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Impact of surgeon and anaesthesiologist sex on patient outcomes after cardiac surgery: a population-based study

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Title: Impact of surgeon and anaesthesiologist sex on patient outcomes after cardiac surgery: a population-based study

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Abstract

Background: Physician sex may be especially influential in the cardiac operating room (COR) given the culmination of many stressors associated with implicit bias and a marked male predominance but has yet to be examined in this context.

Objectives: We sought to determine the association between cardiac physician team sex and patient outcomes.

Design: We performed a population-based, retrospective cohort study.

Participants and Setting: Adult patients who underwent CABG and/or aortic, mitral or tricuspid valve surgery between 2008 and 2018 in Ontario, Canada.

Primary and Secondary Outcome Measures: The primary outcome was all-cause 30-day mortality. Secondary outcomes included major adverse cardiovascular events (MACE) at 30-days and hospital and intensive care unit lengths of stay (LOS). Mixed effects logistic regression was used for categorical outcomes and Poisson regression for continuous outcomes.

Results: 79,862 patients underwent cardiac surgery by 98 surgeons (11.2% female) and 279 anaesthesiologists (23.3% female); 19,893 (24.9%) were treated by sex-discordant physician teams. Physician sex discordance was not associated with overall patient mortality or LOS; however, patients who underwent isolated CABG experienced longer hospital LOS when treated by an all-male physician team as compared to an all-female team. When examining the impact of individual physician sex, the length of hospital stay was longer when isolated CABG procedures were attended by a male surgeon or anaesthesiologist.

Conclusions: Patient outcomes and healthcare resource utilization after cardiac surgery may vary by sex concordance of the attending surgeon-anaesthesiologist team. Physician team sex diversity thus represents an important opportunity for closing existing practice gaps and optimizing patient outcome.

Strengths and limitations of this study

- This study extends the analysis of physician sex to include the dynamic relationship of the cardiac surgeon and anaesthesiologist team.
- Our findings are quantitative and are limited by biases that are inherently present in observational studies.
- We were not able to consider physician gender, as gender variables were not present in the databases used.

Introduction

Teamwork between anaesthesiologists and surgeons, who share leadership roles in the operating room (OR), is critical for full team performance and patient outcome, particularly during times of crisis.[3–5] Poor non-technical skills (e.g. communication, teamwork, leadership) are one of the main contributing factors to adverse events in surgery.[6] Incivility between the OR physician dyad has recently been demonstrated to impair anaesthesiologist performance and increase the likelihood of patient fatality during an operative crisis.[5] In the cardiac operating room (COR), where crisis situations are common, effective teamwork and communication between surgeons and anaesthesiologists may be even more important contributors to patient morbidity and mortality.[7]

While the quality of interactions between surgeons and anaesthesiologists may be driven by a variety of factors, emerging evidence suggests that sex (i.e. biological attributes) and gender (i.e. social constructed norms, roles, behaviors, expressions and identities) in particular warrant further investigation. In the broader realm of medical and surgical practice, physician sex and gender have been shown to influence physician practice patterns,[8] medical education,[9] assessment,[10] remuneration, [11] perceptions of safety culture,[12] burnout,[13] job satisfaction,[13] psychological well-being,[13] and patient outcomes.[14 15] In the high stakes setting of the COR, physician sex and gender may be especially influential given the culmination of many stressors associated with implicit bias[16] and a marked male predominance in comparison to other surgical specialties.[17]

Despite its potential importance to operative success and COR team-based culture, the association between surgeon and anaesthesiologist sex and patient outcomes has yet to be examined in this context. As a first step toward understanding the role of physician sex and gender in the COR, this study aimed to explore the association between physician sex discordance and patient outcomes after cardiac surgery. We hypothesized that better patient outcomes would be observed following cardiac surgery if cared for by COR teams comprised of a surgeon and anaesthesiologist of the same sex.

Methods

The use of data in this project was authorized under section 45 of Ontario's *Personal Health Information Protection Act*, which does not require review by a Research Ethics Board. The dataset from this study is held securely in coded form at ICES (formerly the Institutes for Clinical Evaluative Sciences).[18] This study is reported in accordance to the STROBE checklist.[19]

Design Study Population

We conducted a population-based, retrospective cohort study of Ontario residents 18 years of age or older, who underwent first-time index coronary artery bypass grafting (CABG), and/or aortic, mitral or tricuspid valve surgery between October 1, 2008 and December 31, 2018. Patient exclusion criteria were non-Ontario residency status, those with missing information regarding age and sex, and those who had concomitant arrhythmia, pulmonic valve or thoracic aorta surgery. In addition, patients treated by non-cardiac surgeons and those whose primary cardiac surgeon and/or anaesthesiologist could not be identified, were excluded. A flow diagram detailing the process used to select the study cohort is shown in Supplemental Figure 1.

Data Sources

We used the clinical registry data from CorHealth Ontario and the population-level administrative healthcare databases from ICES. ICES is an independent, non-profit research institute whose legal status under Ontario's health information privacy law allows it to collect and analyze health care and demographic data, without consent, for health system evaluation and improvement. Ontario is Canada's most populous province with a publicly funded, universal health care system that reimburses all medically necessary services. CorHealth maintains a detailed prospective registry of all patients undergoing invasive cardiac procedures in Ontario from 20 advanced cardiac care hospitals. CorHealth demographic, comorbidity and procedural data has been validated through multiple chart audits.[20]

We deterministically linked the following administrative databases by using unique encoded identifier and analyzed them at ICES. Date and type of cardiac procedure from the CorHealth registry was linked with the ICES Physicians Database (physician demographics and clinical specialty), Canadian Institute for Health Information's Discharge Abstract Database (CIHI-DAD; comorbidities and hospital admissions), Ontario Health Insurance Plan (OHIP) database (physician service claims), Registered Persons Database (RPDB; vital statistics), and the Canadian census. These administrative databases have been validated for outcomes, exposures, and comorbidities, including heart failure (HF), chronic obstructive pulmonary disease (COPD), asthma, hypertension, myocardial infarction (MI) and diabetes.[21–23]

Patient and Procedure Characteristics

Patient characteristics were identified from the CorHealth registry and supplemented with data from the CIHI-DAD and OHIP, using International Classification of Diseases (10th Revision; ICD-10-CA) codes within five years prior to the index procedure and according to validated algorithms.[24 25] We estimated each patient's socioeconomic status by using the neighborhood median income from the Canadian census[26] and determined residence status (rural versus urban) using Statistics Canada definitions.[27] Height, weight, and body mass index (BMI) were identified from the CorHealth Ontario registry and used to determine morbid obesity (defined as weight >159 kg or BMI ≥40 kg/m^2).[28] Frailty status was identified using the Johns Hopkins Adjusted Clinical Groups (ACG® System) frailty-defining diagnoses indicator, which is an instrument designed and validated for research of frailty-related outcomes and resource utilization using administrative data.[29 30]

Emergent procedural status was ascertained using the CorHealth registry and supplemented by OHIP code E020C for emergent procedures.[28 31] We defined procedure complexity as simple (isolated CABG or single valve) vs. complex (multiple valves or combined valve(s) + CABG). Information on surgery duration was obtained from the CIHI-DAD.

Exposures

The primary exposure was surgeon-anaesthesiologist sex discordance (i.e., surgeon and anaesthesiologist were of the opposite sex) vs. concordance (i.e., both treating physicians were of the same sex). Secondary exposures consisted of demographic characteristics of the primary surgeons and anaesthesiologists, including age, sex, years since medical school graduation, specialty, hospital, and total number of procedures performed since the inception of ICES databases in 1991 until the date of the index procedure.

Outcomes At 30 Days

Outcomes were assessed from the date of the procedure until 30 days postoperatively. The primary outcome was all-cause mortality. Secondary outcomes were major adverse cardiovascular events (MACE; composite of stroke, repeat revascularization, hospitalization for MI and HF), and hospital and intensive care unit (ICU) lengths of stay (LOS).

Statistical Analysis

L.Y.S. and A.B.E. had full access to all of the data in the study and take responsibility for its integrity and for the data analysis. Continuous variables were compared with a Student's t-test, or with a Wilcoxon rank-sum test for non-normally distributed data. Categorical variables were compared with a chi-square test. The association between physician sex discordance and patient outcomes was modeled using mixed effects logistic regression for categorical outcomes and Poisson regression for continuous outcomes. In each of these models, the choice of surgeon, anaesthesiologist, and hospital were treated as random intercepts and physician, patient and procedure characteristics were fixed effects. We tested for potential effect modification by patient sex, procedure complexity, emergent operative status, and hospital type (teaching vs. community) using multiplicative interaction terms.

Subgroup Analysis

Subgroup analyses were planned *a priori*. Surgeons who underwent subspecialized training (e.g., valvular repair) are more likely to excel in these procedures. However, CABG is a "bread and butter" cardiac procedure in which reduced variations in surgical results are expected to occur. We therefore also performed our analyses in patients who underwent isolated CABG.

Sensitivity Analyses

We repeated our multivariable analyses *first* by further classifying physician sex into male surgeon - male anaesthesiologist, male surgeon - female anaesthesiologist, female surgeon - male anaesthesiologist, and female surgeon - female anaesthesiologist. *Next*, we studied individually the impact of surgeon and anaesthesiologist sex.

Analyses were performed using SAS 9.4 (SAS Institute, USA) and R 3.5.3 (R Foundation, Austria). Statistical significance was defined as a two-sided P-value of < 0.05.

Patient and Public Involvement

Patients and the public were not involved in the conduct of this research study.

Results

A total of 79,862 patients who underwent first-time cardiac surgery met our inclusion criteria (23.4% female). During the study period, surgeries were performed by 98 surgeons (11.2% female) and 279 anaesthesiologists (23.3% female), who formed 2,079 unique physician teams (3.0% both female, 67.6% both male, 9.0% female surgeon - male anaesthesiologist, 20.4% male surgeon - female anaesthesiologist). A total of 19,893 (24.9%) patients were treated by sex-discordant COR physician teams (7.2% by female surgeon - male anaesthesiologist, 17.7% male surgeon - female anaesthesiologist). In contrast, 1,188 (1.5%) patients were treated by all-female physician teams and 58.781 (73.6%) by all-male teams.

While most baseline patient characteristics were similar between those treated by sex discordant vs. concordant physicians (Table 1), those treated by sex discordant physicians were more likely to be morbidly obese, to undergo surgeries of longer duration, but were less likely to be frail. No clinically significant differences were observed in the characteristics of physicians who treated female vs. male patients (Table 2).

Mortality

A total of 335 (1.7%) patients treated by sex discordant and 1,052 (1.8%) by sex concordant physicians died within 30 days of surgery (p=0.51, Table 3). The adjusted OR of 30-day mortality was 0.93 (95% CI 0.80-1.07) for sex discordant physicians, and none of the other physician characteristics were independent mortality risk factors (Table 4). The association of physician sex discordance and 30-day mortality was not modified by patient sex (interaction p=0.33), complex surgery (interaction p=0.20), emergent operative status (interaction p=0.92), and hospital type (interaction p=0.92).

A total of 205 (1.3%) patients who underwent isolated CABG patients by sex discordant and 654 (1.4%) by sex concordant physicians died within 30 days of surgery (p=0.41, Supplemental Table 1). Physician sex discordance was not associated with 30-day mortality (adjusted OR 0.88, 0.74 to 1.05, Supplemental Table 2), and we did not observe a statistically significant interaction between physician sex discordance and patient sex (interaction P=0.59), off-pump CABG (interaction p=0.06), emergent operative status (interaction p=0.57), and hospital type (interaction p=0.62).

MACE

At 30 days, MACE occurred in 678 (3.4%) patients who were treated by sex discordant and 2,247 (3.7%) by sex concordant physicians (p=0.03, Table 3). Neither physician sex discordance (adjusted OR 0.96 [0.87-1.06]), nor any other physician characteristics, were independently associated with MACE (Supplemental Table 3). No modifiers of the association of physician sex discordance with MACE were identified.

In patients who underwent isolated CABG, 524 (3.3%) treated by sex discordant and 1,692 (3.6%) by sex concordant physicians developed MACE (p=0.12, Supplemental Table 1). We did not observe a statistically significant association between physician sex discordance and MACE (adjusted OR 0.99 [0.98-1.11], Supplemental Table 2), and no effect modifiers of the association between physician sex discordance and MACE were identified.

ICU and Hospital LOS

Median ICU and hospital LOS were 2 (IQR, 2-3) and 7 (6-9), respectively, both in patients who were treated by sex discordant and concordant physicians (Table 3). Physician sex discordance was not associated with ICU or hospital LOS in the overall (Supplemental Table 4) nor the isolated CABG group (Supplemental Table 2), and no effect modifiers were identified of the association between physician sex discordance and ICU/hospital LOS.

Sensitivity Analyses

Surgeon-Anaesthesiologist Sex as a Four-Level Categorical Variable

We did not observe an independent association between teams comprised of male surgeon - male anaesthesiologist, male surgeon - female anaesthesiologist, female surgeon - male anaesthesiologist, and female surgeon - female anaesthesiologist, and 30-day mortality, MACE, or ICU LOS (Supplemental Table 5). However, an all-male physician team as compared to an all-female team was associated with longer hospital LOS in CABG patients.

