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Association of Preoperative Medical Consultation With Reduction in Adverse Postoperative Outcomes and Use of Processes of Care Among Residents of Ontario, Canada

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IMPORTANCE It is uncertain whether preoperative medical consultation reduces adverse postoperative clinical outcomes.

OBJECTIVE To investigate the association of preoperative medical consultation with reduction in adverse postoperative outcomes and use of processes of care.

DESIGN, SETTING, AND PARTICIPANTS This was a retrospective cohort study using linked administrative databases from an independent research institute housing routinely collected health data for Ontario's 14 million residents, including sociodemographic features, physician characteristics and services, and receipt of inpatient and outpatient care. The study sample included Ontario residents aged 40 years or older who underwent their first qualifying intermediate- to high-risk noncardiac operation. Propensity score matching was used to adjust for differences between patients who did and did not undergo preoperative medical consultation with discharge dates between April 1, 2005, and March 31, 2018. The data were analyzed from December 20, 2021, to May 15, 2022.

EXPOSURES Receipt of preoperative medical consultation in the 4 months preceding the index surgery.

MAIN OUTCOMES AND MEASURES The primary outcome was 30-day all-cause postoperative mortality. Secondary outcomes included 1-year mortality, inpatient myocardial infarction and stroke, in-hospital mechanical ventilation, length of stay, and 30-day health system costs.

RESULTS Of the total 530 473 individuals (mean [SD] age, 67.1 [10.6] years; 278 903 [52.6%] female) included in the study, 186 299 (35.1%) received preoperative medical consultation. Propensity score matching resulted in 179 809 well-matched pairs (67.8% of the full cohort). The 30-day mortality rate was 0.9% (n = 1534) in the consultation group and 0.7% (n = 1299) in the control group (odds ratio [OR], 1.19; 95% CI, 1.11-1.29). The ORs for 1 year mortality (OR, 1.15; 95% CI, 1.11-1.19), inpatient stroke (OR, 1.21; 95% CI, 1.06-1.37), in-hospital mechanical ventilation (OR, 1.38; 95% CI, 1.31-1.45), and 30-day emergency department visits (OR, 1.07; 95% CI, 1.05-1.09) were higher in the consultation group; however, the rates of inpatient myocardial infarction did not differ. The lengths of stay in acute care were a mean (SD) 6.0 (9.3) days in the consultation group and 5.6 (10.0) days in the control group (difference, 0.4 [95% CI, 0.3-0.5] days), and the median (IQR) total 30-day health system cost was CAD $317 ($229-$959) (US $235 [$170-$711]) higher in the consultation group. Preoperative medical consultation was associated with increased use of preoperative echocardiography (OR, 2.64; 95% CI, 2.59-2.69) and cardiac stress tests (OR, 2.50; 95% CI, 2.43-2.56) and higher odds of receiving a new prescription for β-blockers (OR, 2.96; 95% CI, 2.82-3.12).

CONCLUSIONS AND RELEVANCE In this cohort study, preoperative medical consultation was not associated with a reduction but rather with an increase in adverse postoperative outcomes, suggesting a need for further refinement of target populations, processes, and interventions related to preoperative medical consultation. These findings highlight the need for further research and suggest that referral for preoperative medical consultation and subsequent testing should be carefully guided by individual-level consideration of risks and benefits.

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Medical specialists provide preoperative assessment to between 10% and 40% of patients undergoing elective surgery.[1-4] Despite routine use, evidence supporting preoperative medical consultation yields conflicting results. The few relevant randomized trials[5-7] have typically been single center and limited to older patients cared for in a geriatric context. In vascular surgery, 1 randomized clinical trial[5] demonstrated that preoperative geriatric care reduced the length of stay (LOS). In surgical oncology, 2 randomized clinical trials[6,7] found no difference in complications, LOS, or readmissions.

Observational data are similarly inconclusive. While some single-center, before-and-after studies[8-10] report a reduction in overall mortality, postoperative complications or LOS after implementation of a structured medical preoperative evaluation, other studies[1,2,11,12] either showed no difference in outcomes or suggested possible harm.

Given the limited and conflicting evidence, guidelines remain uncertain around recommending preoperative medical optimization.[13] Further clouding the evidence, most available studies are now more than a decade old and report increased use of care processes (eg, β-blocker initiation and cardiac testing) that have been de-emphasized in perioperative care.[14,15] As the number of people presenting for surgery increases, patients, clinicians, and health system planners require contemporary evidence to inform approaches to preoperative medical optimization.

