Appendix 1: Derivation and Validation of Multicenter Predictive Indices for Cardiac Readmission after Major Cardiac Surgery

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SUPPLEMENTAL MATERIAL

Appendix 1, as supplied by the authors. Appendix to: Sun LY, Chu A, Tam DY, et al. Derivation and validation of predictive indices for 30-day mortality after coronary and valvular surgery in Ontario, Canada. *CMAJ* 2021. doi: 10.1503/cmaj.202901.

Supplemental Table 1. Candidate variables in survey

Demographics
Age
Sex
Race/ethnicity
Risk Factors
Body surface area (BSA)
Height/weight/body mass index (BMI)
Recent smoker/timing
Alcohol consumption
Illicit drug use
Family history of coronary artery disease
Endocarditis
Prior stroke
Prior transient ischemic attack (TIA)
Carotid stenosis
Cerebrovascular disease (stroke/TIA/≥50% stenosis of major extra- or intracranial vessels to the brain/previous cervical or cerebral artery revascularization)
Previous carotid surgery
Diabetes
Diabetes control method
Renal failure/dialysis/ ype of control
Hypertension
Peripheral arterial/vascular disease (PAD/PVD)
Home oxygen
Cancer diagnosis within 5 years
Chronic lung disease
Recent pneumonia
Liver disease
Sleep apnea
Unresponsive neurologic status within 24 hours
Syncope
Immunosuppressive therapy/timing
Organ transplant history
Neurological/musculoskeletal dysfunction severely affecting mobility
Lab Measures
Creatinine
Hematocrit
White blood cells
Platelets
Total albumin
Bilirubin
Previous Cardiac Interventions

Previous coronary artery bypass
Previous percutaneous coronary intervention/timing
Previous aortic valve procedure
Previous mitral valve procedure
Previous transcatheter valve replacement/percutaneous valve repair
Previous other valve procedure
Other open cardiac/thoracic aorta operation
Number of previous cardiovascular surgeries
Previous implantable cardioverter defibrillator
Previous any other cardiac intervention
Preop Cardiac Status/Interventions
Status (e.g., elective, urgent, emergent, salvage)
Critical preoperative state/hemodynamic state
Cardiac presentation on admission (no symptoms, stable angina, unstable angina, NSTEMI, STEMI)
Angina class (Canadian Cardiovascular Society grading)
Immediate operation after catheter procedure
Arrhythmia (atrial fibrillation or flutter, 2nd or 3rd degree heart block, sick sinus syndrome, ventricular tachycardia/fibrillation, remote arrhythmias)
Myocardial infarction history/timing
Mediastinal radiation
Preoperative intra-aortic balloon pump (IABP)
Heart failure (NYHA class and timing)
Cardiogenic shock/timing
Extracorporeal membrane oxygenation (ECMO)
Catheter-based assist device (CBA)
Resuscitation within 24 hours
Pulmonary artery systolic pressure
Cardiac Physiology/Valve Disease
Left ventricular ejection fraction (LVEF)
Number of diseased coronary vessels
Left main disease
Proximal LAD
Aortic root abscess (if AVR/AVR+CABG)
Aortic stenosis or aortic insufficiency
Aortic insufficiency
Mitral stenosis or insufficiency
Mitral insufficiency
Tricuspid insufficiency
Thoracic aorta disease
Preop Medications
ADP inhibitor usage/timing of discontinuation
Steroids within in 24 hours

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Glycoprotein IIb/IIIa inhibitor within 24 hours
Inotropes within 48 hours
ACEi/ARB within 24/48 hours (if urgent/emergent/salvage operation)
P2Y12 platelet inhibitors (e.g., Clopidogrel)
Warfarin/direct oral anti-coagulants

ACEi indicates angiotensin-converting enzyme inhibitor; ADP, adenosine diphosphate; ARB, angiotensin II receptor blocker; AVR, aortic valve replacement; CABG, coronary artery bypass graft; LAD, left anterior descending artery; NYHA, New York Heart Association; STEMI, ST-elevation myocardial infarction.

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Supplemental Table 2. Model candidate variables, data sources, coding/validation and formats*

Variable (reference for code/definition/validation is provided where available)	**Data source**	**Administrative codes/definition and validation (where available)**	**Format**
Age on surgery date	RPDB	NA	Continuous
Sex	RPDB	NA	Categorical: (i) Male, (ii) Female
Ethnicity[1]	Ontario Visible Minority Database	Specificity 99.7% for Chinese and South Asian. PPV 89.3% for South Asians and 91.9% for Chinese. Sensitivity 50.4% for South Asians and 80.2% for Chinese.	Categorical: (i) Chinese, (ii) South Asian, (iii) Other/unknown,
Prior stroke or transient ischemic attack[2]	CIHI DAD, NACRS	ICD-9: 430, 431, 434, 435, 436, 362.3 (Kappa = 0.86 (95% CI 0.81-0.91)) ICD-10-CA: I60, I61, I63 (excluding I63.6), I64, G45.0, G45.1, G45.2, G45.3, G45.8, G45.9, H34.0, H34.1 (Kappa = 0.89 (95% CI 0.82-0.96))	Binary
Carotid endarterectomy/stenting[3]	CIHI DAD, OHIP	CCP: 5012 CCI: 1JE57L (PPV = 99.0% (95% CI 94.6-100); sensitivity 89.6% (95% CI, 86.7-92.1)) or 1JE50 (PPV = 87.0% (95% CI 78.8-92.9); sensitivity 92.9% (95% CI, 87.4-96.1)) OHIP fee codes: N220 (PPV = 99.0% (95% CI 94.6-100)) or R792 (PPV = 100 (95% CI	Binary