Individual Contribution of Surgeon and Anaesthesiologist Sex

Male as compared to female surgeon, and male vs. female anaesthesiologist, was associated with longer hospital LOS in the overall and CABG patient groups (Supplemental Table 5b).

Discussion

Key Findings

The novelty of the present study lies in its consideration of the impact of surgeon-anaesthesiologist dyad on patient outcomes after cardiac surgery. Our key findings are as follows: 1) Physician sex discordance was not associated with overall patient mortality or LOS; 2) Patients who underwent isolated CABG experienced longer hospital LOS when treated by an all-male physician team as compared to an all-female team; 3) When examining the impact of individual physician sex, the length of hospital stay was longer when isolated CABG procedures were attended by a male surgeon or anaesthesiologist.

Interpretation

We found that physician sex discordance was not associated with overall patient mortality or LOS. This stands contrary to our hypothesis as well as reports from other studies suggesting a greater opportunity for tension within sex discordant teams. For example, studies based on non-cardiac OR teams suggest female providers may more often be challenged and perceived negatively by others, and are less likely to speak up when an incorrect decision is made.[8 32 33] Teamwork behaviors such as cooperation, communication, and leadership, have also been observed to vary depending on the number of male and female providers in the room.[8 33 34] Our findings suggest that sex diversity in the COR may actually increase cooperation.[34] In fact, the COR teamwork culture may be changing in recent years, such that sex discordant surgeon-anaesthesiologist pairs are working more effectively together in achieving the observed lower rates of mortality. Further research is needed to qualitatively determine the relevance of this finding to teamwork quality and physician performance.

While previous studies have investigated the role of physician sex individually for surgeons,[14] and primary care practitioners,[35] we extended this analysis to include the dynamic relationship of the cardiac surgeon and anaesthesiologist team. A recent study of 25 cardiac and non-cardiac procedure types performed in Ontario, found that patients treated by female surgeons compared to male surgeons had a lower 30-day mortality (adjusted odds ratio 0.88; 95% CI: 0.79-0.99, P=0.04).[14] These authors postulated, however, that better outcomes in the hands of female surgeons may have been confounded by a higher volume of non-emergent, non-complex procedures being performed by this group. Our subgroup analysis in patients who underwent CABG, a routine procedure, was aimed to overcome this case allocation bias. We observed longer lengths of hospital stay in those treated by all-male surgeon-anaesthesiologist teams as compared to all-female teams, as well as individually by male anaesthesiologists and surgeons. Though researchers have postulated a variety of reasons for better patient outcomes among female surgeons[14 15] and primary care physicians,[35] less work has been done to examine how sex and gender may influence anaesthesia practice or team-based work in the COR. Our findings may in part be explained by greater adherence to practice guidelines by female surgeons and anaesthesiologists, as well as their propensity for more effective interprofessional teamwork, and more active engagement in patient-centered care.[36 37]

The performance of female physicians has also been framed in terms of the challenges they must often overcome to practice effectively in the surgical specialties. For example, Wallis and colleagues suggested that it is possible that "these barriers might create a higher standard for women to gain entrance into the surgical workforce than men, resulting in the selection of a cohort of women that are proportionately more skilled, motivated, and harder working".[14] This may be particularly true of cardiac surgery given it is amongst the most demanding specialties and is traditionally viewed as a male dominated field. Still, studies regarding medical emergencies outside of the COR setting have found that male healthcare professionals outperform their female colleagues, albeit at least in part because women's leadership is more likely to be challenged.[8 33] Consequently, more research is needed to determine when and how to best support male and female physicians to promote effective practice and equity in the COR. As more women continue to pursue cardiac surgery and anesthesiology, it will be important for research to deep-dive into their performance and experiences; this includes the impact of diversity on COR teamwork.

Limitations

Firstly, an important limitation of our study is that we were only able to examine the impact of sex as gender variables were not available in the databases used. In the future, organizations may wish to consider incorporating measures of gender as routinely collected elements. *Secondly*, our findings are quantitative, and are limited by the inherent biases of observational studies. Prospective, qualitative research is warranted to further explore the role of physician sex and gender in the COR along with other potentially important factors such as ethnicity, language, geographic location, country of medical education, and so forth.[38 39] *Thirdly*, our analyses were limited to physician characteristics as the characteristics of other COR providers were not available to us. Future research should consider the interaction of the surgeon and anaesthesiologist pair along with nurses, perfusionists, anaesthesia and surgical assistances, and trainees.

Conclusions

Patient outcomes and healthcare resource utilization after cardiac surgery may vary by sex concordance of the attending surgeon-anaesthesiologist team. Our findings highlight the importance of physician team diversity, as well as the need for further studies to determine how sex, gender, and other sociodemographic traits of COR physicians and allied practitioners might intersect to influence processes of care and patient outcomes in this high-risk and resource intensive setting. We identified sex composition of the COR physician team as a potential area for targeted education and training interventions to close existing practice gaps and ensure the best outcome possible for patients.

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Declaration Of Interests

The authors report no conflicts of interest.

Authors' Contribution

The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

LYS, SB, VC, DSL, TGM, ABE, NE: Contributed substantially to conception and design, or analysis and interpretation of data, drafted the article, revised article critically for important intellectual content, gave final approval of the version to be published, agreed to act as guarantor of the work (ensuring that questions related to any part of the work are appropriately investigated and resolved).

The authors also acknowledge the usage of data compiled and provided by the Canadian Institute for Health Information. These datasets were linked using unique encoded identifiers and analyzed at ICES. The analyses, conclusions, opinions and statements expressed in the manuscript are those of the authors, and do not necessarily reflect those of the above agencies.

Data Sharing Statement

The dataset from this study is held securely in coded form at ICES. While legal data sharing agreements between ICES and data providers (e.g., healthcare organizations and government) prohibit ICES from making the dataset publicly available, access may be granted to those who meet pre-specified criteria for confidential access, available at www.ices.on.ca/DAS (email: das@ices.on.ca). The full dataset creation plan and underlying analytic code are available from the authors upon request, understanding that the computer programs may rely upon coding templates or macros that are unique to ICES and are therefore either inaccessible or may require modification.

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TABLES

Table 1. Patient characteristics by surgeon-anaesthesiologist sex discordance in all cardiac surgery patients.

Variable	Discordant (n=19,893)	Concordant (n=59,969)	Standardized Difference	P-value
Age, mean ± SD, yr	66.3 ± 10.4	66.4 ± 10.4	0	0.76
Female Sex, n (%)	4,678 (23.5)	14,010 (23.4)	0	0.66
Income Quintile, n (%)				
1	3,762 (18.9)	11,771 (19.6)	0.02	0.01
2	3,966 (19.9)	12,374 (20.6)	0.02	
3	4,162 (20.9)	12,226 (20.4)	0.01	
4	4,052 (20.4)	11,970 (20.0)	0.01	
5	3,951 (19.9)	11,628 (19.4)	0.01	
Rural Residence, n (%)	17,212 (86.5)	50,595 (84.4)	0.06	<0.001
Hospital type, n (%)				
Community	6,236 (31.3)	18,104 (30.2)	0.03	0.002
Teaching	13,657 (68.7)	41,865 (69.8)	0.03	
Hypertension, n (%)	17,203 (86.5)	51,845 (86.5)	0	0.93
Atrial fibrillation, n (%)	1,256 (6.3)	3,830 (6.4)	0	0.72
Recent MI within 30 days, n (%)	5,002 (25.1)	15,047 (25.1)	0	0.88
Remote MI, n (%)	4,129 (20.8)	13,003 (21.7)	0.02	0.006
Previous PCI, n (%)	3,048 (15.3)	9,161 (15.3)	0	0.88
Left ventrcular ejection fraction, n (%)				
≥ 50	13,768 (69.2)	41,267 (68.8)	0.01	0.37
35-49	4,257 (21.4)	12,841 (21.4)	0	
20-35	1,591 (8.0)	4,949 (8.3)	0.01	
< 20	277 (1.4)	912 (1.5)	0.01	
Heart failure, n (%)	4,703 (23.6)	14,697 (24.5)	0.02	0.01
Perpheral arterial disease, n (%)	2,334 (11.7)	7,040 (11.7)	0	0.98
Cerebrovascular disease n (%)	1,952 (9.8)	5,887 (9.8)	0	0.99
Dementia, n (%)	31 (0.2)	132 (0.2)	0.01	0.08
Depression, n (%)	300 (1.5)	814 (1.4)	0.01	0.12
Psychosis, n (%)	31 (0.2)	132 (0.2)	0.01	0.08
Smoking status, n (%)				
Never	8,759 (44.0)	26,942 (44.9)	0.02	0.001
Current	3,852 (19.4)	11,922 (19.9)	0.01	
Former	7,282 (36.6)	21,105 (35.2)	0.03	
Chronic obstructive pulmonary disease, n (%)	5,705 (28.7)	17,303 (28.9)	0	0.64
Pulmonary circulation disorder, n (%)	387 (1.9)	1,195 (2.0)	0	0.68
Serum creatinine (µmol/L), n (%)				
<120	17,529 (88.1)	52,151 (87.0)	0.03	<0.001
120-179	1,736 (8.7)	5,670 (9.5)	0.03	
>=180	628 (3.2)	2,148 (3.6)	0.02	
Dialysis, n (%)	384 (1.9)	1,298 (2.2)	0.02	0.05
Diabetes, n (%)	8,994 (45.2)	27,182 (45.3)	0	0.78
Hypothyroidism, n (%)	406 (2.0)	1,004 (1.7)	0.03	<0.001
Morbid obesity, n (%)	9,471 (47.6)	25,824 (43.1)	0.09	<0.001
Primary cancer, n (%)	980 (4.9)	2,928 (4.9)	0	0.80
Metastatic cancer, n (%)	96 (0.5)	285 (0.5)	0	0.90
Anemia, n (%)	2,079 (10.5)	6,027 (10.1)	0.01	0.11
Venous thromboembolism, n (%)	82 (0.4)	214 (0.4)	0.01	0.27
Liver disease, n (%)	179 (0.9)	510 (0.9)	0.01	0.51
Alcohol abuse, n (%)	303 (1.5)	835 (1.4)	0.01	0.18

Frailty, n (%)	2,902 (14.6)	9,683 (16.1)	0.04	<0.001
Surgery type, n (%)				
CABG	15,672 (78.8)	46,842 (78.1)	0.02	0.05
Single valve	2,244 (11.3)	6,708 (11.2)	0	
Multiple valves	283 (1.4)	923 (1.5)	0.01	
CABG + single valve	1,583 (8.0)	5,122 (8.5)	0.02	
CABG + multiple valves	111 (0.6)	374 (0.6)	0.01	
Redo sternotomy, n (%)	460 (2.3)	1,695 (2.8)	0.03	<0.001
Emergent surgery, n (%)	1,197 (6.0)	3,674 (6.1)	0	0.58
Surgery duration, median (IQR), min	273 (232-320)	260 (220-307)	0.2	<0.001

Abbreviations: SD = standard deviation; MI = myocardial infarction; PCI = percutaneous coronary intervention; CABG = coronary artery bypass grafting; IQR = interquartile range

Table 2. Physician characteristics by patient sex.

Variable	Female patients (n=18,688)	Male patients (n=61,174)	Standardized Difference	P-value
Surgeon age, mean ± SD, yr	50.2 ± 8.8	49.9 ± 8.8	0.03	<0.001
Surgeon experience, yr, n (%)				
<10	1,186 (6.3)	4,153 (6.8)	0.02	<0.001
11-20	4,791 (25.6)	16,336 (26.7)	0.02	
21-30	7,144 (38.2)	23,313 (38.1)	0	
>30	5,567 (29.8)	17,372 (28.4)	0.03	
Surgeon volume, median (IQR), per yr	2,942 (1,209-4,366)	2,842 (1,126-4,322)	0.04	<0.001
Anaesthesiologist age, mean ± SD, yr	48.3 ± 9.0	48.3 ± 9.0	0	0.84
Anaesthesiologist experience, yr, n (%)				
0-10	1,626 (8.7)	5,563 (9.1)	0.01	0.04
11-20	6,737 (36.0)	21,877 (35.8)	0.01	
21-30	6,005 (32.1)	19,171 (31.3)	0.02	
>30	4,320 (23.1)	14,563 (23.8)	0.02	
Anaesthesiologist volume, median (IQR), per yr	764 (368-1,311)	758 (366-1,318)	0.01	0.54

Abbreviations: SD = standard deviation; PCI = percutaneous coronary intervention; IQR = interquartile range

Table 3. Thirty-day patient outcomes by physician sex discordance.