To address this ongoing knowledge gap, this study aimed to describe temporal trends in preoperative medical consultations, estimate the association between preoperative medical consultation and postoperative outcomes, and explore the differences in processes of care between patients who did and did not receive a medical consultation prior to undergoing elective noncardiac operation.

Key Points

Question Is a preoperative medical consultation associated with a reduction in adverse postoperative outcomes and use of processes of care?

Findings In this cohort study of 530 473 surgical patients in Ontario, Canada, the 30-day mortality risk among patients who received a preoperative consultation was 0.9% vs 0.7% among those who did not. Preoperative medical consultation was not associated with a reduction in adverse postoperative outcomes and in some cases was associated with worse outcomes.

Meaning These findings suggest that preoperative medical consultation may be more harmful than beneficial, and that further research is needed to develop and evaluate novel approaches to preoperative assessment and optimization.

Methods

Design

We conducted a population-based, retrospective cohort study using linked administrative databases in Ontario, Canada. Data were routinely collected and deidentified, making the study legally (based on the laws in Ontario) exempt from ethics review. The perioperative care of each participant was reconstructed via deterministic linkage across databases at ICES, an independent research institute housing the routinely collected health data for Ontario's 14 million residents; ICES captures sociodemographic features, physician characteristics and services, and receipt of inpatient and outpatient care (a full description is provided in eMethods in Supplement 1). The data were analyzed from December 20, 2021, to May 15, 2022. The study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) and the Reporting of Studies Conducted using Observational Routinely-Collected Health Data (RECORD) reporting guidelines.[16,17]

Study Cohort

We included the first qualifying intermediate- to high-risk noncardiac operations held between April 1, 2005, and March 31, 2018, for each Ontario resident aged 40 years or older.[18] Data on race and ethnicity were not collected because this information was not considered relevant to the analysis. Specific surgical procedures have been previously studied at ICES, including in the context of preoperative medical consultation, using the Canadian Classification of Intervention codes[19] (eMethods in Supplement 1): total hip replacement, total knee replacement, carotid endarterectomy, abdominal aortic aneurysm repair, peripheral vascular operation, nephrectomy, cystectomy, large bowel and rectal operations, liver resection, pancreaticoduodenectomy, gastrectomy or esophagectomy, and pneumonectomy or lobectomy.[20,21]

Exposure

The exposure was preoperative medical consultation in the 4 months preceding the index surgical procedure based on a validated exposure ascertainment algorithm (sensitivity 90%, specificity 92% in comparison with reabstracted medical records in which the provision of specific preoperative care was ascertained). This approach defines a preoperative medical consultation based on an Ontario health insurance plan physician service claim for a consultation by a general internist, cardiologist, endocrinologist, geriatrician, or nephrologist.[1,4]

Outcomes

The primary outcome was 30-day all-cause postoperative mortality, identified from the discharge abstract (in-hospital) and vital statistics (out of hospital).[22] Secondary outcomes included inpatient stroke, inpatient myocardial infarction, in-hospital mechanical ventilation, 30-day emergency department (ED) visits, 1-year mortality, acute hospital LOS, and postoperative 30-day health system costs (excluding the cost of consultation, using a validated patient-level costing algorithm capturing direct and indirect costs[23]). All relevant codes used to define outcomes are provided in eMethods in Supplement 1.

Processes of Care

We identified processes of care that may have resulted from preoperative medical consultation, including echocardiogram, cardiac stress test, coronary angiogram, coronary revascularization, pulmonary function tests, and chest x-rays

(eMethods in Supplement 1). We identified new preoperative prescriptions of β-blockers and statins for patients aged 66 years or older (prescription data were available only for individuals aged ≥65 years) to allow a 1-year look-back period to ascertain prior medication use.

Covariates

We captured covariates postulated to confound the association between receipt of a preoperative medical consultation and postoperative outcomes or processes of care: demographic factors (age, sex, and neighborhood income quintile), surgical factors (hospital type, surgery type, receipt of a preoperative anesthesiology consultation, and year of surgery), and comorbid conditions (each Elixhauser comorbidity using a 3-year look back based on standardized methods via *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision* [*ICD-10*] codes, along with physician fee codes to evaluate the history of dialysis).[24]

Missing Data

We prespecified a complete case analysis if less than 1% of all outcome and exposure data were missing. If more than 1% of the data were missing, we planned to conduct multiple imputed analyses with the number of imputed sets equal to the largest proportion of missing data from either exposure or outcome. Because only 1 of 530 474 observations had missing outcome data, a complete case analysis was performed.