		96.4-100)) (sensitivity for both 81.5% (95% CI, 77.9-84.7))	
Chronic lung disease	CorHealth Registry	History of obstructive or restrictive lung disease and on pharmacological therapy	Binary
History of dialysis	CorHealth Registry	History of dialysis in any form at time of referral	Binary
Liver disease[4]	DAD	ICD-9: 571, 456.0-456.2, 572.2-572.8, 070.2-070.9, 570, 573.3-573.9, V42.7 ICD-10-CA: B18, K70.0-K70.3, K70.9, K71.3-K71.5, K71.7, K73, K74, K76.0, K76.2-K76.4, K76.8, K76.9, Z94.4, I85.0, I85.9, I86.4, I98.2, K70.4, K71.1, K72.1, K72.9, K76.5, K76.6, K76.7 Mild: Kappa 0.53, sensitivity 66.7%, specificity 99.7%, PPV 44.4%, NPV 99.5%. Moderate/severe: Kappa 0.47, sensitivity 52.4%, specificity 98.8%, PPV 44%, NPV 99.2%.	Binary: none versus mild, moderate or severe
Endocarditis	CorHealth Registry	NA	In AVR and CABG+AVR models only. Categorical: (i) None, (ii) Previous, (iii) Current/active;
Home oxygen within 1 year	Assistive Devices Program	NA	Binary
Peripheral artery disease/ peripheral vascular disease[5-7]	CIHI DAD, CIHI SDS, OHIP	Any of: 1. Atherosclerosis/PVD of upper and lower extremity, renal, mesenteric and	Binary

		abdominal aortic systems (ICD-10-CA: I70.1, I70.2, I70.8, I70.9, I73.8, I73.9, I74.0, I74.3, I74.4, I74.5, I74.8, I74.9, I79.2) 2. Abdominal aortic aneurysm (ICD-10-CA I71.3, I71.4) 3. Limb/foot amputation for arterial vascular insufficiency (at least 1 ICD code and one CCP/CCI code on the same hospital record) (ICD-9: 440.2, 440.8, 440.9, 443.9, 444; ICD-10-CA: I70.2, I70.8, I70.9, I73.0, I73.8, I73.9, I74.3, I74.4, I71.3-I71.6, I71.8, I71.9; CCP: 9606, 9611, 9612, 9613, 9614, 9615; CCI: 1TK93LA, 1VC93LA, 1VG93LA, 1VQ93LA, 1WA93LA, 1WE93LA, 1WI93LA, 1WJ93LA, 1WK93LA, 1WL93LA, 1WM93LA, 1WN93LA) 4. Aorto-femoral or limb bypass surgery, or percutaneous transluminal angioplasty of peripheral arteries (including iliac and infrainguinal) (CCI: 1JM76, 1KE50, 1KE57, 1KE76, 1KE80, 1KG50, 1KG57, 1KG76, 1KG80, 1KG87, 1KT50, 1KT57, 1KT76, 1KV80, 1KY50, 1KY80)	

		5. Diabetic angiopathy (ICD-10-CA: E115.0, E115.1)	
Hypertension[8]	Ontario Hypertension Database	ICD-9: 401, 402, 403, 404, 405 ICD-10-CA: I10, I11, I12, I13, I15 OHIP diagnosis codes: 401, 402, 403, 404, 405 ≥1 hospitalization or ≥2 OHIP diagnosis codes in a two-year period. OR 1 OHIP followed by OHIP/hospitalization. Sensitivity 72%, specificity 95%, PPV 87%, NPV 88%.	Binary
Diabetes	CorHealth Registry	NA	Binary
Body mass index	CorHealth Registry	Calculated as weight/height^2	Categorical: (i) 18-25, (ii) 26-29, (iii) 30-50. Missing are imputed using procedure and sex specific cohort mean; values <18 are recoded as 18, and values >50 recoded as 50.
Cancer[9]	Ontario Cancer Registry	NA	Categorical: (i) Never/unknown, (ii) ≤1 to <3 years, (iii) ≥3 years
Smoking history	CorHealth Registry	NA	Categorical: (i) Never/unknown/missing, (ii) Current, (iii) Former
Coma on index admission	CIHI DAD	ICD-10-CA: R402.9, E100, E101.01, E101.11, E101.21, E110, E110.1, E111.01, E111.11, E111.21, E130, E130.1, E131.01, E131.21, E140, E140.1, E141.01, E141.21	Binary