Variable	Discordant (n=19,893)	Concordant (n=59,969)	Standardized Difference	P-value
Mortality, n (%)	335 (1.7)	1,052 (1.8)	0.01	0.51
MACE, n (%)	678 (3.4)	2,247 (3.7)	0.02	0.03
Hospital length of stay, median (IQR), days	7 (6-9)	7 (6-9)	0.03	<0.001
ICU length of stay, median (IQR), days	2 (2-4)	2 (2-4)	0.06	<0.001

Abbreviations: MACE = major adverse cardiovascular events; ICU = intensive care unit, IQR = interquartile range

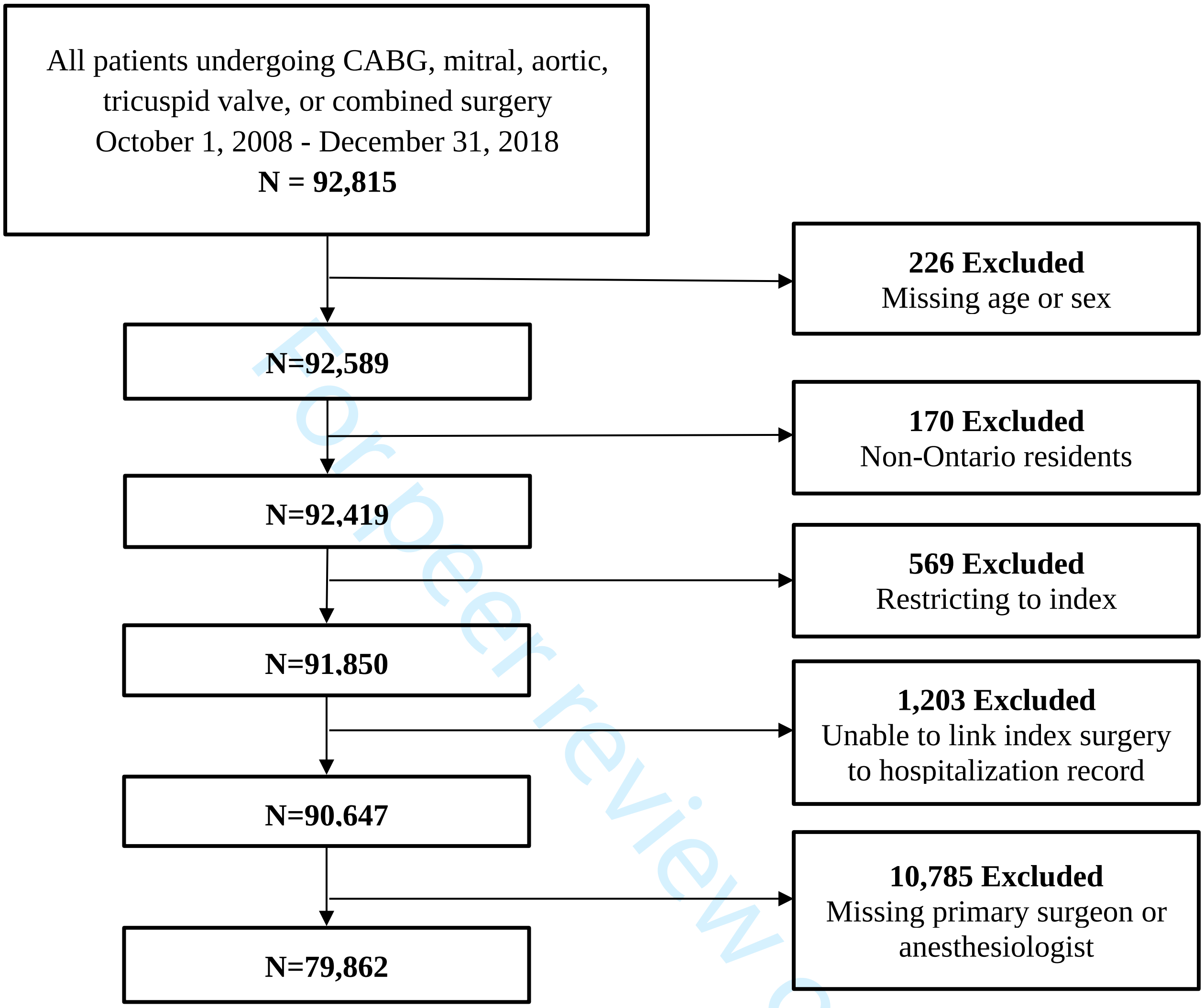
Table 4. Predictors of all-cause patient mortality at 30 days, by surgeon-anaesthesiologist sex discordance.

Variable	Adjusted OR (95% CI)	P-value
Physician characteristics		
Physician sex discordance	0.93 (0.80-1.07)	0.30
Surgeon experience, yr		
<10	Reference	Reference
11-20	1.24 (0.93-1.66)	0.14
21-30	1.07 (0.76-1.51)	0.71
>30	1.26 (0.83-1.91)	0.28
Surgeon volume, per 100 cases	1.00 (0.99-1.01)	0.55
Anaesthesiologist volume, per 100 cases	1.00 (0.99-1.02)	0.79
Anaesthesiologist experience, yr		
<10	Reference	Reference
11-20	1.15 (0.92-1.45)	0.22
21-30	1.01 (0.78-1.31)	0.93
>30	1.03 (0.78-1.37)	0.82
Patient characteristics		
Patient age, per 10 yr	1.69 (1.57-1.80)	<0.001
Female patient sex	1.56 (1.37-1.77)	<0.001
Income quintile		
1	1.44 (1.20-1.73)	<0.001
2	1.24 (1.03-1.48)	0.03
3	1.19 (0.99-1.44)	0.07
4	1.09 (0.90-1.33)	0.36
5	Reference	Reference
Rural residence	0.95 (0.81-1.12)	0.57
Community hospital	1.24 (0.81-1.91)	0.33
Hypertension	1.01 (0.81-1.25)	0.95
Atrial fibrillation	1.14 (0.97-1.35)	0.11
Recent MI within 30 days	1.39 (1.20-1.61)	<0.001
Remote MI	1.24 (1.07-1.44)	0.006
Previous PCI	1.03 (0.88-1.21)	0.70
Left ventricular ejection fraction		
≥ 50	Reference	Reference
35-49	1.23 (1.07-1.42)	0.004
20-35	1.72 (1.46-2.04)	<0.001
< 20	2.52 (1.91-3.32)	<0.001
Heart failure	1.90 (1.67-2.17)	<0.001
Peripheral arterial disease	1.45 (1.26-1.67)	<0.001
Cerebrovascular disease	1.37 (1.19-1.59)	<0.001
Dementia	2.46 (1.37-4.41)	0.003
Depression	0.97 (0.66-1.42)	0.86

Psychosis	1.42 (0.56-3.60)	0.46
Smoking status		
Never	Reference	Reference
Current	1.01 (0.84-1.20)	0.96
Former	1.01 (0.89-1.15)	0.87
Chronic obstructive pulmonary disease	1.33 (1.18-1.49)	<0.001
Pulmonary circulatory disorder	1.68 (1.33-2.13)	<0.001
Serum creatinine (µmol/L)		
<120	Reference	Reference
120-179	1.67 (1.44-1.94)	<0.001
>=180	2.78 (2.23-3.45)	<0.001
Dialysis	1.14 (0.86-1.50)	0.37
Diabetes	0.96 (0.85-1.08)	0.49
Hypothyroidism	0.75 (0.52-1.08)	0.12
Morbid obesity	0.97 (0.86-1.09)	0.61
Primary cancer	0.97 (0.77-1.22)	0.81
Metastatic cancer	1.16 (0.59-2.31)	0.66
Anemia	1.25 (1.08-1.45)	0.002
Venous thromboembolism	1.39 (0.80-2.44)	0.25
Liver disease	1.45 (0.94-2.25)	0.09
Alcohol abuse	1.21 (0.80-1.81)	0.37
Frailty	0.82 (0.71-0.95)	0.01
Redo sternotomy	1.10 (0.87-1.40)	0.44
Emergent surgery	2.91 (2.49-3.39)	<0.001
Complex surgery	1.32 (1.14-1.53)	0.0002
Surgery duration, per 10 min	1.07 (1.07-1.08)	<0.001

Abbreviations: MI = myocardial infarction; PCI = percutaneous coronary intervention

Supplemental Figure 1. Cohort flow diagram



Abbreviation: CABG = coronary artery bypass surgery

Supplemental Table 1. Thirty-day outcomes in patients who underwent CABG, by physician sex discordance.

Variable	Discordant (n=19,893)	Concordant (n=59,969)	Standardized Difference	P-value
Mortality, n (%)	205 (1.3)	654 (1.4)	0.01	0.41
MACE, n (%)	524 (3.3)	1,692 (3.6)	0.01	0.12
Hospital length of stay, median (IQR), days	7 (6-9)	7 (6-9)	0.03	0.007
ICU length of stay, median (IQR), days	2 (2-3)	2 (2-3)	0.07	<0.001

Abbreviations: MACE = major adverse cardiovascular events; ICU = intensive care unit, IQR = interquartile range

Supplemental Table 2. Adjusted associations between surgeon-anaesthesiologist sex discordance and CABG outcomes at 30 days.

Outcome	Adjusted measure (95% CI)	P-value
Mortality	OR: 0.88 (0.74-1.05)	0.16
MACE	OR: 0.99 (0.98-1.11)	0.40
Hospital length of stay	RR: 1.00 (0.99-1.02)	0.70
ICU length of stay	RR: 0.99 (0.98-1.00)	0.09

Abbreviations: MACE = major adverse cardiovascular events; ICU = intensive care unit; OR = odds ratio; RR = risk ratio; CI = confidence interval

Supplemental Table 3. Predictors of major adverse cardiovascular events at 30 days in the overall cohort, by surgeon-anaesthesiologist sex discordance.

Variable	Adjusted OR (95 CI)	P-value
Physician characteristics		
Physician sex discordance	0.96 (0.87-1.06)	0.40
Surgeon experience, yr		
<10	Reference	Reference
11-20	0.91 (0.76-1.10)	0.33
21-30	0.97 (0.77-1.22)	0.79
>30	1.04 (0.78-1.37)	0.80
Surgeon volume, per 100 cases	1.00 (1.00-1.01)	0.71
Anaesthesiologist volume, per 100 cases	1.00 (0.99-1.01)	0.74
Anaesthesiologist experience, yr		
<10	Reference	Reference
11-20	1.12 (0.97-1.31)	0.13
21-30	1.13 (0.95-1.33)	0.17
>30	1.06 (0.87-1.28)	0.57
Patient characteristics		
Patient age, per 10 yr	1.30 (1.25-1.36)	<0.001
Female patient sex	1.45 (1.33-1.58)	<0.001
Income quintile		
1	1.07 (0.95-1.21)	0.27
2	1.15 (1.02-1.30)	0.02
3	1.04 (0.92-1.17)	0.58
4	1.01 (0.89-1.14)	0.89
5	Reference	Reference
Rural residence	0.99 (0.89-1.10)	0.83
Community hospital	0.79 (0.61-1.02)	0.08
Hypertension	1.12(0.97-1.28)	0.12
Atrial fibrillation	1.18 (1.04-1.34)	0.00
Recent MI within 30 days	1.98 (1.80-2.18)	<0.001
Remote MI	1.47 (1.32-1.63)	<0.001
Previous PCI	0.93 (0.83-1.03)	0.16
Left ventricular ejection fraction		
≥ 50	Reference	Reference
35-49	1.08 (0.98-1.19)	0.11
20-35	1.18 (1.04-1.34)	0.01
< 20	1.10 (0.84-1.44)	0.49
Heart failure	1.42 (1.30-1.55)	<0.001
Peripheral arterial disease	1.32 (1.20-1.47)	<0.001

Cerebrovascular disease	1.36 (1.22-1.51)	<0.001
Dementia	1.05 (0.59-1.89)	0.86
Depression	1.20 (0.93-1.55)	0.16
Psychosis	0.87 (0.40-1.88)	0.72
Smoking status		
Never	Reference	Reference
Current	1.05 (0.93-1.17)	0.43
Former	1.02 (0.93-1.11)	0.73
Chronic obstructive pulmonary disease	1.04 (0.95-1.12)	0.41
Pulmonary circulatory disorder	1.22 (0.99-1.51)	0.06
Serum creatinine (μmol/L)		
<120	Reference	Reference
120-179	1.16 (1.03-1.30)	0.01
>=180	1.23 (1.01-1.49)	0.04
Dialysis	1.21 (0.95-1.55)	0.12
Diabetes	1.02 (0.94-1.10)	0.65
Hypothyroidism	0.95 (0.75-1.21)	0.67
Morbid obesity	1.12 (1.03-1.22)	0.01
Primary cancer	0.93 (0.79-1.10)	0.40
Metastatic cancer	1.02 (0.94-1.10)	0.95
Anemia	1.23 (1.10-1.37)	0.0002
Venous thromboembolism	0.64 (0.35-1.17)	0.15
Liver disease	1.00 (0.69-1.44)	0.10
Alcohol abuse	1.28 (0.97-1.68)	0.08
Frailty	1.07 (0.97-1.18)	0.17
Redo sternotomy	1.44 (1.19-1.73)	0.0001
Emergent surgery	1.68 (1.48-1.90)	<0.001
Complex surgery	1.17 (1.04-1.32)	0.01
Surgery duration, per 10 min	1.02 (1.01-1.02)	<0.001

Abbreviations: MI = myocardial infarction; PCI = percutaneous coronary intervention

Supplemental Table 4a. Predictors of intensive care unit length of stay in the overall cohort, by surgeon-anaesthesiologist sex discordance.