Subgroup Analyses

Analyses in prespecified subgroups evaluated the consistency of the primary association. Subgroups included age (40-64 years; ≥65 years); year of surgery (2005-2010; 2011-2017); sex; presence of ischemic heart disease, diabetes, or pulmonary disease; revised cardiac risk index (0, 1-2, and ≥3); surgery type (vascular, abdominal or thoracic, or orthopedic); hospital type; and receipt of preoperative anesthesia consultation. We matched 1:1 using the propensity score while forcing a match on the subgroup characteristic. Adequate covariate balance was achieved for each subgroup. In the post hoc analysis, we evaluated β-blocker use stratified by year of surgery, and assessed association between 30-day mortality and preoperative medical consultation performed by general internists vs subspecialists.

Sensitivity Analyses

Sensitivity analyses assessed the robustness of our primary analyses. First, we estimated an average treatment effect (the effect of moving the full population from unexposed to exposed) using inverse probability of treatment weighting based on the propensity score. Next, we assessed whether patients who received preoperative medical consultation may have been systematically different from those who did not, beyond measured covariates. These included measures of health system behaviors, namely, adherence to nonsurgery-related screening tests such as screening mammography, colonoscopy, and fecal occult testing within 2 years before index surgery (obtained from fee codes). Comparisons were also made in the use of epidural anesthesia in relevant operations (obtained from fee codes), as the use of epidural anesthesia was unlikely to be associated with exposure but could be a marker of greater perioperative risk.[25,26] The E-value, a form of quantitative bias analysis that focuses on estimating the size of a confounder association that could produce bias equal to the study's exposure-outcome association, was calculated for the primary analysis. The E-value is the value of the minimum strength of association that an unmeasured confounder would need to have with both exposure and outcome that would nullify the association between them, conditional on measured covariates.[27]

Statistical Analysis

All analyses were performed using Stata version 15 (Stata Corp LLC). Descriptive statistics were calculated using means and SDs (continuous normal variables), medians and interquartile ranges (skewed continuous variables), and counts and proportions (categorical variables). Differences between the individuals who did or did not receive a preoperative medical consultation were compared using standardized differences.[28] The trend in consultation use over time was characterized using linear regression analysis. Because outcomes were prespecified, a 2-sided $P < .05$ indicated statistical significance. Secondary and subgroup analyses were not adjusted for multiple comparisons, and readers should apply careful judgment in assessing the clinical significance of the differences reported.[29]

To estimate the association of preoperative medical consultation with postoperative outcomes, we conducted unadjusted and adjusted analyses. We specified a primary approach to adjustment using a propensity score–matched design to estimate an average treatment effect in the treated (ATT).[30] The ATT is estimated between those most similar at baseline. We used 1:1 nearest neighbor matching (without replacement) on the propensity score (caliper width = 0.2 SD of the logit of the propensity score).[31,32] We specified a multivariable logistic regression model to predict the probability of receipt of a preoperative medical consultation using variables defined a priori, based on clinical significance and literature review[1,12]: age (linear), sex (binary), year (linear), surgery type (categorical: 12 procedure types included), income quintile (5-level categorical), hospital type (categorical: teaching, low-volume nonteaching, mid-volume nonteaching, high-volume nonteaching), comorbid disease (binary for each comorbidity), and preoperative anesthesia consultation (binary); continuous variable parameterization was based on best-fitting polynomial transformations. The propensity score model was refined using a structured iterative approach until all absolute standardized differences were less than 10.0%.[31,32] The propensity score accounted for clustering using random intercept at the local health integration networks (LHINs; of which there are 14 in Ontario). This was the highest level of our data hierarchy.[33] After matching, we used regression models with nested random effects for our analytic data set accounting for clustering at the levels of both LHIN and matched pairs. Regression models appropriate for each type of outcome data were used to estimate effect sizes and 95% CIs (logistic-binary, median cost [quintile], and log γ-LOS).

Results

Between April 1, 2005, and March 31, 2018, 186 299 (35.1%) of the 530 473 patients (mean [SD] age, 67.1 [10.6] years; 278 903 [52.6%] female) undergoing elective intermediate- to high-risk noncardiac operations received preoperative medical consultation. Variation in consultation rates across LHINs (range, 16.0%-47.0%) was evident (eTable 1 in Supplement 1). Overall prevalence of preoperative medical consultation remained stable over time (eFigure 1 in Supplement 1). Patients who received preoperative medical consultations were older (mean [SD] age, 69 [10.2] years in the consultation group vs 66 [10.6] years in the control group) and had more comorbidities (eTable 2 in Supplement 1). A greater proportion of patients who had preoperative medical consultations received care at teaching hospitals (39.2% vs 33.2%), had preoperative anesthesia consultations (77.5% vs 69.2%), and underwent orthopedic procedures (70.9% vs 59.9%).