Previous organ transplant[10]	Canadian Organ Replacement Registry	NA	Binary
Body surface area	CorHealth Registry	Calculated as sqrt((height*weight)/3600)	Continuous. Missing are imputed using procedure and sex specific cohort mean; values <1.4 are recoded as 1.4, values >2.6 are recoded as 2.6.
Creatinine	CorHealth Registry	NA	Categorical: (i) 0-119/missing, (ii) 120-179, (iii) 180+
Hematocrit	OLIS	NA	Continous. Missing are imputed using procedure and sex specific cohort mean; values <0.25 are recoded as 0.25, values >0.5 are recoded as 0.5.
Platelets	OLIS	NA	Categorical: (i) <130, (ii) 130-400, (iii) >400. Missing are imputed using procedure specific cohort mean.
Leukocytes	OLIS	NA	Continuous. Missing are imputed using procedure specific cohort mean. Values >30 are recoded as 30.
Previous CABG[11]	CIHI DAD, CorHealth Registry	From CIHI DAD: CCP: 481 CCI: 1IJ76 (PPV = 98.3-98.5%)	Binary
Previous transcatheter valve replacement/percutaneous valve repair[11]	CIHI DAD, CIHI SDS	CCI: 1HU80^^, 1HU90^^, 1HV80^^, 1HV90^^, 1HT80^^, 1HT90^^, 1HS80^^, 1HS90^^, where ^^="GP" or "GR" (For any valve surgery, PPV 97.3-97.6%)	Binary
Previous open valve or other open cardiac/thoracic aorta operation (aortic valve procedures are treated as a separate variable in	CIHI DAD	Open aortic valve procedures: CCP: 4703, 4713, 4724, 4725 CCI: 1HV80^^ or 1HV90^^ where ^^ not = "GP" or "GR"	Binary

AVR and CABG+AVR models)[11]		OHIP fee code R738, R863 Open mitral valve procedures: CCP: 4702, 4212, 4722, 4723 CCI: 1HU80^^ or 1HU90^^ where ^^ not = "GP" or "GR" OHIP fee code R734-735 Other open valve procedures: CCP: 4705, 4715, 4728, 4729, 4704, 4714, 4726, 4727 CCI: 1HT80^^, 1HT90^^, 1HS80^^ or 1HS90^^ where ^^ not="GP" or "GR" OHIP fee code R772, R728 Open cardiac/thoracic aorta operations: CCI: 1I*XXYY (where *=A to S, and (XX=76 OR YY=LA, TQ, VS, MF or NA)), 1HJ76, 1HJ82LA, 1HM78LA, 1HM80LA, 1HN71LA, 1HN80LA, 1HN87LA, 1HP53LAQP, 1HP54LAQP, 1HP55LAQP, 1HP71LA, 1HP76, 1HP78LA, 1HP80LA, 1HP82LA, 1HP83LA, 1HP87LA, 1HR71LA, 1HR80LA, 1HR80STFL, 1HR84LA, 1HR87LA, 1HY85, 1HZ85, 1HZ34LAXXN, 1HZ53LA, 1HZ53QA, 1HZ53SY, 1HZ55LA, 1HZ55QA, 1HZ56LA, 1HZ80LA, 1HZ80WKAG, 1HZ85LA, 1HZ87LA	

		(For any valve surgery, PPV 97.3-97.6%)	
Number of previous cardiovascular surgeries	CIHI DAD	Includes CCI procedures (count maximum of 1 per day): 1HH59LA, 1HH59LA, 1HP78, 1IB, 1IA, 1IC, 1ID, 1IC, 1IC, 1ID, 1HM78LA, 1LZ37LAQM, 1LZ37GPQM, 1HA87, 1HZ53LAKP, 1HZ55LAKP, 1HZ80, 1HY85, 1HZ85, 1GT85, 1HP53LA, 1HP54LA, 1HP55LA, 1IJ76, 1HS, 1HT, 1HU, 1HV, 1HW, 1HX	Categorical: (i) None prior to this surgery, (ii) 1 or more previous surgeries
History of PCI and timing[11]	CIHI DAD, CIHI SDS	CCP: 4802, 4803 CCI: 1IJ50, 1IJ54 or 1IJ57GQ (PPV = 96.0%)	Categorical: (i) No, (ii) Yes >1 day prior, (iii) Yes within 1 day of surgery date
Previous implantable cardioverter defibrillator[12,13]	CIHI DAD, CIHI SDS, OHIP	CCP: 4974, 4988 CCI: 1HZ53GRFS, 1HZ53HAFS, 1HZ53LAFS, 1HZ53SYFS, 1HZ55GPFS, 1HZ55LAFS, 1HZ55QAFS, 2HZ07FS, 2HZ07NR OHIP fee code: G317, G321, R753, R761	Binary
Moribund (not expected to live between admission date and surgery date)	OHIP	OHIP fee code E016	Binary
New York Heart Association (NYHA) class	CorHealth Registry	NA	Categorical: Class I to IV, and missing
Shock, pre-op ECMO, pre-op CBA, pr-eop IABP, resuscitation	CIHI DAD, CorHealth Registry	Shock:	Binary

(within 1 day or on admission), or recent (within 30 days) ventricular tachycardia/ fibrillation (for AVR and CABG+AVR models only)		ICD-10-CA: R57.0 or flag in CorHealth registry Pre-op ECMO: CCI: 1LZ37GPQM or 1LZ37LAQM Pre-op CBA: CCI: 1HP53GPQP Pre-op IABP: Flag in CorHealth Registry Resuscitation: CCI: 1GZ30CJ, 1GZ30CJNB, 1GZ30JH, 1HZ30JN or 1HZ30JY within 1 day prior to surgery date; or flag in CorHealth registry Ventricular tachycardia/ fibrillation: ICD-10-CA: I47.0, I47.2, or I49.0	
Status	CIHI DAD	Wait at home = Hospital admission category = elective and admission date ≤ 1 day before surgery date Wait in hospital/urgent if Hospital admission category = elective and admission date > 1 day before surgery date, or Hospital admission category = urgent.	Categorical: (i) Wait at home, (ii) Wait in hospital/urgent
Cardiac presentation on admission	CorHealth Registry	NA	Categorical: (i) STEMI, (ii) NSTEMI, (iii) Unstable angina, (iv) Other (i.e., elective,

