matching Service (CaRMS). 2024 Program descriptions [updated July 2024]. Available from: <https://www.carms.ca/match/msm/program-descriptions/>.
- Crowley J, Ball L, Hiddink GJ. Nutrition in medical education: a systematic review. *Lancet Planet Health*. 2019;3(9):e379–89.
- de Koning R, Egiz A, Kotecha J, Ciuculete AC, Ooi SZY, Bankole NDA, et al. Survey fatigue during the COVID-19 pandemic: an analysis of neurosurgery survey response rates. *Front Surg*. 2021;8:690680.
- Deusenberry CM, Coley KC, Korytkowski MT, Donihi AC. Hypoglycemia in hospitalized patients treated with sulfonylureas. *Pharmacotherapy*. 2012;32(7):613–7.
- Doherty JU, Gluckman TJ, Hucker WJ, Januzzi JL, Jr, Ortel TL, Saxonhouse SJ, et al. 2017 ACC Expert Consensus Decision Pathway for Periprocedural Management of Anticoagulation in Patients With Nonvalvular Atrial Fibrillation: A Report of the American College of Cardiology Clinical Expert Consensus Document Task Force. *J Am Coll Cardiol*. 2017;69(7):871–98.
- Douketis JD, Spyropoulos AC, Duncan J, Carrier M, Le Gal G, Tafur AJ, et al. Perioperative management of patients with atrial fibrillation receiving a direct oral anticoagulant. *JAMA Intern Med*. 2019;179(11):1469–78.
- Douketis JD, Spyropoulos AC, Kaatz S, Becker RC, Caprini JA, Dunn AS, et al. Perioperative bridging anticoagulation in patients with atrial fibrillation. *N Engl J Med*. 2015;373(9):823–33.
- Dronge AS, Perkal MF, Kancir S, Concato J, Aslan M, Rosenthal RA. Long-term glycemic control and postoperative infectious complications. *Arch Surg*. 2006;141(4):375–80; discussion 80.
- Duceppe E, Parlow J, MacDonald P, Lyons K, McMullen M, Srinathan S, et al. Canadian cardiovascular society guidelines on perioperative cardiac risk assessment and management for patients who undergo noncardiac surgery. *Can J Cardiol*. 2017;33(1):17–32.
- Duggan EW, Carlson K, Umpierrez GE. Perioperative hyperglycemia management: an update. *Anesthesiology*. 2017;126(3):547–60.
- Eysenbach G. Improving the quality of web surveys: the Checklist for Reporting Results of Internet E-Surveys (CHERRIES). *J Med Internet Res*. 2004;6(3): e34.
- Falck-Ytter Y, Francis CW, Johanson NA, Curley C, Dahl OE, Schulman S, et al. Prevention of VTE in orthopedic surgery patients: antithrombotic therapy and prevention of thrombosis, 9th ed: American College of Chest Physicians evidence-based clinical practice guidelines. *Chest*. 2012;141(2 Suppl):e278S–e325S.
- Flemons K, Bosch M, Coakeley S, Muzammal B, Kachra R, Ruzycski SM. Barriers and facilitators of following perioperative internal medicine recommendations by surgical teams: a sequential, explanatory mixed-methods study. *Perioperative Medicine*. 2022;11(1):2.
- Fleisher LA, Fleischmann KE, Auerbach AD, Barnason SA, Beckman JA, Bozkurt B, et al. 2014 ACC/AHA guideline on perioperative cardiovascular evaluation and management of patients undergoing noncardiac surgery: executive summary: a report of the American College of Cardiology/American Heart Association Task Force on practice guidelines. *Circulation*. 2014;130(24):2215–45.
- Gould MK, Garcia DA, Wren SM, Karanickolas PJ, Arcelus JL, Heit JA, et al. Prevention of VTE in nonorthopedic surgical patients: antithrombotic therapy and prevention of thrombosis, 9th ed: American College of Chest Physicians evidence-based clinical practice guidelines. *Chest*. 2012;141(2 Suppl):e227S–e77S.
- Horlocker TT, Vandermeulen E, Kopp SL, Gogarten W, Leffert LR, Benzon HT. Regional anesthesia in the patient receiving antithrombotic or thrombolytic therapy: American Society of Regional Anesthesia and Pain Medicine evidence-based guidelines (fourth edition). *Reg Anesth Pain Med*. 2018;43(3):263–309.
- Katz RI, Cimino L, Vitkun SA. Preoperative medical consultations: impact on perioperative management and surgical outcome. *Can J Anesth*. 2005;52(7):697–702.
- Kunutsor SK, Hamal PB, Tomassini S, Yeung J, Whitehouse MR, Matharu GS. Clinical effectiveness and safety of spinal anaesthesia compared with general anaesthesia in patients undergoing hip fracture surgery using a consensus-based core outcome set and patient-and public-informed outcomes: a systematic review and meta-analysis of randomised controlled trials. *Br J Anaesth*. 2022;129(5):788–800.
- Kristensen SD, Knuuti J, Saraste A, Anker S, Bøtker HE, Hert SD, et al. 2014 ESC/ESA guidelines on non-cardiac surgery: cardiovascular assessment and management: the Joint Task Force on non-cardiac surgery: cardiovascular assessment and management of the European Society of Cardiology (ESC) and the European Society of Anaesthesiology (ESA). *Eur Heart J*. 2014;35(35):2383–431.