Association of Preoperative Medical Consultations With Postoperative Outcomes

In the full cohort, 1666 patients (0.9%) died from among the 186 299 individuals who underwent preoperative consultation, compared with 2159 patients (0.6%) from among 344 174 individuals who did not undertake consultation (odds ratio [OR], 1.43; 95% CI, 1.34-1.53; $P < .001$). Propensity score matching resulted in 179 809 matched pairs (67.8% of the full cohort) (eFigure 2 in Supplement 1). Overlap of propensity scores improved after matching (eFigure 3 in Supplement 1), and all absolute standardized differences were less than 10.0% (**Table 1**). In the matched cohort, 30-day mortality was higher in the preoperative medical consultation group (n = 1534; 0.9%) compared with that in the control group (n = 1299; 0.7%) (OR, 1.19; 95% CI, 1.11-1.29). The E-value was 1.64.

The ORs for 1-year mortality (OR, 1.15; 95% CI, 1.11-1.19), inpatient stroke (OR, 1.21; 95% CI, 1.06-1.37), in-hospital mechanical ventilation (OR, 1.38; 95% CI, 1.31-1.45), and 30-day ED visits (OR, 1.07; 95% CI, 1.05-1.09) were higher in the consultation group (**Table 2**); however, the odds of inpatient myocardial infarction did not differ significantly. The mean (SD) LOS in acute care was 6.0 (9.3) days in the consultation group and 5.6 (10.0) days in the control group (difference, 0.4 [95% CI, 0.3-0.5] days) and the median (IQR) total 30-day health system cost was CAD $317 (IQR, CAD $229-$959) (US $235 [$170-711]) higher in the consultation group (Table 2). Results were directionally consistent in the unadjusted analyses compared with those of the adjusted analyses (eTable 3 in Supplement 1).

Processes of Care

Use of preoperative processes of care was uniformly higher in the medical consultation group after matching, including increased use of new preoperative β-blockers and statins, as well as oral anticoagulants within 30 days of hospital discharge. Preoperative medical consultation was associated with increased use of preoperative echocardiography (OR, 2.64; 95% CI, 2.59-2.69) and cardiac stress tests (OR, 2.50; 95% CI, 2.43-2.56), and higher odds of receiving a new prescription for β-blockers (OR, 2.96; 95% CI, 2.82-3.12) (**Table 3**). The β-blocker results were consistent during the periods from 2005 to 2010 and 2011 to 2017 (eTable 4 in Supplement 1). Results from unadjusted analyses were directionally consistent with those from the adjusted analyses (eTable 5 in Supplement 1).

Subgroup and Sensitivity Analyses

Prior to adjustment, the consultation group had lower odds of undergoing cancer screening and receiving epidural anesthesia (eTable 6 in Supplement 1). After matching, there was no significant difference between the groups in the use of screening mammography and colon cancer screening. Individuals receiving a consultation were more likely to receive epidural anesthesia after matching (OR, 1.14; 95% CI, 1.11-1.16) (**Table 4**).

The ATE was consistent with the ATT results for 30-day mortality (OR, 1.25; 95% CI, 1.16-1.33). In the matched subgroup analyses, the association of preoperative medical consultations with 30-day mortality was directionally consistent for all included subgroups (**Figure**; eTable 7 in Supplement 1). The OR for 30-day mortality was higher among patients in the consultation group who were assessed by subspecialists, including cardiologists, nephrologists, geriatricians, and endocrinologists (OR, 1.46; 95% CI, 1.29-1.65), than that among patients assessed by general internists (OR, 1.15; 95% CI, 1.06-1.27).

Discussion

In this cohort study of adult patients who underwent elective noncardiac operations, we found no reduction in adverse postoperative outcomes (30-day and 1-year mortality, inpatient stroke, in-hospital mechanical ventilation, 30-day ED visits, acute care LOS, and 30-day costs) associated with the receipt of a preoperative medical consultation. These findings are consistent with observational data from earlier periods.[1] According to the present study, preoperative medical consultation was associated with increased use of testing procedures (eg, echocardiograms, cardiac stress tests) and initiation of new prescriptions for β-blockers. These data suggest a need for further refinement of target populations, processes, and interventions related to preoperative medical consultation to improve perioperative outcomes.