			stable coronary disease, rule out coronary artery disease, or missing)
Recent myocardial infarction (≤30 days before referral)	CorHealth Registry	NA	Binary
Atrial fibrillation or flutter	CIHI DAD, NACRS	ICD-10-CA: I48	Categorical: (i) none, (ii) recent (within 30 days) (iii) remote (>30 days)
Heart block or bradycardia	CIHI DAD, NACRS	ICD-10-CA: I44.2, I45.3, I49.5	Categorical: (i) none, (ii) recent (within 30 days) (iii) remote (>30 days)
Ventricular tachycardia or fibrillation	CIHI DAD, NACRS	ICD-10-CA: I47.0, I47.2, or I490	Categorical: (i) none, (ii) recent (within 30 days) (iii) remote (>30 days); for AVR and CABG+AVR models, combined with shock/ECMO/IABP/CBA/resuscitation
History of radiation treatment to mediastinum/heart	Ontario Cancer Registry	NA	Binary
Left ventricular ejection fraction	CorHealth Registry	NA	Categorical: (i) ≥35%, (ii) <35%, (iii) Missing
Left main disease	CorHealth Registry	NA	Binary
Proximal left anterior descending artery (LAD) stenosis	CorHealth Registry	NA	Binary
Number of diseased coronary vessels	CorHealth Registry	NA	Categorical: (i) 1, (ii) 2, (iii) 3, (iv) Unknown
Mitral regurgitation	CorHealth Registry	NA	Binary
Aortic stenosis or regurgitation	CorHealth Registry	NA	Binary
Tricuspid insufficiency	CIHI DAD	ICD-9: 397.0 ICD-10-CA: I07.1	Binary
Thoracic aorta disease (excludes aortic dissections and abdominal aortic aneurysm)	CIHI DAD	ICD-9 441.1, 441.2, 441.6, 441.7 ICD-10-CA I71.1, I71.2, I71.5, I71.6	Binary
Intensive/critical care unit admission within 48 hours[14]	CIHI DAD	Special care unit (SCU) code 10, 20, 30, 40 or 45 (includes admission to medical/surgical intensive care, critical care and	Binary

		cardiac care units) (sensitivity 96%, specificity 90%, PPV 35%, NPV 100%)	
Hospital Frailty Risk Score[15]	CIHI DAD	Look back five years Kappa 0.22 (95% CI 0.15-30) compared with dichotomized Fried scale; 0.30 (95% CI 0.22-0.38) compared with dichotomized Rockwood scale.	Categorical: (i) <1.0, (ii) 1.0-3.0, (iii) >3.0

AVR indicates aortic valve replacement; CABG, coronary artery bypass graft; CBA, catheter-based assist device; CCI, Canadian Classification of Health Interventions; CCP, Canadian Classification of Diagnostic, Therapeutic, and Surgical Procedures; CIHI DAD, Canadian Institute for Health Information Discharge Abstract Database; CIHI SDS, Canadian Institute for Health Information Same-day Surgery database; ECMO, extracorporeal membrane oxygenation; IABP, intra-aortic balloon pump; ICD, International Classification of Diseases; NA, not applicable; NACRS, National Ambulatory Care Reporting System; NPV, negative predictive value; NSTEMI, non-ST-elevation myocardial infarction OHIP, Ontario Health Insurance Plan Physician Claims Database; OLIS, Ontario Laboratories Information System; PCI, percutaneous coronary intervention; PPV, positive predictive value; RPBB, Registered Persons Database; STEMI, ST-elevation myocardial infarction; TIA, transient ischemic attack.

* Where a variable's data source is the CorHealth Registry, information is obtained from the patient's electronic medical record.

Supplemental Table 3. Baseline characteristics of CABG derivation and validation cohorts