Variable	Rate Ratio (95% CI)	P-value
Physician characteristics		
Physician sex discordance	0.99 (0.98-1.01)	0.52
Surgeon experience, yr		
<10	Reference	Reference
11-20	0.99 (0.97-1.02)	0.65
21-30	1.02 (0.99-1.06)	0.14
>30	1.02 (0.98-1.06)	0.24
Surgeon volume, per 100 cases	1.00 (1.00-1.00)	0.33
Anaesthesiologist experience, yr		
0-10	Reference	Reference
11-20	0.98 (0.96-1.00)	0.04
21-30	0.99 (0.97-1.02)	0.51
>30	1.00 (0.97-1.03)	0.89
Anaesthesiologist volume, per 100 cases	1.00 (1.00-1.00)	0.71
Surgery duration	1.02 (1.02-1.02)	<0.001
Patient characteristics		
Patient age, yr	1.09 (1.08-1.09)	<0.001
Female patient sex	1.07 (1.06-1.08)	<0.001
Income quintile		
1	1.05 (1.04-1.07)	<0.001
2	1.03 (1.02-1.04)	<0.001
3	1.03 (1.02-1.04)	<0.001
4	1.01 (1.00-1.02)	0.17
5	Reference	Reference
Rural residence	0.98 (0.97-0.99)	0.00
Community hospital	0.98 (0.86-1.13)	0.82
Hypertension	0.96 (0.95-0.97)	<0.001
Atrial fibrillation	1.06 (1.04-1.07)	<0.001
Recent MI within 30 days	1.02 (1.01-1.03)	0.00
Remote MI	1.00 (0.99-1.01)	0.69

Previous PCI	1.00 (0.99-1.01)	0.70
Left ventricular ejection fraction		
≥ 50%	Reference	Reference
35-49%	1.03 (1.02-1.04)	<0.001
20-35%	1.11 (1.10-1.13)	<0.001
< 20%	1.21 (1.18-1.24)	<0.001
Heart failure	1.21 (1.20-1.22)	<0.001
Peripheral arterial disease	1.05 (1.04-1.06)	<0.001
Cerebrovascular disease	1.04 (1.03-1.05)	<0.001
Dementia	1.02 (0.95-1.09)	0.54
Depression	1.18 (1.15-1.22)	<0.001
Psychosis	1.03 (0.96-1.11)	0.39
Smoking status		
Never	Reference	Reference
Current	1.02 (1.01-1.03)	<0.001
Former	1.00 (0.99-1.01)	1.00
Chronic obstructive pulmonary disease	1.05 (1.04-1.06)	<0.001
Pulmonary circulatory disorder	1.23 (1.21-1.26)	<0.001
Serum creatinine (μmol/L)		
<120	Reference	Reference
120-179	1.16 (1.15-1.18)	<0.001
>=180	1.33 (1.31-1.36)	<0.001
Dialysis	1.06 (1.04-1.09)	<0.001
Diabetes	1.03 (1.02-1.03)	<0.001
Hypothyroidism	1.01 (0.98-1.03)	0.60
Morbid obesity	0.99 (0.98-1.00)	0.02
Primary cancer	1.00 (0.99-1.02)	0.72
Metastatic cancer	0.99 (0.94-1.04)	0.62
Anemia	1.15 (1.14-1.16)	<0.001
Venous thromboembolism	0.94 (0.89-0.99)	0.02
Liver disease	1.09 (1.05-1.12)	<0.001
Alcohol abuse	1.10 (1.07-1.14)	<0.001
Frailty	1.09 (1.08-1.10)	<0.001
Complex surgery	1.15 (1.14-1.17)	<0.001

Redo sternotomy	0.97 (0.95-0.99)	0.00
Emergent surgery	1.46 (1.44-1.48)	<0.001

Abbreviations: MI = myocardial infarction; PCI = percutaneous coronary intervention

Supplemental Table 4b. Predictors of hospital length of stay in the overall cohort, by surgeon-anaesthesiologist sex discordance.

Variable	Rate Ratio (95% CI)	P-value
Physician characteristics		
Physician sex discordance	0.99 (0.98-1.00)	0.03
Surgeon experience, yr		
<10	Reference	Reference
11-20	0.99 (0.98-1.01)	0.35
21-30	1.01 (0.99-1.03)	0.41
>30	1.01 (0.98-1.03)	0.65
Surgeon volume, per 100 cases	1.00 (1.00-1.00)	<.0001
Anaesthesiologist experience, yr		
0-10	Reference	Reference
11-20	0.99 (0.98-1.00)	0.03
21-30	0.98 (0.97-1.00)	0.03
>30	0.97 (0.96-0.99)	0.00
Anaesthesiologist volume, per 100 cases	1.00 (1.00-1.00)	0.01
Surgery duration	1.01 (1.01-1.01)	<.0001
Patient characteristics		
Patient age, yr	1.11 (1.10-1.11)	<.0001
Female patient sex	1.11 (1.10-1.12)	<.0001
Income quintile		
1	1.07 (1.06-1.08)	<.0001
2	1.04 (1.03-1.04)	<.0001
3	1.03 (1.02-1.03)	<.0001
4	1.01 (1.01-1.02)	0.0002
5	Reference	Reference
Rural residence	1.00 (0.99-1.00)	0.15
Community hospital	1.02 (0.92-1.12)	0.71
Hypertension	0.98 (0.97-0.99)	<.0001
Atrial fibrillation	1.06 (1.05-1.07)	<.0001
Recent MI within 30 days	1.02 (1.02-1.03)	<.0001
Remote MI	1.00 (0.99-1.01)	0.80
Previous PCI	0.97 (0.97-0.98)	<.0001
Left ventricular ejection fraction		
≥ 50%	Reference	Reference
35-49%	1.02 (1.01-1.03)	<.0001
20-35%	1.06 (1.05-1.06)	<.0001
< 20%	1.10 (1.08-1.12)	<.0001
Heart failure	1.17 (1.16-1.18)	<.0001
Peripheral arterial disease	1.04 (1.04-1.05)	<.0001
Cerebrovascular disease	1.06 (1.05-1.07)	<.0001
Dementia	1.03 (0.99-1.08)	0.10

Depression	1.19 (1.17-1.21)	<.0001
Psychosis	1.22 (1.17-1.27)	<.0001
Smoking status		
Never	Reference	Reference
Current	1.00 (0.99-1.00)	0.20
Former	1.00 (0.99-1.00)	0.63
Chronic obstructive pulmonary disease	1.06 (1.05-1.06)	<.0001
Pulmonary circulatory disorder	1.14 (1.13-1.16)	<.0001
Serum creatinine (µmol/L)		
<120	Reference	Reference
120-179	1.10 (1.09-1.11)	<.0001
>=180	1.25 (1.23-1.27)	<.0001
Dialysis	1.11 (1.09-1.13)	<.0001
Diabetes	1.03 (1.03-1.04)	<.0001
Hypothyroidism	1.01 (1.00-1.03)	0.13
Morbid obesity	1.00 (0.99-1.00)	0.29
Primary cancer	1.02 (1.01-1.03)	0.0003
Metastatic cancer	1.00 (0.97-1.04)	0.83
Anemia	1.14 (1.13-1.15)	<.0001
Venous thromboembolism	1.01 (0.98-1.04)	0.60
Liver disease	1.06 (1.04-1.09)	<.0001
Alcohol abuse	1.07 (1.05-1.09)	<.0001
Frailty	1.15 (1.14-1.16)	<.0001
Complex surgery	1.13 (1.12-1.13)	<.0001
Redo sternotomy	0.95 (0.94-0.96)	<.0001
Emergent surgery	1.22 (1.21-1.24)	<.0001

Abbreviations: MI = myocardial infarction; PCI = percutaneous coronary intervention

Supplemental Table 5a. Sensitivity analysis of the association between physician sex and 30-day mortality and MACE in the overall cohort.

Physician Team	Mortality Adjusted OR (95% CI)	Mortality P-value	MACE Adjusted OR (95% CI)	MACE P-value
Model with physician sex as a 4-level categorical variable:				
Female surgeon + female anaesthesiologist	Reference	Reference	Reference	Reference
Male surgeon + male anaesthesiologist	1.35 (0.77-2.37)	0.30	1.03 (0.72-1.47)	0.87
Female surgeon + male anaesthesiologist	1.20 (0.69-2.10)	0.52	0.86 (0.61-1.22)	0.41
Male surgeon + female anaesthesiologist	1.24 (0.69-2.20)	0.47	1.02 (0.71-1.46)	0.93
Model with surgeon sex only:				
Male surgeon	1.15 (0.84-1.57)	0.38	1.16 (0.93-1.44)	0.19
Model with anaesthesiologist sex only:				
Male anaesthesiologist	1.10 (0.94-1.28)	0.23	1.00 (0.90-1.11)	0.97

Abbreviations: MACE = major adverse cardiovascular events

Supplemental Table 5b. Sensitivity analysis of the association between physician sex and 30-day mortality and MACE in the CABG cohort.

Physician Team	Mortality Adjusted OR (95% CI)	Mortality P-value	MACE Adjusted OR (95% CI)	MACE P-value
Model with physician sex as a 4-level categorical variable:				
Female surgeon + female anaesthesiologist	Reference	Reference	Reference	Reference
Male surgeon + male anaesthesiologist	1.31 (0.69-2.50)	0.41	0.92 (0.63-1.34)	0.66
Female surgeon + male anaesthesiologist	0.98 (0.50-1.91)	0.94	0.77 (0.52-1.13)	0.18
Male surgeon + female anaesthesiologist	1.20 (0.62-2.32)	0.59	0.96 (0.65-1.42)	0.84
Model with surgeon sex only:				
Male surgeon	1.31 (0.94-1.18)	0.12	1.14 (0.91-1.44)	0.26
Model with anaesthesiologist sex only:				
Male anaesthesiologist	1.09 (0.90-1.31)	0.39	0.94 (0.83-1.06)	0.30

Abbreviations: MACE = major adverse cardiovascular events; CABG = coronary artery bypass grafting

Supplemental Table 6a. Sensitivity analysis of the association between physician sex and lengths of stay in the overall cohort.

Physician Team	ICU Length of Stay		Hospital Length of Stay	
	Rate Ratio (95% CI)	P-value	Rate Ratio (95% CI)	P-value
Model with physician sex as a 4-level categorical variable:				
Female surgeon + female anaesthesiologist	Reference	Reference	Reference	Reference
Male surgeon + male anaesthesiologist	1.07 (1.00-1.15)	0.06	1.07 (1.00-1.15)	0.06
Female surgeon + male anaesthesiologist	0.99 (0.97-1.02)	0.52	0.99 (0.97-1.02)	0.52
Male surgeon + female anaesthesiologist	1.06 (0.99-1.34)	0.12	1.06 (0.99-1.14)	0.12
Model with surgeon sex only:				
Male surgeon	1.02 (0.96-1.09)	0.54	1.10 (1.03-1.17)	0.006
Model with anaesthesiologist sex only:				
Male anaesthesiologist	1.16 (0.99-1.04)	0.19	1.02 (1.00-1.03)	0.03

Abbreviations: ICU = intensive care unit

Supplemental Table 6b. Sensitivity analysis of the association between physician sex and lengths of stay in the CABG cohort.

Physician Team	ICU Length of Stay		Hospital Length of Stay	
	Rate Ratio (95% CI)	P-value	Rate Ratio (95% CI)	P-value
Model with physician sex as a 4-level categorical variable:				
Female surgeon + female anaesthesiologist	Reference	Reference	Reference	Reference
Male surgeon + male anaesthesiologist	1.05 (0.97-1.13)	0.21	1.07 (1.00-1.15)	0.049
Female surgeon + male anaesthesiologist	1.03 (0.98-1.08)	0.21	1.00 (0.97-1.03)	0.90
Male surgeon + female anaesthesiologist	1.05 (0.97-1.13)	0.25	1.06 (0.99-1.14)	0.09
Model with surgeon sex only:				
Male surgeon	1.02 (0.96-1.09)	0.48	1.10 (1.03-1.18)	0.004
Model with anaesthesiologist sex only:				
Male anaesthesiologist	1.01 (0.98-1.03)	0.55	1.02 (1.00-1.04)	0.01

Abbreviations: ICU = intensive care unit; CABG = coronary artery bypass grafting

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1-2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5-6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up (*b*) For matched studies, give matching criteria and number of exposed and unexposed	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-7
Bias	9	Describe any efforts to address potential sources of bias	7-8
Study size	10	Explain how the study size was arrived at	9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6-8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding (*b*) Describe any methods used to examine subgroups and interactions (*c*) Explain how missing data were addressed (*d*) If applicable, explain how loss to follow-up was addressed (*e*) Describe any sensitivity analyses	7-9
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram	9
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest (c) Summarise follow-up time (eg, average and total amount)	9
Outcome data	15*	Report numbers of outcome events or summary measures over time	9-11

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (*b*) Report category boundaries when continuous variables were categorized (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	9-11
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	11
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12-14
Generalisability	21	Discuss the generalisability (external validity) of the study results	14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

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Impact of surgeon and anaesthesiologist sex on patient outcomes after cardiac surgery: a population-based study

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Title: Impact of surgeon and anaesthesiologist sex on patient outcomes after cardiac surgery: a population-based study

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Abstract

Background: Effective teamwork between anaesthesiologists and surgeons is essential for optimizing patient safety in the cardiac operating room (OR). While many factors may influence the relationship between these two physicians, the role of sex and gender have yet to be investigated.

Objectives: We sought to determine the association between cardiac physician team sex discordance and patient outcomes.

Design: We performed a population-based, retrospective cohort study.

Participants and Setting: Adult patients who underwent CABG and/or aortic, mitral or tricuspid valve surgery between 2008 and 2018 in Ontario, Canada.