While it is difficult to infer causality between preoperative medical consultation and increased postoperative adverse events with observational data, several factors may contribute to our results. Despite multiple large trials[34,35] published previously on perioperative cardiac optimization, no medical intervention has conclusively been found to improve outcomes; some have even demonstrated harm. For example, initiation of preoperative β blockade may increase the risk of stroke and death.[34] Initiation of treatment with acetylsalicylic acid and clonidine were found to be nonsuperior to the placebo with signals toward harm due to bleeding and hypotension, respectively.[35,36] As preoperative medical assessments often focus on cardiac risk, even less evidence informs the management of other common medical conditions such

Table 1. Characteristics of Propensity Score–Matched and Unmatched Cohorts by Preoperative Medical Consultation Status

Characteristic	Unmatched cohort			Propensity score–matched cohort		
	No. (%)			No. (%)		
	Consultation (n = 6490)	No consultation (n = 164 365)	ASD, %	Consultation (n = 179 809)	No consultation (n = 179 809)	ASD, %
Age, mean (SD), y	74.8 (9.1)	63.4 (10.6)	115.2	68.7 (10.2)	68.7 (10.1)	0.6
Sex						
Male	3497 (53.9)	78 090 (47.5)	12.8	85 140 (47.4)	84 843 (47.2)	0.3
Female	2993 (46.1)	86 275 (52.5)		94 669 (52.6)	94 966 (52.8)	
Neighborhood income, CAD$[a]						
Quintile 1 (lowest)	1485 (22.9)	26 493 (16.1)	17.1	33 051 (18.4)	33 803 (18.8)	1.1
Quantile 2	1428 (22.0)	31 456 (19.1)	7.1	36 797 (20.5)	36 943 (20.6)	0.2
Quantile 3	1218 (18.8)	32 820 (20.0)	3.0	36 080 (20.1)	36 139 (20.1)	0.1
Quintile 4	1023 (15.8)	35 110 (21.4)	14.4	36 214 (20.1)	36 030 (20.0)	0.3
Quintile 5 (highest)	868 (13.4)	37 588 (22.9)	24.8	37 667 (20.9)	36 894 (20.5)	1.1
Missing	468 (7.2)	898 (0.6)	35.0	0	0	NA
Hospital type						
Teaching	4430 (68.3)	48 385 (29.4)	84.3	68 639 (38.2)	66 120 (36.8)	2.9
Nonteaching	2060 (31.7)	115 980 (70.6)		111 170 (61.8)	113 689 (63.2)	
Procedure						
Abdominal aortic aneurysm repair	89 (1.5)	2064 (1.3)	1.0	6427 (3.6)	6451 (3.6)	0.1
Carotid endarterectomy	58 (0.9)	2929 (1.8)	7.7	3721 (2.1)	3887 (2.2)	0.6
Peripheral vascular bypass	50 (0.8)	5244 (3.2)	17.4	5826 (3.2)	5654 (3.1)	0.5
Total hip replacement	1928 (29.7)	30 362 (18.5)	26.5	45 058 (25.1)	45 484 (25.3)	0.5
Total knee replacement	3063 (47.3)	46 586 (28.3)	39.6	81 993 (45.6)	83 977 (46.7)	2.2
Large bowel resection	937 (14.4)	45 046 (27.4)	32.3	20 657 (11.5)	19 753 (11.0)	1.6
Gastrectomy or esophagectomy	79 (1.2)	5062 (3.1)	12.9	2713 (1.5)	2452 (1.4)	1.2
Liver resection	6 (0.1)	3020 (1.8)	17.9	1084 (0.6)	957 (0.5)	0.9
Whipple procedure	45 (0.7)	1526 (0.9)	2.6	1109 (0.6)	980 (0.6)	0.9
Nephrectomy	137 (2.1)	11 595 (7.1)	23.8	5787 (3.2)	5325 (3.0)	1.5
Cystectomy	62 (1.0)	2290 (1.4)	4.1	1822 (1.0)	1680 (0.9)	0.8
Pneumonectomy or lobectomy	36 (0.6)	8641 (5.3)	28.3	3612 (2.0)	3209 (1.8)	1.6
Comorbidities						
Coronary artery disease	4257 (65.6)	4289 (2.6)	177.7	26 030 (14.5)	26 318 (14.6)	0.5
Congestive heart failure	1735 (26.7)	678 (0.4)	83.2	5818 (3.2)	5889 (3.3)	0.2
Cerebrovascular disease	710 (10.9)	975 (0.6)	45.5	3607 (2.0)	3764 (2.1)	0.6
Peripheral vascular disease	355 (5.5)	2145 (1.3)	23.2	4505 (2.5)	4444 (2.5)	0.2
Atrial fibrillation	2103 (32.4)	476 (0.3)	96.4	5627 (3.1)	5807 (3.2)	0.6
Cardiac valvular condition						
Aortic stenosis	494 (7.6)	168 (0.1)	39.8	1314 (0.7)	1381 (0.8)	0.4
Need for anticoagulation[b]	288 (4.4)	62 (0.03)	30.1	465 (0.3)	529 (0.3)	0.7
Hypertension	5021 (77.4)	25 673 (15.6)	157.6	62 552 (34.8)	59 616 (33.2)	3.4
Diabetes	3117 (48.0)	15 317 (9.3)	94.7	37 298 (20.7)	37 007 (20.6)	0.4
Pulmonary disease	1256 (19.4)	6192 (3.8)	50.3	11 599 (6.5)	11 257 (6.3)	0.8
Dialysis or renal disease	530 (8.2)	753 (0.5)	38.6	2630 (1.5)	2616 (1.5)	0.1
Rheumatologic disease	104 (1.6)	565 (0.3)	12.8	1100 (0.6)	1033 (0.6)	0.5
Liver disease	81 (1.2)	877 (0.5)	7.6	1163 (0.6)	925 (0.5)	1.7
Thromboembolic disease	177 (2.7)	247 (0.2)	21.8	632 (0.4)	662 (0.4)	0.3
Dementia	95 (1.5)	250 (0.2)	14.7	634 (0.4)	658 (0.4)	0.2
Malignant disease	1718 (26.5)	57 503 (35.0)	18.5	35 113 (19.5)	33 741 (18.8)	1.9
Anesthesia consultation[c]	5186 (79.9)	100 419 (61.1)	42.2	139 107 (77.4)	137 648 (76.6)	1.9