Characteristic	FY2017 & FY2018 (N=13,435)	FY2015 & FY2016 (N=13,447)	FY2019 (N=6430)
	n (%), unless otherwise specified		
Age on procedure date			
Mean (SD)	66.3 (9.4)	65.9 (9.7)	66.2 (9.5)
Median (IQR)	67 (60-73)	66 (59-73)	67 (60-73)
Male sex	10,820 (80.5)	10,785 (80.2)	5243 (81.5)
Ethnicity			
Chinese	259 (1.9)	265 (2.0)	155 (2.4)
South Asian	730 (5.4)	641 (4.8)	332 (5.2)
Other	12,446 (92.6)	12,541 (93.3)	5943 (92.4)
Prior stroke	358 (2.7)	352 (2.6)	196 (3.0)
Prior transient ischemic attack	351 (2.6)	353 (2.6)	190 (3.0)
Prior carotid endarterectomy/stent	158 (1.2)	162 (1.2)	72 (1.1)
Chronic lung disease	1008 (7.5)	1,049 (7.8)	457 (7.1)
Dialysis	227 (1.7)	236 (1.8)	145 (2.3)
Liver disease	152 (1.1)	143 (1.1)	63 (1.0)
Home oxygen in prior 1 year	12 (0.1)	25 (0.2)	*1-5 (0.02-0.08)
Peripheral artery/vascular disease	599 (4.5)	664 (4.9)	267 (4.2)
Hypertension	11,394 (84.8)	11,359 (84.5)	4412 (68.6)
Diabetes	5562 (41.4)	5577 (41.5)	2694 (41.9)
Body mass index, kg/m^2			
Mean (SD)	29.3 (9.3)	29.9 (36.0)	29.3 (8.7)
Median (IQR)	28 (25-32)	28 (25-32)	28 (25-32)
Missing	673 (5.0%)	861 (6.4)	424 (6.6)
Body surface area, m^2			
Mean (SD)	2.00 (0.25)	2.00 (0.24)	2.00 (0.24)
Median (IQR)	2 (2-2)	2 (2-2)	2 (2-2)
Missing	673 (5.0%)	861 (6.4)	424 (6.6)
Cancer/Time since diagnosis			
No cancer	11,985 (89.2)	11,908 (88.6)	5702 (88.7)
<1 to 3 years	364 (2.7)	420 (3.1)	209 (3.3)
≥3 years	1086 (8.1)	1119 (8.3)	519 (8.1)
Smoking history			
Current	2806 (20.9)	2866 (21.3)	1283 (20.0)
Former	4373 (32.5)	4741 (35.3)	1999 (31.1)
Never	6256 (46.6)	5840 (43.4)	3148 (49.0)
Coma on admission	*1-5 (0.007-0.04)	*1-5 (0.007-0.04)	*1-5 (0.02-0.08)
Organ transplant	60 (0.4)	44 (0.3)	18 (0.3)
Creatinine (μmol/L)			
0-119	11,299 (84.1)	11,303 (84.1)	5175 (80.5)
120-179	1210 (9.0)	1147 (8.5)	553 (8.6)
180+	535 (4.0)	473 (3.5)	264 (4.1)
Missing	391 (2.9)	524 (3.9)	438 (6.8)
Hematocrit			
Mean (SD)	0.41 (0.05)	0.41 (0.05)	0.42 (0.04)
Median (IQR)	0 (0-0)	0 (0-0)	0 (0-0)

Missing	571 (4.3%)	215 (1.6)	534 (8.3)
Platelets ($x10^3/mm^3$)			
Mean (SD)	226.6 (65.7)	223.0 (66.2)	233.1 (62.8)
Median (IQR)	219 (183-260)	216 (180-255)	226 (193-263)
Missing	577 (4.3%)	215 (1.6)	534 (8.3)
Leukocytes ($x10^9/L$)			
Mean (SD)	7.7 (3.9)	7.9 (2.4)	7.5 (2.3)
Median (IQR)	7 (6-9)	8 (6-9)	7 (6-9)
Missing	573 (4.3%)	215 (1.6)	534 (8.3)
Previous CABG	84 (0.6)	95 (0.7)	30 (0.5)
Previous transcatheter valve	0 (0.0)	0 (0.0)	0 (0.0)
Previous open valve, or other open cardiac or thoracic aorta operation	80 (0.6)	72 (0.5)	32 (0.5)
Number of previous cardiovascular surgeries			
None	13,305 (99)	13,330 (99.1)	6375 (99.1)
≥1	130 (1)	117 (0.9)	55 (0.9)
History and timing of PCI			
Within 1 day	*1-5 (0.007-0.04) *2288-2292 (17.0-17.0)	6 (0.04)	*1-5 (0.02-0.08) *1142-1146 (17.8-17.8)
>1 day prior	2082 (15.5)		
None	11,142 (82.9)	11,359 (84.5)	5283 (82.2)
Previous implantable cardioverter defibrillator	62 (0.5)	69 (0.5)	44 (0.7)
Shock or pre-op ECMO, IABP or CBA	208 (1.5)	240 (1.8)	97 (1.5)
Resuscitation within 1 day or on admission	152 (1.1)	136 (1.0)	47 (0.7)
Moribund	464 (3.5)	445 (3.3)	243 (3.8)
New York Heart Association (NYHA) class			
1	4754 (35.4)	4865 (36.2)	2033 (31.6)
2	1254 (9.3)	1221 (9.1)	683 (10.6)
3	626 (4.7)	623 (4.6)	327 (5.1)
4	149 (1.1)	195 (1.5)	62 (1.0)
No symptoms/missing/NA/unknown	6652 (49.5)	6543 (48.7)	3325 (51.7)
Status			
Urgent or waiting in hospital	7784 (57.9)	7824 (58.2)	3852 (59.9)
Waiting at home	5651 (42.1)	5623 (41.8)	2578 (40.1)
Cardiac presentation on admission			
STEMI	876 (6.5)	894 (6.6)	431 (6.7)
NSTEMI	3589 (26.7)	3608 (26.8)	1858 (28.9)
Unstable angina	2338 (17.4)	2531 (18.8)	1064 (16.5)
Other	6632 (49.4)	6414 (47.7)	3077 (47.9)
Recent myocardial infarction	4770 (35.5)	4806 (35.7)	2375 (36.9)
Atrial fibrillation or flutter			
None	12,196 (90.8)	12,272 (91.3)	5869 (91.3)
Recent (within 30 days)	861 (6.4)	840 (6.2)	390 (6.1)
Remote (>30 days)	378 (2.8)	335 (2.5)	171 (2.7)
Heart block or bradycardia			
None	13,279 (98.8)	13,319 (99.0)	6,356 (98.8)
Recent (within 30 days)	58 (0.4)	38 (0.3)	27 (0.4)
Remote (>30 days)	98 (0.7)	90 (0.7)	47 (0.7)
Ventricular tachycardia or fibrillation	13,156 (97.9)	13,195 (98.1)	6271 (97.5)