Primary and Secondary Outcome Measures: The primary outcome was all-cause 30-day mortality. Secondary outcomes included major adverse cardiovascular events (MACE) at 30-days and hospital and intensive care unit lengths of stay (LOS). Mixed effects logistic regression was used for categorical outcomes and Poisson regression for continuous outcomes.

Results: 79,862 patients underwent cardiac surgery by 98 surgeons (11.2% female) and 279 anaesthesiologists (23.3% female); 19,893 (24.9%) were treated by sex-discordant physician teams. Physician sex discordance was not associated with overall patient mortality or LOS; however, patients who underwent isolated CABG experienced longer hospital LOS when treated by an all-male physician team as compared to an all-female team (adjusted odds ratio [OR]=1.07; p=0.049). When examining the impact of individual physician sex, the length of hospital stay was longer when isolated CABG procedures were attended by a male surgeon (OR=1.10; p=0.004) or anaesthesiologist (OR=1.02; p=0.01).

Conclusions: Patient mortality and length of stay after cardiac surgery may vary by sex concordance of the attending surgeon-anaesthesiologist team. Further research is needed to examine the underlying mechanisms of these observed relationships.

Strengths and limitations of this study

- Robust statistical methods were applied to a novel research question.
- Analyses were limited to physician characteristics.
- Information on gender was not availale in the databases used; accordingly, only biological sex could be studied.
- Analyses were quantitative. Findings could be further explored in future qualitative studies.

Introduction

Teamwork between anaesthesiologists and surgeons, who share leadership roles in the operating room (OR), is critical for full team performance and patient outcome, particularly during times of crisis.[1–3] Poor non-technical skills (e.g. communication, teamwork, leadership) are one of the main contributing factors to adverse events in surgery.[4] Incivility between the OR physician dyad has recently been demonstrated to impair anaesthesiologist performance and increase the likelihood of patient fatality during an operative crisis.[3] In the cardiac operating room (COR), where crisis situations are common, effective teamwork and communication between surgeons and anaesthesiologists may be even more important contributors to patient morbidity and mortality.[5]

While the quality of interactions between surgeons and anaesthesiologists may be driven by a variety of factors, emerging evidence suggests that sex (i.e. biological attributes) and gender (i.e. social constructed norms, roles, behaviors, expressions and identities) in particular warrant further investigation. In the broader realm of medical and surgical practice, physician sex and gender have been shown to influence physician practice patterns,[6] medical education,[7] assessment,[8] remuneration,[9] perceptions of safety culture,[10] burnout,[11] job satisfaction,[11] psychological well-being,[11] and patient outcomes.[12] [13] In the high stakes setting of the COR, physician sex and gender may be especially influential given the culmination of many stressors associated with implicit bias[14] and a marked male predominance in comparison to other surgical specialties.[15]

Despite its potential importance to operative success and COR team-based culture, the association between surgeon and anaesthesiologist sex and patient outcomes has yet to be examined in this context. As a first step toward understanding the role of physician sex and gender in the COR, this study aimed to explore the association between physician sex discordance and patient outcomes after cardiac surgery. We hypothesized that better patient outcomes would be observed following cardiac surgery if cared for by COR teams comprised of a surgeon and anaesthesiologist of the same sex.

Methods

The use of data in this project was authorized under section 45 of Ontario's *Personal Health Information Protection Act*, which does not require review by a Research Ethics Board. Patient data were deidentified before access by the study authors. The dataset from this study is held securely in coded form at ICES (formerly the Institutes for Clinical Evaluative Sciences).[16] This study is reported in accordance to the STROBE checklist.[17]

Design Study Population

We conducted a population-based, retrospective cohort study of Ontario residents 18 years of age or older, who underwent first-time index coronary artery bypass grafting (CABG), and/or aortic, mitral or tricuspid valve surgery between October 1, 2008 and December 31, 2018. Patient exclusion criteria were non-Ontario residency status, those with missing information regarding age and sex, and those who had concomitant arrhythmia, pulmonic valve or thoracic aorta surgery. In addition, patients treated by non-cardiac surgeons and those whose primary cardiac surgeon and/or anaesthesiologist could not be identified, were excluded. A flow diagram detailing the process used to select the study cohort is shown in Supplemental Figure 1.

Data Sources

We used the clinical registry data from CorHealth Ontario and the population-level administrative healthcare databases from ICES. ICES is an independent, non-profit research institute whose legal status under Ontario's health information privacy law allows it to collect and analyze health care and demographic data, without consent, for health system evaluation and improvement. Ontario is Canada's most populous province with a publicly funded, universal health care system that reimburses all medically necessary services. CorHealth maintains a detailed prospective registry of all patients undergoing invasive cardiac procedures in Ontario from 20 advanced cardiac care hospitals. CorHealth demographic, comorbidity and procedural data has been validated through multiple chart audits.[18]

We deterministically linked the following administrative databases by using unique encoded identifier and analyzed them at ICES. Date and type of cardiac procedure from the CorHealth registry was linked with the ICES Physicians Database (physician demographics and clinical specialty), Canadian Institute for Health Information's Discharge Abstract Database (CIHI-DAD; comorbidities and hospital admissions), Ontario Health Insurance Plan (OHIP) database (physician service claims), Registered Persons Database (RPDB; vital statistics), and the Canadian census. These administrative databases have been validated for outcomes, exposures, and comorbidities, including heart failure (HF), chronic obstructive pulmonary disease (COPD), asthma, hypertension, myocardial infarction (MI) and diabetes.[19–21]

Patient and Procedure Characteristics

Patient characteristics were identified from the CorHealth registry and supplemented with data from the CIHI-DAD and OHIP, using International Classification of Diseases (10^{th} Revision; ICD-10-CA) codes within five years prior to the index procedure and according to validated algorithms.[22 23] We estimated each patient's socioeconomic status by using the neighborhood median income from the Canadian census[24] and determined residence status (rural versus urban) using Statistics Canada definitions.[25] Height, weight, and body mass index (BMI) were identified from the CorHealth Ontario registry and used to determine morbid obesity (defined as weight >159 kg or BMI ≥40 kg/m^2).[26] Frailty status was identified using the Johns Hopkins Adjusted Clinical Groups (ACG® System) frailty-defining diagnoses indicator, which is an instrument designed and validated for research of frailty-related outcomes and resource utilization using administrative data.[27 28]

Emergent procedural status was ascertained using the CorHealth registry and supplemented by OHIP code E020C for emergent procedures.[26 29] We defined procedure complexity as simple (isolated CABG or single valve) vs. complex (multiple valves or combined valve(s) + CABG). Information on surgery duration was obtained from the CIHI-DAD.

Exposures

The primary exposure was surgeon-anaesthesiologist sex discordance (i.e., surgeon and anaesthesiologist were of the opposite sex) vs. concordance (i.e., both treating physicians were of the same sex). Secondary exposures consisted of demographic characteristics of the primary surgeons and anaesthesiologists, including age, sex, years since medical school graduation, specialty, hospital, and total number of procedures performed since the inception of ICES databases in 1991 until the date of the index procedure.

Outcomes At 30 Days

Outcomes were assessed from the date of the procedure until 30 days postoperatively. The primary outcome was all-cause mortality. Secondary outcomes were hospital and intensive care unit (ICU) lengths of stay (LOS) as well as major adverse cardiovascular events (MACE). MACE was defined as a composite of stroke, repeat revascularization, hospitalization for MI and HF. Stroke included ischemic stroke and was generally defined as new focal or global neurologic deficit of cerebrovascular origin lasting 24 hours or longer that was not present before surgery.

Statistical Analysis

L.Y.S. and A.B.E. had full access to all of the data in the study and take responsibility for its integrity and for the data analysis. Continuous variables were compared with a Student's t-test, or with a

Wilcoxon rank-sum test for non-normally distributed data. Categorical variables were compared with a chi-square test. The association between physician sex discordance and patient outcomes was modeled using mixed effects logistic regression for categorical outcomes and Poisson regression for continuous outcomes. In each of these models, the choice of surgeon, anaesthesiologist, and hospital were treated as random intercepts and physician, patient and procedure characteristics were fixed effects. We tested for potential effect modification by patient sex, procedure complexity, emergent operative status, and hospital type (teaching vs. community) using multiplicative interaction terms.

Subgroup Analysis

Subgroup analyses were planned *a priori*. Surgeons who underwent subspecialized training (e.g., valvular repair) are more likely to excel in these procedures. However, CABG is a “bread and butter” cardiac procedure in which reduced variations in surgical results are expected to occur. We therefore also performed our analyses in patients who underwent isolated CABG.

Sensitivity Analyses

We repeated our multivariable analyses *first* by further classifying physician sex into male surgeon - male anaesthesiologist, male surgeon - female anaesthesiologist, female surgeon - male anaesthesiologist, and female surgeon - female anaesthesiologist. *Next*, we studied individually the impact of surgeon and anaesthesiologist sex.

Analyses were performed using SAS 9.4 (SAS Institute, USA) and R 3.5.3 (R Foundation, Austria). Statistical significance was defined as a two-sided P-value of < 0.05.

Patient and Public Involvement

Patients and the public were not involved in the conduct of this research study.

Results

A total of 79,862 patients who underwent first-time cardiac surgery met our inclusion criteria (23.4% female). During the study period, surgeries were performed by 98 surgeons (11.2% female) and 279 anaesthesiologists (23.3% female), who formed 2,079 unique physician teams (3.0% both female, 67.6% both male, 9.0% female surgeon - male anaesthesiologist, 20.4% male surgeon - female anaesthesiologist). A total of 19,893 (24.9%) patients were treated by sex-discordant COR physician teams (7.2% by female surgeon - male anaesthesiologist, 17.7% male surgeon - female anaesthesiologist). In contrast, 1,188 (1.5%) patients were treated by all-female physician teams and 58.781 (73.6%) by all-male teams.

While most baseline patient characteristics were similar between those treated by sex discordant vs. concordant physicians (Table 1), those treated by sex discordant physicians were more likely to be morbidly obese, to undergo surgeries of longer duration, but were less likely to be frail. No clinically significant differences were observed in the characteristics of physicians who treated female vs. male patients (Table 2).

Mortality

A total of 335 (1.7%) patients treated by sex discordant and 1,052 (1.8%) by sex concordant physicians died within 30 days of surgery (p=0.51, Table 3). The adjusted OR of 30-day mortality was 0.93 (95% CI 0.80-1.07) for sex discordant physicians, and none of the other physician characteristics were independent mortality risk factors (Table 4). The association of physician sex discordance and 30-day mortality was not modified by patient sex (interaction p=0.33), complex surgery (interaction p=0.20), emergent operative status (interaction p=0.92), and hospital type (interaction p=0.92).

A total of 205 (1.3%) patients who underwent isolated CABG patients by sex discordant and 654 (1.4%) by sex concordant physicians died within 30 days of surgery (p=0.41, Supplemental Table 1). Physician sex discordance was not associated with 30-day mortality (adjusted OR 0.88, 0.74 to 1.05, Supplemental Table 2), and we did not observe a statistically significant interaction between physician sex discordance and patient sex (interaction P=0.59), off-pump CABG (interaction p=0.06), emergent operative status (interaction p=0.57), and hospital type (interaction p=0.62).

MACE

At 30 days, MACE occurred in 678 (3.4%) patients who were treated by sex discordant and 2,247 (3.7%) by sex concordant physicians (p=0.03, Table 3). Neither physician sex discordance (adjusted OR 0.96 [0.87-1.06]), nor any other physician characteristics, were independently associated with MACE (Supplemental Table 3). No modifiers of the association of physician sex discordance with MACE were identified.

In patients who underwent isolated CABG, 524 (3.3%) treated by sex discordant and 1,692 (3.6%) by sex concordant physicians developed MACE (p=0.12, Supplemental Table 1). We did not observe a statistically significant association between physician sex discordance and MACE (adjusted OR 0.99 [0.98-1.11], Supplemental Table 2), and no effect modifiers of the association between physician sex discordance and MACE were identified.

ICU and Hospital LOS

Median ICU and hospital LOS were 2 days (IQR, 2-3) and 7 days (6-9), respectively, both in patients who were treated by sex discordant and concordant physicians (Table 3). Physician sex discordance was not associated with ICU or hospital LOS in the overall (Supplemental Table 4) nor the isolated CABG group (Supplemental Table 2), and no effect modifiers were identified of the association between physician sex discordance and ICU/hospital LOS.

Sensitivity Analyses

Surgeon-Anaesthesiologist Sex as a Four-Level Categorical Variable

We did not observe an independent association between teams comprised of male surgeon - male anaesthesiologist, male surgeon - female anaesthesiologist, female surgeon - male anaesthesiologist, and female surgeon - female anaesthesiologist, and 30-day mortality, MACE, or ICU LOS (Supplemental Tables 5a and 5b). However, an all-male physician team as compared to an all-female team was associated with longer hospital LOS in CABG patients (adjusted OR=1.07 [1.00-1.15]; p=0.049) (Supplemental Table 6a).

Individual Contribution of Surgeon and Anaesthesiologist Sex

Male as compared to female surgeon (adjusted OR=1.10 [1.03-1.18]; p=0.004), and male vs. female anaesthesiologist (adjusted OR=1.02 [1.00-1.04]; p=0.01), was associated with longer hospital LOS in the overall and CABG patient groups (Supplemental Table 6b).