Abbreviations: ASD, absolute standardized difference; NA, not applicable.

[a] Mean exchange rate, CAD $1.35 = US $1.00.

[b] History of mitral stenosis, mechanical aortic valve replacement, or mitral valve replacement.

[c] Outpatient anesthesia consultation within 60 days before surgery.

Table 2. Primary and Secondary Outcomes in the Propensity Score–Matched Pairs by Preoperative Medical Consultation Status

Outcomes	Cohort, No. (%)		OR (95% CI)[a]
	Consultation (n = 179 809)	No consultation (n = 179 809)	
Primary outcome			
30-d Mortality	1534 (0.9)	1299 (0.7)	1.19 (1.11-1.29)
Secondary outcomes (binary)			
Inpatient stroke	522 (0.3)	438 (0.2)	1.21 (1.06-1.37)
Inpatient myocardial infarction	1994 (1.1)	1869 (1.0)	1.05 (0.99-1.12)
In-hospital mechanical ventilation[b]	3951 (2.2)	3031 (1.7)	1.38 (1.31-1.45)
30-d Emergency department visit	31 836 (17.7)	31 047 (17.3)	1.07 (1.05-1.09)
1-y Mortality	6994 (3.9)	6130 (3.4)	1.15 (1.11-1.19)
Secondary outcomes (continuous), difference			
Acute care length of stay mean (SD) d; difference (95% CI), d	6.0 (10.0)	5.6 (9.3)	0.4 (0.3-0.5)
30-d Cost, CAD$; median (IQR)[c]	14 329	14 012	317 (229-959)

Abbreviation: OR, odds ratio.

[a] Event rate in the exposed cohort (preoperative medical consultation) relative to that in the control cohort (no consultation).

[b] During index admission for surgery.

[c] Mean exchange rate, CAD $1.35 = US $1.00.