None			
Recent (within 30 days)	165 (1.2)	149 (1.1)	85 (1.3)
Remote (>30 days)	114 (0.8)	103 (0.8)	74 (1.2)
History of mediastinal radiation	*1-5 (0.007-0.04)	*1-5 (0.007-0.04)	*1-5 (0.02-0.08)
Left ventricular ejection fraction (LVEF)			
≥50%	8872 (66.0)	8,531 (63.4)	4,283 (66.6)
35-49%	2825 (21.0)	2,950 (21.9)	1,246 (19.4)
20-34%	944 (7.0)	1,105 (8.2)	451 (7.0)
<20%	162 (1.2)	212 (1.6)	65 (1.0)
Missing	632 (4.7)	649 (4.8)	385 (6.0)
Left main disease	4042 (30.1)	4155 (30.9)	2003 (31.2)
Proximal LAD stenosis	7532 (56.1)	7440 (55.3)	3900 (60.7)
Number of diseased coronary vessels			
Unknown	120 (0.9)	109 (0.8)	49 (0.8)
1	630 (4.7)	699 (5.2)	311 (4.8)
2	3913 (29.1)	4251 (31.6)	1800 (28.0)
3	8772 (65.3)	8388 (62.4)	4270 (66.4)
Mitral regurgitation	31 (0.2)	49 (0.4)	27 (0.4)
Aortic stenosis or regurgitation	37 (0.3)	36 (0.3)	28 (0.4)
Severe tricuspid insufficiency	*1-5 (0.007-0.04)	*1-5 (0.007-0.04)	*1-5 (0.02-0.08)
Thoracic aorta disease	25 (0.2)	19 (0.1)	19 (0.3)
ICU or CCU admission within 48 hours	551 (4.1)	577 (4.3)	247 (3.8)
Hospital Frailty Risk Score			
Mean (SD)	2.9 (3.8)	2.9 (3.8)	2.8 (3.9)
Median (IQR)	1 (0-4)	1 (0-4)	1 (0-4)

CABG indicates coronary artery bypass graft; CBA, catheter-based assist device; CCU, critical care unit; ECMO, extracorporeal membrane oxygenation; IABP, intra-aortic balloon pump; ICU, intensive care unit; IQR, interquartile range; LAD, left anterior descending artery; NSTEMI, non-ST-elevation myocardial infarction; PCI, percutaneous coronary intervention; SD, standard deviation; STEMI, ST-elevation myocardial infarction.

* Data suppressed due to small counts.

Supplemental Table 4. Baseline characteristics of AVR derivation and validation cohorts

Characteristic	FY2017 & FY2018 (N=1970)	FY2015 & FY2016 (N=1946)	FY 2019 (N=777)
	n (%), unless otherwise specified		
Age on procedure date			
Mean (SD)	68.3 (10.2)	68.8 (11.3)	65.9 (10.6)
Median (IQR)	70 (63-76)	70 (63-77)	67 (61-73)
Male sex	1236 (62.7)	1181 (60.7)	494 (63.6)
Ethnicity			
Chinese	20 (1.0)	18 (0.9)	6 (0.8)
South Asian	22 (1.1)	27 (1.4)	8 (1.0)
Other	1928 (97.9)	1901 (97.7)	763 (98.2)
Prior stroke	75 (3.8)	67 (3.4)	34 (4.4)
Prior transient ischemic attack	62 (3.1)	57 (2.9)	29 (3.7)
Prior carotid endarterectomy/stent	22 (1.1)	11 (0.6)	*1-5 (0.1-0.6)
Chronic lung disease	193 (9.8)	213 (10.9)	79 (10.2)
Dialysis	31 (1.6)	19 (1.0)	10 (1.3)
Liver disease	33 (1.7)	43 (2.2)	16 (2.1)
Endocarditis			
Current	66 (3.4)	39 (2.0)	29 (3.7)
Previous	23 (1.2)	30 (1.5)	12 (1.5)
Home oxygen in prior 1 year	7 (0.4)	*1-5 (0.05-0.3)	0 (0.0)
Peripheral artery/vascular disease	67 (3.4)	81 (4.2)	29 (3.7)
Hypertension	1530 (77.7)	1531 (78.7)	526 (67.7)
Diabetes	534 (27.1)	499 (25.6)	192 (24.7)
Body mass index, kg/m^2			
Mean (SD)	30.5 (9.7)	30.3 (12.1)	29.8 (6.5)
Median (IQR)	29 (26-34)	29 (26-33)	29 (25-33)
Missing	91 (4.6%)	134 (6.9)	58 (7.5)
Body surface area, m^2			
Mean (SD)	2.00 (0.27)	1.97 (0.26)	1.99 (0.26)
Median (IQR)	2 (2-2)	2 (2-2)	2 (2-2)
Missing	91 (4.6%)	134 (6.9)	58 (7.5)
Cancer/Time since diagnosis			
No cancer	1646 (83.6)	1619 (83.2)	666 (85.7)
<1 to 3 years	71 (3.6)	85 (4.4)	33 (4.2)
≥3 years	253 (12.8)	242 (12.4)	78 (10.0)
Smoking history			
Current	255 (12.9)	259 (13.3)	129 (16.6)
Former	634 (32.2)	619 (31.8)	211 (27.2)
Never	1081 (54.9)	1068 (54.9)	437 (56.2)
Coma on admission	0 (0)	0 (0)	0 (0)
Organ transplant	13 (0.7)	10 (0.5)	7 (0.9)
Creatinine (μmol/L)			
0-119	1687 (85.6)	1609 (82.7)	641 (82.5)
120-179	160 (8.1)	157 (8.1)	60 (7.7)
180+	53 (2.7)	52 (2.7)	23 (3.0)