Post-hoc analyses

We conducted a post-hoc power analysis to determine whether the lack of observed between group mortality difference was due to the small number of outcome events. Using logistic regression with a sample size of 79,862 patients (24.9% treated by sex discordant surgeon-anesthesiologist pairs) and an observed OR of 0.93, we were able to achieve 19% power at a 0.05 significance level. At the request of the reviewers, we repeated our analysis for the composite endpoint of death and MACE. The findings of this post hoc analysis also did not reach statistical significance (adjusted OR, 0.96 [0.88-1.05], p=0.37; Supplemental Table 7).

Discussion

Key Findings

The novelty of the present study lies in its consideration of the impact of surgeon-anaesthesiologist dyad on patient outcomes after cardiac surgery. Our key findings are as follows: 1) Physician sex discordance was not associated with overall patient mortality or LOS; 2) Patients who underwent isolated CABG experienced longer hospital LOS when treated by an all-male physician team as compared to an all-female team; 3) When examining the impact of individual physician sex, the length of hospital stay was clinically and statistically significantly longer when procedures were attended by a male surgeon.

Interpretation

We found that physician sex discordance was not associated with overall patient mortality or LOS. This stands contrary to our hypothesis as well as reports from other studies suggesting a greater opportunity for tension within sex discordant teams. For example, studies based on non-cardiac OR teams suggest female providers may more often be challenged and perceived negatively by others, and are less likely to speak up when an incorrect decision is made.[6 30 31] Teamwork behaviors such as cooperation, communication, and leadership, have also been observed to vary depending on the number of male and female providers in the room.[6 31 32] Our findings suggest that sex diversity in the COR may actually increase cooperation.[32] In fact, the COR teamwork culture may be changing in recent years, such that sex discordant surgeon-anaesthesiologist pairs are working more effectively together in achieving the observed lower rates of mortality. Further research is needed to qualitatively determine the relevance of this finding to teamwork quality and physician performance.

While previous studies have investigated the role of physician sex individually for surgeons,[12] and primary care practitioners,[33] we extended this analysis to include the dynamic relationship of the cardiac surgeon and anaesthesiologist team. A recent study of 25 cardiac and non-cardiac procedure types performed in Ontario, found that patients treated by female surgeons compared to male surgeons had a lower 30-day mortality (adjusted odds ratio 0.88; 95% CI: 0.79-0.99, P=0.04).[12] These authors postulated, however, that better outcomes in the hands of female surgeons may have been confounded by a higher volume of non-emergent, non-complex procedures being performed by this group. Our subgroup analysis in patients who underwent CABG, a routine procedure, was aimed to overcome this case allocation bias. We observed clinically and statistically significant longer lengths of hospital stay in those treated by all-male surgeon-anaesthesiologist teams as compared to all-female teams, as well as individually by male surgeons. Though researchers have postulated a variety of reasons for better patient outcomes among female surgeons[12 13] and primary care physicians,[33] less work has been done to examine how sex and gender may influence anaesthesia practice or team-based work in the COR. Our findings may in part be explained by greater adherence to practice guidelines by female surgeons and anaesthesiologists, as well as their propensity for more effective interprofessional teamwork, and more active engagement in patient-centered care.[34 35]

The performance of female physicians has also been framed in terms of the challenges they must often overcome to practice effectively in the surgical specialties. For example, Wallis and colleagues suggested that it is possible that "these barriers might create a higher standard for women to gain entrance into the surgical workforce than men, resulting in the selection of a cohort of women that are proportionately more skilled, motivated, and harder working".[12] This may be particularly true of cardiac surgery given it is amongst the most demanding specialties and is traditionally viewed as a male dominated field. Still, studies regarding medical emergencies outside of the COR setting have found that male healthcare professionals outperform their female colleagues, albeit at least in part because women's leadership is more likely to be challenged.[6 31] Consequently, more research is needed to determine when and how to best support male and female physicians to promote effective practice and equity in the COR. As more women continue to pursue cardiac surgery and anesthesiology, it will be important for research to deep-dive into their performance and experiences; this includes the impact of diversity on COR teamwork.

Limitations

Firstly, an important limitation of our study is that we were only able to examine the impact of sex as gender variables were not available in the databases used. In the future, organizations may wish to consider incorporating measures of gender as routinely collected elements. *Secondly*, our findings are quantitative, and are limited by the inherent biases of observational studies. Prospective, qualitative research is warranted to further explore the role of physician sex and gender in the COR along with other potentially important factors such as ethnicity, language, geographic location, country of medical education, and so forth.[36 37] *Thirdly*, an a priori power analysis was not performed. *Fourthly,* our analyses were limited to physician characteristics as the characteristics of other COR providers were not available to us. Future research should consider the interaction of the surgeon and anaesthesiologist pair along with nurses, perfusionists, anaesthesia and surgical assistances, and trainees.

Conclusions

Patient mortality and length of stay after cardiac surgery may vary by sex concordance of the attending surgeon-anaesthesiologist team. Further research is needed to examine the underlying mechanisms of these observed relationships.

Funding Statement

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Declaration Of Interests

The authors report no conflicts of interest.

Authors' Contribution

The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

LYS, SB, VC, DSL, TGM, ABE, NE: Contributed substantially to conception and design, or analysis and interpretation of data, drafted the article, revised article critically for important intellectual content, gave final approval of the version to be published, agreed to act as guarantor of the work (ensuring that questions related to any part of the work are appropriately investigated and resolved).

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Data Sharing Statement

The dataset from this study is held securely in coded form at ICES. While legal data sharing agreements between ICES and data providers (e.g., healthcare organizations and government) prohibit ICES from making the dataset publicly available, access may be granted to those who meet pre-specified criteria for confidential access, available at www.ices.on.ca/DAS (email: das@ices.on.ca). The full dataset creation plan and underlying analytic code are available from the authors upon request, understanding that the computer programs may rely upon coding templates or macros that are unique to ICES and are therefore either inaccessible or may require modification.

Ethical approval statement

The use of data in this project was authorized under section 45 of Ontario's Personal Health Information

Protection Act, which does not require review by a Research Ethics Board.

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TABLES

Table 1. Patient characteristics by surgeon-anaesthesiologist sex discordance in all cardiac surgery patients.

Variable	Discordant (n=19,893)	Concordant (n=59,969)	Standardized Difference	P-value
Age, mean ± SD, yr	66.3 ± 10.4	66.4 ± 10.4	0	0.76
Female Sex, n (%)	4,678 (23.5)	14,010 (23.4)	0	0.66
Income Quintile, n (%)				
1	3,762 (18.9)	11,771 (19.6)	0.02	0.01
2	3,966 (19.9)	12,374 (20.6)	0.02	
3	4,162 (20.9)	12,226 (20.4)	0.01	
4	4,052 (20.4)	11,970 (20.0)	0.01	
5	3,951 (19.9)	11,628 (19.4)	0.01	
Rural Residence, n (%)	17,212 (86.5)	50,595 (84.4)	0.06	<0.001
Hospital type, n (%)				
Community	6,236 (31.3)	18,104 (30.2)	0.03	0.002
Teaching	13,657 (68.7)	41,865 (69.8)	0.03	
Hypertension, n (%)	17,203 (86.5)	51,845 (86.5)	0	0.93
Atrial fibrillation, n (%)	1,256 (6.3)	3,830 (6.4)	0	0.72
Recent MI within 30 days, n (%)	5,002 (25.1)	15,047 (25.1)	0	0.88
Remote MI, n (%)	4,129 (20.8)	13,003 (21.7)	0.02	0.006
Previous PCI, n (%)	3,048 (15.3)	9,161 (15.3)	0	0.88
Left ventrcular ejection fraction, n (%)				
≥ 50	13,768 (69.2)	41,267 (68.8)	0.01	0.37
35-49	4,257 (21.4)	12,841 (21.4)	0	
20-35	1,591 (8.0)	4,949 (8.3)	0.01	
< 20	277 (1.4)	912 (1.5)	0.01	
Heart failure, n (%)	4,703 (23.6)	14,697 (24.5)	0.02	0.01
Perpheral arterial disease, n (%)	2,334 (11.7)	7,040 (11.7)	0	0.98
Cerebrovascular disease n (%)	1,952 (9.8)	5,887 (9.8)	0	0.99
Dementia, n (%)	31 (0.2)	132 (0.2)	0.01	0.08
Depression, n (%)	300 (1.5)	814 (1.4)	0.01	0.12
Psychosis, n (%)	31 (0.2)	132 (0.2)	0.01	0.08
Smoking status, n (%)				
Never	8,759 (44.0)	26,942 (44.9)	0.02	0.001
Current	3,852 (19.4)	11,922 (19.9)	0.01	
Former	7,282 (36.6)	21,105 (35.2)	0.03	
Chronic obstructive pulmonary disease, n (%)	5,705 (28.7)	17,303 (28.9)	0	0.64
Pulmonary circulation disorder, n (%)	387 (1.9)	1,195 (2.0)	0	0.68
Serum creatinine (µmol/L), n (%)				
<120	17,529 (88.1)	52,151 (87.0)	0.03	<0.001
120-179	1,736 (8.7)	5,670 (9.5)	0.03	
>=180	628 (3.2)	2,148 (3.6)	0.02	
Dialysis, n (%)	384 (1.9)	1,298 (2.2)	0.02	0.05
Diabetes, n (%)	8,994 (45.2)	27,182 (45.3)	0	0.78
Hypothyroidism, n (%)	406 (2.0)	1,004 (1.7)	0.03	<0.001
Morbid obesity, n (%)	9,471 (47.6)	25,824 (43.1)	0.09	<0.001
Primary cancer, n (%)	980 (4.9)	2,928 (4.9)	0	0.80
Metastatic cancer, n (%)	96 (0.5)	285 (0.5)	0	0.90
Anemia, n (%)	2,079 (10.5)	6,027 (10.1)	0.01	0.11
Venous thromboembolism, n (%)	82 (0.4)	214 (0.4)	0.01	0.27
Liver disease, n (%)	179 (0.9)	510 (0.9)	0.01	0.51
Alcohol abuse, n (%)	303 (1.5)	835 (1.4)	0.01	0.18

Frailty, n (%)	2,902 (14.6)	9,683 (16.1)	0.04	<0.001
Surgery type, n (%)				
CABG	15,672 (78.8)	46,842 (78.1)	0.02	0.05
Single valve	2,244 (11.3)	6,708 (11.2)	0	
Multiple valves	283 (1.4)	923 (1.5)	0.01	
CABG + single valve	1,583 (8.0)	5,122 (8.5)	0.02	
CABG + multiple valves	111 (0.6)	374 (0.6)	0.01	
Redo sternotomy, n (%)	460 (2.3)	1,695 (2.8)	0.03	<0.001
Emergent surgery, n (%)	1,197 (6.0)	3,674 (6.1)	0	0.58
Surgery duration, median (IQR), min	273 (232-320)	260 (220-307)	0.2	<0.001

Abbreviations: SD = standard deviation; MI = myocardial infarction; PCI = percutaneous coronary intervention; CABG = coronary artery bypass grafting; IQR = interquartile range

Table 2. Physician characteristics by patient sex.

Variable	Female patients (n=18,688)	Male patients (n=61,174)	Standardized Difference	P-value
Surgeon age, mean ± SD, yr	50.2 ± 8.8	49.9 ± 8.8	0.03	<0.001
Surgeon experience, yr, n (%)				
<10	1,186 (6.3)	4,153 (6.8)	0.02	<0.001
11-20	4,791 (25.6)	16,336 (26.7)	0.02	
21-30	7,144 (38.2)	23,313 (38.1)	0	
>30	5,567 (29.8)	17,372 (28.4)	0.03	
Surgeon volume, median (IQR).	2,942 (1,209-4,366)	2,842 (1,126-4,322)	0.04	<0.001
Anaesthesiologist age, mean ± SD, yr	48.3 ± 9.0	48.3 ± 9.0	0	0.84
Anaesthesiologist experience, yr, n (%)				
0-10	1,626 (8.7)	5,563 (9.1)	0.01	0.04
11-20	6,737 (36.0)	21,877 (35.8)	0.01	
21-30	6,005 (32.1)	19,171 (31.3)	0.02	
>30	4,320 (23.1)	14,563 (23.8)	0.02	
Anaesthesiologist volume, median (IQR)	764 (368-1,311)	758 (366-1,318)	0.01	0.54

Abbreviations: SD = standard deviation; PCI = percutaneous coronary intervention; IQR = interquartile range
Total case volumes reflect the number of cases performed since 1991 until the date of the index procedure.

Table 3. Thirty-day patient outcomes by physician sex discordance.

Variable	Discordant (n=19,893)	Concordant (n=59,969)	Standardized Difference	P-value
Mortality, n (%)	335 (1.7)	1,052 (1.8)	0.01	0.51
MACE, n (%)	678 (3.4)	2,247 (3.7)	0.02	0.03
Hospital length of stay, median (IQR), days	7 (6-9)	7 (6-9)	0.03	<0.001
ICU length of stay, median (IQR), days	2 (2-4)	2 (2-4)	0.06	<0.001

Abbreviations: MACE = major adverse cardiovascular events; ICU = intensive care unit, IQR = interquartile range

Table 4. Predictors of all-cause patient mortality at 30 days, by surgeon-anaesthesiologist sex discordance.