Table 3. Processes of Care in the Propensity Score–Matched Pairs by Preoperative Medical Consultation Status

Process	Cohort, No. (%)		OR (95% CI)[a]
	Consultation	No consultation	
Preoperative event (n = 179 809 in each group)			
Preoperative testing[b]			
Echocardiogram	49 302 (27.4)	23 303 (13.0)	2.64 (2.59-2.69)
Cardiac stress test	34 133 (19.0)	16 064 (8.9)	2.50 (2.43-2.56)
Chest x-ray	90 616 (50.4)	77 305 (43.0)	1.29 (1.27-1.31)
Pulmonary function test	22 304 (12.4)	15 039 (8.4)	1.51 (1.47-1.55)
Preoperative cardiac procedures[b]			
Coronary angiogram	4693 (2.6)	1707 (1.0)	3.08 (2.89-3.28)
Revascularization (PCI or CABG)	1500 (0.8)	735 (0.4)	2.23 (2.03-2.44)
Medications (n = 117 945 in each group)[c]			
Preoperative medications			
β-Blocker use[d]	36 739 (31.2)	29 318 (24.9)	1.43 (1.40-1.46)
New β-blocker use[e]	6072 (5.2)	2192 (1.9)	2.96 (2.82-3.12)
Statin use[d]	73 092 (62.0)	68 360 (58.0)	1.20 (1.18-1.22)
New statin use[e]	5617 (4.8)	3572 (3.0)	1.62 (1.59-1.70)
Postoperative medications[f]			
Warfarin	9182 (7.8)	8133 (6.9)	1.21 (1.17-1.25)
Low-molecular-weight heparin	3840 (3.3)	3930 (3.3)	0.98 (0.93-1.03)
Direct oral anticoagulant[g]	7404 (6.3)	5775 (4.9)	1.30 (1.25-1.35)

Abbreviations: CABG, coronary artery bypass graft; OR, odds ratio; PCI, percutaneous coronary intervention.

[a] Event rate in the exposed cohort (preoperative medical consultation) relative to that in the control cohort (no consultation).

[b] Within 180 days before surgery.

[c] Applied only to subgroup of patients aged 66 years or older.

[d] Prescription within 100 days before surgery.

[e] Prescription within 100 days before surgery but no prescription during 180 to 365 days before surgery.

[f] Prescription within 30 days after discharge from hospital.

[g] Direct oral anticoagulants included rivaroxaban, apixaban, dabigatran, and edoxaban.

Table 4. Tracer Analyses in the Propensity Score–Matched Pairs by Preoperative Medical Consultation Status and Procedures Unrelated to Consultation

Procedure	No. (%)		OR (95% CI)[a]
	Consultation (n = 179 809)	No consultation (n = 179 809)	
Screening mammography[b]	17 036 (9.5)	17 812 (9.9)	0.94 (0.92-0.96)
Colon cancer screening[b,c]	68 937 (38.3)	69 094 (38.4)	1.00 (0.98-1.01)
Epidural anesthesia	24 166 (13.4)	22 071 (12.3)	1.14 (1.11-1.16)

Abbreviation: OR, odds ratio.

[a] Event rate in the exposed cohort (preoperative medical consultation) relative to that in the control cohort (no consultation).

[b] Within 2 years before hospital admission for surgery.

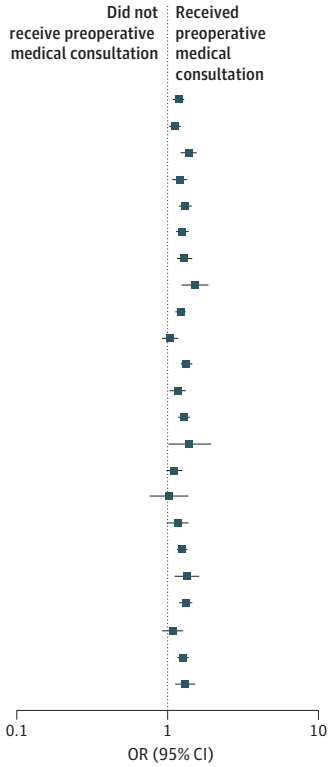
[c] Colonoscopy or fecal occult blood testing.

as respiratory disease and diabetes.[37-39] Other possible mediators of this association, such as changes in the behaviors of surgeons, anesthesiologists, and other perioperative health care practitioners based on results of preoperative medical consultation should also be considered but will require approaches beyond the use of routinely collected health care data. The association of preoperative consultations with surgical delay should also be considered.