Missing	70 (3.6)	128 (6.6)	53 (6.8)
Hematocrit			
Mean (SD)	0.40 (0.05)	0.40 (0.05)	0.41 (0.04)
Median (IQR)	0 (0-0)	0 (0-0)	0 (0-0)
Missing	55 (2.8%)	14 (0.7)	53 (6.8)
Platelets ($x10^3/mm^3$)			
Mean (SD)	217.1 (69.0)	214.2 (69.9)	229.8 (66.4)
Median (IQR)	214 (174-250)	208 (171-247)	219 (188-262)
Missing	55 (2.8%)	14 (0.7)	53 (6.8)
Leukocytes ($x10^9/L$)			
Mean (SD)	7.4 (2.6)	7.5 (2.7)	7.4 (2.4)
Median (IQR)	7 (6-8)	7 (6-9)	7 (6-8)
Missing	56 (2.8%)	14 (0.7)	53 (6.8)
Previous CABG	48 (2.4)	58 (3.0)	15 (1.9)
Previous transcatheter valve	*1-5 (0.05-0.3)	*1-5 (0.05-0.3)	*1-5 (0.1-0.6)
Previous open valve, or other open cardiac or thoracic aorta operation	168 (8.5)	142 (7.3)	68 (8.8)
Number of previous cardiovascular surgeries			
None	1818 (92.3)	1821 (93.6)	715 (92.0)
≥1	152 (7.7)	125 (6.4)	62 (8.0)
History and timing of PCI			
Within 1 day			
>1 day prior	142 (7.2)	128 (6.6)	41 (5.3)
None	1828 (92.8)	1818 (93.4)	736 (94.7)
Previous implantable cardioverter defibrillator	13 (0.7)	13 (0.7)	6 (0.8)
Shock or pre-op ECMO, IABP or CBA	17 (0.9)	13 (0.7)	8 (1.0)
Resuscitation within 1 day or on admission	28 (1.4)	21 (1.1)	*1-5 (0.1-0.6)
Moribund	76 (3.9)	55 (2.8)	34 (4.4)
New York Heart Association (NYHA) class			
1	442 (22.4)	484 (24.9)	196 (25.2)
2	703 (35.7)	653 (33.6)	262 (33.7)
3	550 (27.9)	554 (28.5)	190 (24.5)
4	66 (3.4)	75 (3.9)	27 (3.5)
No symptoms/missing/NA/unknown	209 (10.6)	180 (9.2)	102 (13.1)
Status			
Urgent or waiting in hospital	375 (19.0)	409 (21.0)	183 (23.6)
Waiting at home	1595 (81.0)	1537 (79.0)	594 (76.4)
Cardiac presentation on admission			
STEMI	*1-5 (0.05-0.3)	*1-5 (0.05-0.3)	*1-5 (0.1-0.6)
NSTEMI	11 (0.6)	16 (0.8)	6 (0.8)
Unstable angina	*7-11 (0.4-0.6)	*8-12 (0.4-0.6)	*1-5 (0.1-0.6)
Other	1947 (98.8)	1917 (98.5)	765 (98.5)
Recent myocardial infarction	46 (2.3)	52 (2.7)	33 (4.2)
Atrial fibrillation or flutter			
None	1628 (82.6)	1591 (81.8)	658 (84.7)
Recent (within 30 days)	210 (10.7)	206 (10.6)	75 (9.7)
Remote (>30 days)	132 (6.7)	149 (7.7)	44 (5.7)
Heart block or bradycardia	1935 (98.2)	1899 (97.6)	755 (97.2)