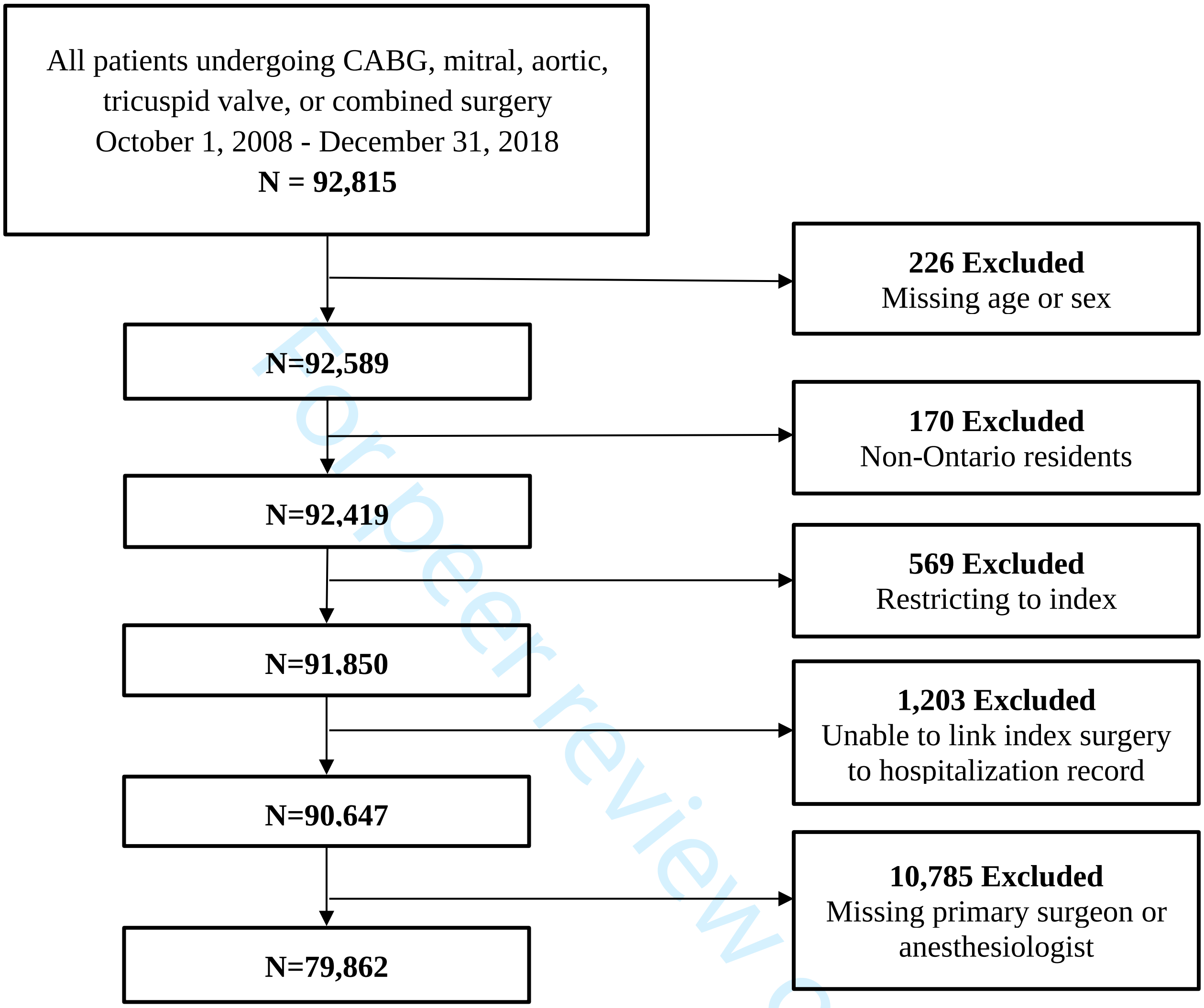
Variable	Adjusted OR (95% CI)	P-value
Physician characteristics		
Physician sex discordance	0.93 (0.80-1.07)	0.30
Surgeon experience, yr		
<10	Reference	Reference
11-20	1.24 (0.93-1.66)	0.14
21-30	1.07 (0.76-1.51)	0.71
>30	1.26 (0.83-1.91)	0.28
Surgeon volume, per 100 cases	1.00 (0.99-1.01)	0.55
Anaesthesiologist volume, per 100 cases	1.00 (0.99-1.02)	0.79
Anaesthesiologist experience, yr		
<10	Reference	Reference
11-20	1.15 (0.92-1.45)	0.22
21-30	1.01 (0.78-1.31)	0.93
>30	1.03 (0.78-1.37)	0.82
Patient characteristics		
Patient age, per 10 yr	1.69 (1.57-1.80)	<0.001
Female patient sex	1.56 (1.37-1.77)	<0.001
Income quintile		
1	1.44 (1.20-1.73)	<0.001
2	1.24 (1.03-1.48)	0.03
3	1.19 (0.99-1.44)	0.07
4	1.09 (0.90-1.33)	0.36
5	Reference	Reference
Rural residence	0.95 (0.81-1.12)	0.57
Community hospital	1.24 (0.81-1.91)	0.33
Hypertension	1.01 (0.81-1.25)	0.95
Atrial fibrillation	1.14 (0.97-1.35)	0.11
Recent MI within 30 days	1.39 (1.20-1.61)	<0.001
Remote MI	1.24 (1.07-1.44)	0.006
Previous PCI	1.03 (0.88-1.21)	0.70
Left ventricular ejection fraction		
≥ 50	Reference	Reference
35-49	1.23 (1.07-1.42)	0.004
20-35	1.72 (1.46-2.04)	<0.001
< 20	2.52 (1.91-3.32)	<0.001
Heart failure	1.90 (1.67-2.17)	<0.001
Peripheral arterial disease	1.45 (1.26-1.67)	<0.001
Cerebrovascular disease	1.37 (1.19-1.59)	<0.001
Dementia	2.46 (1.37-4.41)	0.003
Depression	0.97 (0.66-1.42)	0.86

Psychosis	1.42 (0.56-3.60)	0.46
Smoking status		
Never	Reference	Reference
Current	1.01 (0.84-1.20)	0.96
Former	1.01 (0.89-1.15)	0.87
Chronic obstructive pulmonary disease	1.33 (1.18-1.49)	<0.001
Pulmonary circulatory disorder	1.68 (1.33-2.13)	<0.001
Serum creatinine (µmol/L)		
<120	Reference	Reference
120-179	1.67 (1.44-1.94)	<0.001
>=180	2.78 (2.23-3.45)	<0.001
Dialysis	1.14 (0.86-1.50)	0.37
Diabetes	0.96 (0.85-1.08)	0.49
Hypothyroidism	0.75 (0.52-1.08)	0.12
Morbid obesity	0.97 (0.86-1.09)	0.61
Primary cancer	0.97 (0.77-1.22)	0.81
Metastatic cancer	1.16 (0.59-2.31)	0.66
Anemia	1.25 (1.08-1.45)	0.002
Venous thromboembolism	1.39 (0.80-2.44)	0.25
Liver disease	1.45 (0.94-2.25)	0.09
Alcohol abuse	1.21 (0.80-1.81)	0.37
Frailty	0.82 (0.71-0.95)	0.01
Redo sternotomy	1.10 (0.87-1.40)	0.44
Emergent surgery	2.91 (2.49-3.39)	<0.001
Complex surgery	1.32 (1.14-1.53)	0.0002
Surgery duration, per 10 min	1.07 (1.07-1.08)	<0.001

Abbreviations: MI = myocardial infarction; PCI = percutaneous coronary intervention

Total case volumes reflect the number of cases performed since 1991 until the date of the index procedure.

Supplemental Figure 1. Cohort flow diagram



Abbreviation: CABG = coronary artery bypass surgery

Supplemental Table 1. Thirty-day outcomes in patients who underwent CABG, by physician sex discordance.

Variable	Discordant (n=19,893)	Concordant (n=59,969)	Standardized Difference	P-value
Mortality, n (%)	205 (1.3)	654 (1.4)	0.01	0.41
MACE, n (%)	524 (3.3)	1,692 (3.6)	0.01	0.12
Hospital length of stay, median (IQR), days	7 (6-9)	7 (6-9)	0.03	0.007
ICU length of stay, median (IQR), days	2 (2-3)	2 (2-3)	0.07	<0.001

Abbreviations: MACE = major adverse cardiovascular events; ICU = intensive care unit, IQR = interquartile range

Supplemental Table 2. Adjusted associations between surgeon-anaesthesiologist sex discordance and CABG outcomes at 30 days.

Outcome	Adjusted measure (95% CI)	P-value
Mortality	OR: 0.88 (0.74-1.05)	0.16
MACE	OR: 0.99 (0.98-1.11)	0.40
Hospital length of stay	RR: 1.00 (0.99-1.02)	0.70
ICU length of stay	RR: 0.99 (0.98-1.00)	0.09

Abbreviations: MACE = major adverse cardiovascular events; ICU = intensive care unit; OR = odds ratio; RR = risk ratio; CI = confidence interval

Supplemental Table 3. Predictors of major adverse cardiovascular events at 30 days in the overall cohort, by surgeon-anaesthesiologist sex discordance.

Variable	Adjusted OR (95% CI)	P-value
Physician characteristics		
Physician sex discordance	0.96 (0.87-1.06)	0.40
Surgeon experience, yr		
<10	Reference	Reference
11-20	0.91 (0.76-1.10)	0.33
21-30	0.97 (0.77-1.22)	0.79
>30	1.04 (0.78-1.37)	0.80
Surgeon volume, per 100 cases	1.00 (1.00-1.01)	0.71
Anaesthesiologist volume, per 100 cases	1.00 (0.99-1.01)	0.74
Anaesthesiologist experience, yr		
<10	Reference	Reference
11-20	1.12 (0.97-1.31)	0.13
21-30	1.13 (0.95-1.33)	0.17
>30	1.06 (0.87-1.28)	0.57
Patient characteristics		
Patient age, per 10 yr	1.30 (1.25-1.36)	<0.001
Female patient sex	1.45 (1.33-1.58)	<0.001
Income quintile		
1	1.07 (0.95-1.21)	0.27
2	1.15 (1.02-1.30)	0.02
3	1.04 (0.92-1.17)	0.58
4	1.01 (0.89-1.14)	0.89
5	Reference	Reference
Rural residence	0,99 (0.89-1.10)	0.83
Community hospital	0.79 (0.61-1.02)	0.08
Hypertension	1.12(0.97-1.28)	0.12
Atrial fibrillation	1.18 (1.04-1.34)	0.00
Recent MI within 30 days	1.98 (1.80-2.18)	<0.001
Remote MI	1.47 (1.32-1.63)	<0.001
Previous PCI	0.93 (0.83-1.03)	0.16
Left ventricular ejection fraction		
≥ 50	Reference	Reference
35-49	1.08 (0.98-1.19)	0.11
20-35	1.18 (1.04-1.34)	0.01
< 20	1.10 (0.84-1.44)	0.49
Heart failure	1.42 (1.30-1.55)	<0.001
Peripheral arterial disease	1.32 (1.20-1.47)	<0.001

Cerebrovascular disease	1.36 (1.22-1.51)	<0.001
Dementia	1.05 (0.59-1.89)	0.86
Depression	1.20 (0.93-1.55)	0.16
Psychosis	0.87 (0.40-1.88)	0.72
Smoking status		
Never	Reference	Reference
Current	1.05 (0.93-1.17)	0.43
Former	1.02 (0.93-1.11)	0.73
Chronic obstructive pulmonary disease	1.04 (0.95-1.12)	0.41
Pulmonary circulatory disorder	1.22 (0.99-1.51)	0.06
Serum creatinine (μmol/L)		
<120	Reference	Reference
120-179	1.16 (1.03-1.30)	0.01
>=180	1.23 (1.01-1.49)	0.04
Dialysis	1.21 (0.95-1.55)	0.12
Diabetes	1.02 (0.94-1.10)	0.65
Hypothyroidism	0.95 (0.75-1.21)	0.67
Morbid obesity	1.12 (1.03-1.22)	0.01
Primary cancer	0.93 (0.79-1.10)	0.40
Metastatic cancer	1.02 (0.94-1.10)	0.95
Anemia	1.23 (1.10-1.37)	0.0002
Venous thromboembolism	0.64 (0.35-1.17)	0.15
Liver disease	1.00 (0.69-1.44)	0.10
Alcohol abuse	1.28 (0.97-1.68)	0.08
Frailty	1.07 (0.97-1.18)	0.17
Redo sternotomy	1.44 (1.19-1.73)	0.0001
Emergent surgery	1.68 (1.48-1.90)	<0.001
Complex surgery	1.17 (1.04-1.32)	0.01
Surgery duration, per 10 min	1.02 (1.01-1.02)	<0.001

Abbreviations: MI = myocardial infarction; PCI = percutaneous coronary intervention
Total case volumes reflect the number of cases performed since 1991 until the date of the index procedure.

Supplemental Table 4a. Predictors of intensive care unit length of stay in the overall cohort, by surgeon-anaesthesiologist sex discordance.