The paucity of data supporting the benefit of preoperative medical consultation likely contributes to the wide variation in practice. Consistent with this study's findings, another population-level study[4] found the strongest predictor of

Figure. Odds Ratios (ORs) for 30-Day Mortality Among Patients Who Received Preoperative Medical Consultation vs Those Who Did Not (in Matched Subgroups)

Group	OR (95% CI)
Entire matched cohort	1.19 (1.11-1.29)
Year 2005-2010	1.12 (1.02-1.23)
Year 2011-2017	1.39 (1.23-1.56)
Teaching hospital	1.20 (1.07-1.35)
Nonteaching hospital	1.31 (1.19-1.45)
Male	1.25 (1.14-1.38)
Female	1.29 (1.15-1.46)
Age 40-64 y	1.51 (1.23-1.86)
Age ≥65 y	1.22 (1.13-1.32)
Ischemic heart disease	1.03 (0.91-1.18)
No ischemic heart disease	1.33 (1.22-1.46)
Diabetes	1.17 (1.03-1.33)
No diabetes	1.29 (1.18-1.41)
RCRI = 0	1.40 (1.01-1.94)
RCRI = 1-2	1.10 (0.98-1.25)
RCRI ≥ 3	1.02 (0.76-1.38)
Pulmonary disease	1.17 (0.99-1.38)
No pulmonary disease	1.25 (1.15-1.36)
Vascular procedure	1.34 (1.11-1.62)
Abdominal/thoracic procedure	1.32 (1.19-1.46)
Orthopedic procedure	1.08 (0.92-1.27)
Anesthesia consultation	1.27 (1.16-1.38)
No anesthesia consultation	1.31 (1.12-1.53)



RCRI indicates Revised Cardiac Risk Index.

obtaining a preoperative medical consultation to be the individual hospital, rather than surgical or patient factors. These sources of variation stand in contrast to existing evidence[5,9,10,40] of benefit for specific approaches to preoperative medical optimization focused on geriatric care, in which studies support reductions in several key adverse outcomes when comprehensive geriatric optimization is applied to higher-risk older patients.

Residual confounding and indication bias may contribute to our results. Prior to matching, consultation patients were older and had greater comorbidity, which would increase the risk of adverse outcomes. However, propensity score matching balanced all measured covariates and markers of unmeasured health behaviors, such as uptake of routine cancer screening between matched pairs. Further support for the validity of the study results comes from sensitivity and subgroup analyses that were consistent with the primary findings. Finally, the E-value of 1.64 makes substantial contribution from a residual confounder less likely.[27] For context, the adjusted OR for 90-day postoperative mortality associated with congestive heart failure was 1.95 (95% CI, 1.69-2.44).[41] An unidentified confounder would need to have a similar strength of association with the primary outcome as congestive heart failure to nullify our estimate.[41,42]

Contributors to harm that could be associated with medical consultation include the association of consultation with processes of care. The increase in the use of preoperative cardiac and respiratory testing in our study was comparable with previously published data,[1,12] despite recommendations from major guidelines cautioning against the routine use of these tests as they rarely provide useful additional information.[14,15,43] Also, the higher preoperative prescription of β-blockers has persisted over time even with guidelines deemphasizing this practice.[14,15,34] It is perhaps not surprising that 30-day mortality did not decrease after 2010, around the time the guidelines shifted their position on perioperative β-blocker use (eTable 7 in Supplement 1). Therefore, in addition to the possibility that testing could delay time-sensitive operations,[44,45] some interventions could be inadvertently contributing to a greater risk of stroke and death.

Limitations

This study has several limitations. Due to the retrospective design, the possibility of selection bias and residual confounding remains despite balancing measured covariates using propensity scores and consistent results from sensitivity analyses. Routinely collected data carry a risk of misclassification bias, although use of a validated exposure definition and gold standard source of mortality data decrease this risk in the current study. While the difference in 30-day mortality between the consultation and comparison groups was statistically significant, the absolute difference was small.

Results of secondary outcomes must be interpreted cautiously in the context of multiple testing; the congruence of results with those from other studies[1,12] (such as 1-year mortality) may add credibility to these findings. In addition, we were unable to capture details of processes of care, such as indications for preoperative echocardiography and β blockade, due to limitations of administrative databases; future analyses based on data that can make such links would be helpful to identify causal mediators. Patient-centered outcomes such as shared decision-making, patient satisfaction, and functional or cognitive outcomes could not be captured using available data; research incorporating these end points is needed. In addition, these results do not apply to patients undergoing urgent or emergent surgery or patients who had their procedures cancelled following preoperative medical consultation. Finally, our data were obtained from the Ontario provincial databases and may not be generalizable to other locations, although our findings were consistent with those using data from the US.[12]

Conclusions

In this cohort study, preoperative medical consultation prior to elective surgery was associated with potential harm. Because consultation requires effort and resources from patients, clinicians, and the health care system, ongoing support for preoperative medical consultation should hinge on the production of credible evidence of benefit. Until then, referral for preoperative medical consultation and subsequent testing should be carefully guided by individual-level consideration of risks and benefits.

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