- Lui DTW, Wu T, Au ICH, Liu X, Fung MMH, Lee CH, et al. A population-based study of SGLT2 inhibitor-associated postoperative diabetic ketoacidosis in patients with type 2 diabetes. *Drug Saf*. 2023;46(1):53–64.
- Macpherson DS, Lofgren RP. Outpatient internal medicine preoperative evaluation: a randomized clinical trial. *Med Care*. 1994;32(5):498–507.
- Massicotte L, Chalaoui KD, Beaulieu D, Roy JD, Bissonnette F. Comparison of spinal anesthesia with general anesthesia on morphine requirement after abdominal hysterectomy. *Acta Anaesthesiol Scand*. 2009;53(5):641–7.
- Muñoz M, Acheson AG, Auerbach M, Besser M, Habler O, Kehlet H, et al. International consensus statement on the peri-operative management of anaemia and iron deficiency. *Anaesthesia*. 2017;72(2):233–47.
- National Blood Authority. Patient blood management guidelines: module 2 perioperative. Canberra: Australian Government. National Health and Medical Research Council; 2012. p. 168.
- Narouze S, Benzon HT, Provenzano D, Buvanendran A, De Andres J, Deer T, et al. Interventional spine and pain procedures in patients on antiplatelet and anticoagulant medications (second edition): guidelines from the American Society of Regional Anesthesia and Pain Medicine, the European Society of Regional Anaesthesia and Pain Therapy, the American Academy of Pain Medicine, the International Neuromodulation Society, the North American Neuromodulation Society, and the World Institute of Pain. *Reg Anesth Pain Med*. 2018;43(3):225–62.
- Paus-Jenssen L, Ward HA, Card SE. An internist's role in perioperative medicine: a survey of surgeons' opinions. *BMC Fam Pract*. 2008;9(1):4.



- Pei S, Wei W, Yang K, Yang Y, Pan Y, Wei J, et al. Recruitment maneuver to reduce postoperative pulmonary complications after laparoscopic abdominal surgery: a systematic review and meta-analysis. *J Clin Med*. 2022;11(19):5841.
- Pham CT, Gibb CL, Fitridge RA, Karnon JD. Effectiveness of preoperative medical consultations by internal medicine physicians: a systematic review. *BMJ Open*. 2017;7(12): e018632.
- Richards T, Baikady RR, Clevenger B, Butcher A, Abeysiri S, Chau M, et al. Preoperative intravenous iron to treat anaemia before major abdominal surgery (PREVENTT): a randomised, double-blind, controlled trial. *Lancet*. 2020;396(10259):1353–61.
- Rohatgi N, Loftus P, Grujic O, Cullen M, Hopkins J, Ahuja N. Surgical comanagement by hospitalists improves patient outcomes: a propensity score analysis. *Ann Surg*. 2016;264(2):275–82.
- Shaw M, Pelecanos AM, Mudge AM. Evaluation of internal medicine physician or multidisciplinary team comanagement of surgical patients and clinical outcomes: a systematic review and meta-analysis. *JAMA Netwo Open*. 2020;3(5):e204088-e.
- The Royal College of Physicians and Surgeons of Canada. General internal medicine competencies. 2018. Available from: <https://www.royalcollege.ca/>.
- Thepsoparn M, Punyawattanakit P, Jaruwangsanti N, Singhatanadgige W, Chalermkitpanit P. Effects of general anesthesia with and without thoracic epidural block on length of stay after open spine surgery: a single-blinded randomized controlled trial. *Spine J*. 2022;22(10):1694–9.
- Thrombosis Canada. NOACS/DOACS: peri-operative management 2017. Available from: <https://thrombosiscanada.ca/wp-content/uploads/2019/05/NOACS-DOACS-Perioperative-Management.pdf>.
- Thrombosis Canada. Thromboprophylaxis: non-orthopedic surgery. 2019. Available from: <https://thrombosiscanada.ca/wp-content/uploads/2019/05/Thromboprophylaxis-Non-Ortho.pdf>.
- Thrombosis Canada. Thromboprophylaxis: orthopedic surgery. 2019. Available from: <https://thrombosiscanada.ca/wp-content/uploads/2019/05/Thromboprophylaxis-Orthopedic.pdf>.
- Vazirani S, Lankarani-Fard A, Liang L-J, Stelzner M, Asch SM. Perioperative processes and outcomes after implementation of a hospitalist-run preoperative clinic. *J Hosp Med*. 2012;7(9):697–701.
- Wijeyesundera DN, Beattie WS, Hillis GS, Abbott TEF, Shulman MA, Ackland GL, et al. Integration of the Duke activity status index into preoperative risk evaluation: a multicentre prospective cohort study. *Br J Anaesth*. 2020;124(3):261–70.
- Wijeyesundera DN, Pearse RM, Shulman MA, Abbott TEF, Torres E, Ambosta A, et al. Assessment of functional capacity before major non-cardiac surgery: an international, prospective cohort study. *Lancet*. 2018;391(10140):2631–40.
- Wischmeyer PE, Carli F, Evans DC, Guilbert S, Kozar R, Pryor A, et al. American society for enhanced recovery and perioperative quality initiative joint consensus statement on nutrition screening and therapy within a surgical enhanced recovery pathway. *Anesth Analg*. 2018;126(6):1883–95.

## Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.