Variable	Rate Ratio (95% CI)	P-value
Physician characteristics		
Physician sex discordance	0.99 (0.98-1.01)	0.52
Surgeon experience, yr		
<10	Reference	Reference
11-20	0.99 (0.97-1.02)	0.65
21-30	1.02 (0.99-1.06)	0.14
>30	1.02 (0.98-1.06)	0.24
Surgeon volume, per 100 cases	1.00 (1.00-1.00)	0.33
Anaesthesiologist experience, yr		
0-10	Reference	Reference
11-20	0.98 (0.96-1.00)	0.04
21-30	0.99 (0.97-1.02)	0.51
>30	1.00 (0.97-1.03)	0.89
Anaesthesiologist volume, per 100 cases	1.00 (1.00-1.00)	0.71
Surgery duration	1.02 (1.02-1.02)	<0.001
Patient characteristics		
Patient age, yr	1.09 (1.08-1.09)	<0.001
Female patient sex	1.07 (1.06-1.08)	<0.001
Income quintile		
1	1.05 (1.04-1.07)	<0.001
2	1.03 (1.02-1.04)	<0.001
3	1.03 (1.02-1.04)	<0.001
4	1.01 (1.00-1.02)	0.17
5	Reference	Reference
Rural residence	0.98 (0.97-0.99)	0.00
Community hospital	0.98 (0.86-1.13)	0.82
Hypertension	0.96 (0.95-0.97)	<0.001
Atrial fibrillation	1.06 (1.04-1.07)	<0.001
Recent MI within 30 days	1.02 (1.01-1.03)	0.00
Remote MI	1.00 (0.99-1.01)	0.69

Previous PCI	1.00 (0.99-1.01)	0.70
Left ventricular ejection fraction		
≥ 50%	Reference	Reference
35-49%	1.03 (1.02-1.04)	<0.001
20-35%	1.11 (1.10-1.13)	<0.001
< 20%	1.21 (1.18-1.24)	<0.001
Heart failure	1.21 (1.20-1.22)	<0.001
Peripheral arterial disease	1.05 (1.04-1.06)	<0.001
Cerebrovascular disease	1.04 (1.03-1.05)	<0.001
Dementia	1.02 (0.95-1.09)	0.54
Depression	1.18 (1.15-1.22)	<0.001
Psychosis	1.03 (0.96-1.11)	0.39
Smoking status		
Never	Reference	Reference
Current	1.02 (1.01-1.03)	<0.001
Former	1.00 (0.99-1.01)	1.00
Chronic obstructive pulmonary disease	1.05 (1.04-1.06)	<0.001
Pulmonary circulatory disorder	1.23 (1.21-1.26)	<0.001
Serum creatinine (μmol/L)		
<120	Reference	Reference
120-179	1.16 (1.15-1.18)	<0.001
>=180	1.33 (1.31-1.36)	<0.001
Dialysis	1.06 (1.04-1.09)	<0.001
Diabetes	1.03 (1.02-1.03)	<0.001
Hypothyroidism	1.01 (0.98-1.03)	0.60
Morbid obesity	0.99 (0.98-1.00)	0.02
Primary cancer	1.00 (0.99-1.02)	0.72
Metastatic cancer	0.99 (0.94-1.04)	0.62
Anemia	1.15 (1.14-1.16)	<0.001
Venous thromboembolism	0.94 (0.89-0.99)	0.02
Liver disease	1.09 (1.05-1.12)	<0.001
Alcohol abuse	1.10 (1.07-1.14)	<0.001
Frailty	1.09 (1.08-1.10)	<0.001
Complex surgery	1.15 (1.14-1.17)	<0.001

Redo sternotomy	0.97 (0.95-0.99)	0.00
Emergent surgery	1.46 (1.44-1.48)	<0.001

Abbreviations: MI = myocardial infarction; PCI = percutaneous coronary intervention
Total case volumes reflect the number of cases performed since 1991 until the date of the index procedure.

Supplemental Table 4b. Predictors of hospital length of stay in the overall cohort, by surgeon-anaesthesiologist sex discordance.

Variable	Rate Ratio (95% CI)	P-value
Physician characteristics		
Physician sex discordance	0.99 (0.98-1.00)	0.03
Surgeon experience, yr		
<10	Reference	Reference
11-20	0.99 (0.98-1.01)	0.35
21-30	1.01 (0.99-1.03)	0.41
>30	1.01 (0.98-1.03)	0.65
Surgeon volume, per 100 cases	1.00 (1.00-1.00)	<.0001
Anaesthesiologist experience, yr		
0-10	Reference	Reference
11-20	0.99 (0.98-1.00)	0.03
21-30	0.98 (0.97-1.00)	0.03
>30	0.97 (0.96-0.99)	0.00
Anaesthesiologist volume, per 100 cases	1.00 (1.00-1.00)	0.01
Surgery duration	1.01 (1.01-1.01)	<.0001
Patient characteristics		
Patient age, yr	1.11 (1.10-1.11)	<.0001
Female patient sex	1.11 (1.10-1.12)	<.0001
Income quintile		
1	1.07 (1.06-1.08)	<.0001
2	1.04 (1.03-1.04)	<.0001
3	1.03 (1.02-1.03)	<.0001
4	1.01 (1.01-1.02)	0.0002
5	Reference	Reference
Rural residence	1.00 (0.99-1.00)	0.15
Community hospital	1.02 (0.92-1.12)	0.71
Hypertension	0.98 (0.97-0.99)	<.0001
Atrial fibrillation	1.06 (1.05-1.07)	<.0001
Recent MI within 30 days	1.02 (1.02-1.03)	<.0001
Remote MI	1.00 (0.99-1.01)	0.80
Previous PCI	0.97 (0.97-0.98)	<.0001
Left ventricular ejection fraction		
≥ 50%	Reference	Reference
35-49%	1.02 (1.01-1.03)	<.0001
20-35%	1.06 (1.05-1.06)	<.0001
< 20%	1.10 (1.08-1.12)	<.0001
Heart failure	1.17 (1.16-1.18)	<.0001
Peripheral arterial disease	1.04 (1.04-1.05)	<.0001
Cerebrovascular disease	1.06 (1.05-1.07)	<.0001
Dementia	1.03 (0.99-1.08)	0.10

Depression	1.19 (1.17-1.21)	<.0001
Psychosis	1.22 (1.17-1.27)	<.0001
Smoking status		
Never	Reference	Reference
Current	1.00 (0.99-1.00)	0.20
Former	1.00 (0.99-1.00)	0.63
Chronic obstructive pulmonary disease	1.06 (1.05-1.06)	<.0001
Pulmonary circulatory disorder	1.14 (1.13-1.16)	<.0001
Serum creatinine (µmol/L)		
<120	Reference	Reference
120-179	1.10 (1.09-1.11)	<.0001
>=180	1.25 (1.23-1.27)	<.0001
Dialysis	1.11 (1.09-1.13)	<.0001
Diabetes	1.03 (1.03-1.04)	<.0001
Hypothyroidism	1.01 (1.00-1.03)	0.13
Morbid obesity	1.00 (0.99-1.00)	0.29
Primary cancer	1.02 (1.01-1.03)	0.0003
Metastatic cancer	1.00 (0.97-1.04)	0.83
Anemia	1.14 (1.13-1.15)	<.0001
Venous thromboembolism	1.01 (0.98-1.04)	0.60
Liver disease	1.06 (1.04-1.09)	<.0001
Alcohol abuse	1.07 (1.05-1.09)	<.0001
Frailty	1.15 (1.14-1.16)	<.0001
Complex surgery	1.13 (1.12-1.13)	<.0001
Redo sternotomy	0.95 (0.94-0.96)	<.0001
Emergent surgery	1.22 (1.21-1.24)	<.0001

Abbreviations: MI = myocardial infarction; PCI = percutaneous coronary intervention
Total case volumes reflect the number of cases performed since 1991 until the date of the index procedure.

Supplemental Table 5a. Sensitivity analysis of the association between physician sex and 30-day mortality and MACE in the overall cohort.

Physician Team	Mortality Adjusted OR (95% CI)	Mortality P-value	MACE Adjusted OR (95% CI)	MACE P-value
Model with physician sex as a 4-level categorical variable:				
Female surgeon + female anaesthesiologist	Reference	Reference	Reference	Reference
Male surgeon + male anaesthesiologist	1.35 (0.77-2.37)	0.30	1.03 (0.72-1.47)	0.87
Female surgeon + male anaesthesiologist	1.20 (0.69-2.10)	0.52	0.86 (0.61-1.22)	0.41
Male surgeon + female anaesthesiologist	1.24 (0.69-2.20)	0.47	1.02 (0.71-1.46)	0.93
Model with surgeon sex only:				
Male surgeon	1.15 (0.84-1.57)	0.38	1.16 (0.93-1.44)	0.19
Model with anaesthesiologist sex only:				
Male anaesthesiologist	1.10 (0.94-1.28)	0.23	1.00 (0.90-1.11)	0.97

Abbreviations: MACE = major adverse cardiovascular events

Supplemental Table 5b. Sensitivity analysis of the association between physician sex and 30-day mortality and MACE in the CABG cohort.

Physician Team	Mortality Adjusted OR (95% CI)	Mortality P-value	MACE Adjusted OR (95% CI)	MACE P-value
Model with physician sex as a 4-level categorical variable:				
Female surgeon + female anaesthesiologist	Reference	Reference	Reference	Reference
Male surgeon + male anaesthesiologist	1.31 (0.69-2.50)	0.41	0.92 (0.63-1.34)	0.66
Female surgeon + male anaesthesiologist	0.98 (0.50-1.91)	0.94	0.77 (0.52-1.13)	0.18
Male surgeon + female anaesthesiologist	1.20 (0.62-2.32)	0.59	0.96 (0.65-1.42)	0.84
Model with surgeon sex only:				
Male surgeon	1.31 (0.94-1.18)	0.12	1.14 (0.91-1.44)	0.26
Model with anaesthesiologist sex only:				
Male anaesthesiologist	1.09 (0.90-1.31)	0.39	0.94 (0.83-1.06)	0.30

Abbreviations: MACE = major adverse cardiovascular events; CABG = coronary artery bypass grafting

Supplemental Table 6a. Sensitivity analysis of the association between physician sex and lengths of stay in the CABG cohort.

Physician Team	ICU Length of Stay		Hospital Length of Stay	
	Rate Ratio (95% CI)	**P-value**	**Rate Ratio (95% CI)**	**P-value**
Model with physician sex as a 4-level categorical variable:				
Female surgeon + female anaesthesiologist	Reference	Reference	Reference	Reference
Male surgeon + male anaesthesiologist	1.05 (0.97-1.13)	0.21	1.07 (1.00-1.15)	0.049
Female surgeon + male anaesthesiologist	1.03 (0.98-1.08)	0.21	1.00 (0.97-1.03)	0.90
Male surgeon + female anaesthesiologist	1.05 (0.97-1.13)	0.25	1.06 (0.99-1.14)	0.09
Model with surgeon sex only:				
Male surgeon	1.02 (0.96-1.09)	0.48	1.10 (1.03-1.18)	0.004
Model with anaesthesiologist sex only:				
Male anaesthesiologist	1.01 (0.98-1.03)	0.55	1.02 (1.00-1.04)	0.01

Abbreviations: ICU = intensive care unit; CABG = coronary artery bypass grafting

Supplemental Table 6b. Sensitivity analysis of the association between physician sex and lengths of stay in the overall cohort.

Physician Team	ICU Length of Stay		Hospital Length of Stay	
	Rate Ratio (95% CI)	P-value	Rate Ratio (95% CI)	P-value
Model with physician sex as a 4-level categorical variable:				
Female surgeon + female anaesthesiologist	Reference	Reference	Reference	Reference
Male surgeon + male anaesthesiologist	1.07 (1.00-1.15)	0.06	1.07 (1.00-1.15)	0.06
Female surgeon + male anaesthesiologist	0.99 (0.97-1.02)	0.52	0.99 (0.97-1.02)	0.52
Male surgeon + female anaesthesiologist	1.06 (0.99-1.34)	0.12	1.06 (0.99-1.14)	0.12
Model with surgeon sex only:				
Male surgeon	1.02 (0.96-1.09)	0.54	1.10 (1.03-1.17)	0.006
Model with anaesthesiologist sex only:				
Male anaesthesiologist	1.16 (0.99-1.04)	0.19	1.02 (1.00-1.03)	0.03

Abbreviations: ICU = intensive care unit

Supplemental Table 7. Post-hoc power analysis

Power	N	Pcnt N X=1	P0	P1	Odds Ratio	R Squared	Alpha	Beta
0.19	79862	24.9	0.02	0.02	0.93	0.04	0.05	0.81

N is the size of the sample drawn from the population.
P0 is the response probability at the mean of X.
P1 is the response probability when X is increased to one standard deviation above the mean.
Alpha is the probability of rejecting a true null hypothesis.
Beta is the probability of accepting a false null hypothesis.

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1-2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5-6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up (*b*) For matched studies, give matching criteria and number of exposed and unexposed	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-7
Bias	9	Describe any efforts to address potential sources of bias	7-8
Study size	10	Explain how the study size was arrived at	9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6-8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding (*b*) Describe any methods used to examine subgroups and interactions (*c*) Explain how missing data were addressed (*d*) If applicable, explain how loss to follow-up was addressed (*e*) Describe any sensitivity analyses	7-9
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram	9
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest (c) Summarise follow-up time (eg, average and total amount)	9
Outcome data	15*	Report numbers of outcome events or summary measures over time	9-11

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (*b*) Report category boundaries when continuous variables were categorized (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	9-11
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	11
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12-14
Generalisability	21	Discuss the generalisability (external validity) of the study results	14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.