None			
Recent (within 30 days)	16 (0.8)	11 (0.6)	11 (1.4)
Remote (>30 days)	19 (1.0)	36 (1.8)	11 (1.4)
Ventricular tachycardia or fibrillation			
None	1947 (98.8)	1912 (98.3)	768 (98.8)
Recent (within 30 days)	*1-5 (0.05-0.3)	9 (0.5)	*1-5 (0.1-0.6)
Remote (>30 days)	*18-22 (0.9-1.1)	25 (1.3)	*4-8 (0.5-1.0)
History of mediastinal radiation	0 (0.0)	*1-5 (0.05-0.3)	0 (0.0)
Left ventricular ejection fraction (LVEF)			
≥50%	1597 (81.1)	1611 (82.8)	614 (79.0)
35-49%	190 (9.6)	180 (9.2)	83 (10.7)
20-34%	84 (4.3)	81 (4.2)	30 (3.9)
<20%	10 (0.5)	15 (0.8)	*1-5 (0.1-0.6)
Missing	89 (4.5)	59 (3.0)	*45-49 (5.8-6.3)
Left main disease	*1-5 (0.05-0.3)	13 (0.7)	*1-5 (0.1-0.6)
Proximal LAD stenosis	24 (1.2)	36 (1.8)	8 (1.0)
Number of diseased coronary vessels			
Unknown	1821 (92.4)	1766 (90.8)	724 (93.2)
1	110 (5.6)	123 (6.3)	39 (5.0)
2	21 (1.1)	34 (1.7)	*9-13 (1.2-1.7)
3	18 (0.9)	23 (1.2)	*1-5 (0.1-0.6)
Mitral regurgitation	19 (1.0)	18 (0.9)	7 (0.9)
Aortic stenosis or regurgitation	1866 (94.7)	1892 (97.2)	735 (94.6)
Severe tricuspid insufficiency	*1-5 (0.05-0.3)	*1-5 (0.05-0.3)	*1-5 (0.1-0.6)
Thoracic aorta disease	20 (1.0)	14 (0.7)	*1-5 (0.1-0.6)
ICU or CCU admission within 48 hours	26 (1.3)	31 (1.6)	16 (2.1)
Hospital Frailty Risk Score			
Mean (SD)	2.6 (4.2)	2.8 (4.3)	2.5 (4.3)
Median (IQR)	1 (0-4)	1 (0-4)	0 (0-3)

CABG indicates coronary artery bypass graft; CBA, catheter-based assist device; CCU, critical care unit; ECMO, extracorporeal membrane oxygenation; IABP, intra-aortic balloon pump; ICU, intensive care unit; IQR, interquartile range; LAD, left anterior descending artery; NSTEMI, non-ST-elevation myocardial infarction; PCI, percutaneous coronary intervention; SD, standard deviation; STEMI, ST-elevation myocardial infarction.

* Data suppressed due to small counts.

Supplemental Table 5. Baseline characteristics of CABG+AVR derivation and validation cohorts

Characteristic	FY2017 & FY2018 (N=1510)	FY2015 & FY2016 (N=1601)	FY 2019 (N=555)
	n (%), unless otherwise specified		
Age on procedure date			
Mean (SD)	72.4 (8.1)	73.2 (8.4)	71.7 (8.1)
Median (IQR)	73 (67-78)	74 (68-79)	73 (66-78)
Male sex	1187 (78.6)	1231 (76.9)	453 (81.6)
Ethnicity			
Chinese	6 (0.4)	7 (0.4)	*1-5 (0.2-0.9)
South Asian	22 (1.5)	23 (1.4)	*4-8 (0.7-1.4)
Other	1482 (98.1)	1571 (98.1)	546 (98.4)
Prior stroke	63 (4.2)	57 (3.6)	27 (4.9)
Prior transient ischemic attack	64 (4.2)	78 (4.9)	25 (4.5)
Prior carotid endarterectomy/stent	27 (1.8)	33 (2.1)	13 (2.3)
Chronic lung disease	161 (10.7)	180 (11.2)	54 (9.7)
Dialysis	28 (1.9)	25 (1.6)	9 (1.6)
Liver disease	23 (1.5)	26 (1.6)	13 (2.3)
Endocarditis			
Current	*11-15 (0.07-1.0)	8 (0.5)	*1-5 (0.2-0.9)
Previous	*1-5 (0.0-0.3)	6 (0.4)	*1-5 (0.2-0.9)
Home oxygen in prior 1 year	*1-5 (0.0-0.3)	*1-5 (0.06-0.3)	*1-5 (0.2-0.9)
Peripheral artery/vascular disease	79 (5.2)	105 (6.6)	31 (5.6)
Hypertension	1344 (89.0)	1430 (89.3)	444 (80.0)
Diabetes	553 (36.6)	608 (38.0)	197 (35.5)
Body mass index, kg/m^2			
Mean (SD)	30.0 (11.8)	29.6 (7.1)	31.1 (18.7)
Median (IQR)	29 (26-33)	29 (26-33)	29 (26-33)
Missing	63 (4.2%)	80 (5.0)	15 (2.7)
Body surface area, m^2			
Mean (SD)	2.01 (0.27)	1.99 (0.24)	2.02 (0.24)
Median (IQR)	2 (2-2)	2 (2-2)	2 (2-2)
Missing	63 (4.2%)	80 (5.0)	15 (2.7)
Cancer/Time since diagnosis			
No cancer	1243 (82.3)	1314 (82.1)	455 (82.0)
<1 to 3 years	68 (4.5)	80 (5.0)	20 (3.6)
≥3 years	199 (13.2)	207 (12.9)	80 (14.4)
Smoking history			
Current	245 (16.2)	234 (14.6)	77 (13.9)
Former	594 (39.3)	637 (39.8)	217 (39.1)
Never	671 (44.4)	730 (45.6)	261 (47.0)
Coma on admission	0 (0)	0 (0)	0 (0)
Organ transplant	8 (0.5)	14 (0.9)	*1-5 (0.2-0.9)
Creatinine (μmol/L)			
0-119	1241 (82.2)	1256 (78.5)	450 (81.1)
120-179	183 (12.1)	193 (12.1)	70 (12.6)
180+	51 (3.4)	73 (4.6)	21 (3.8)
Missing	35 (2.3)	79 (4.9)	14 (2.5)

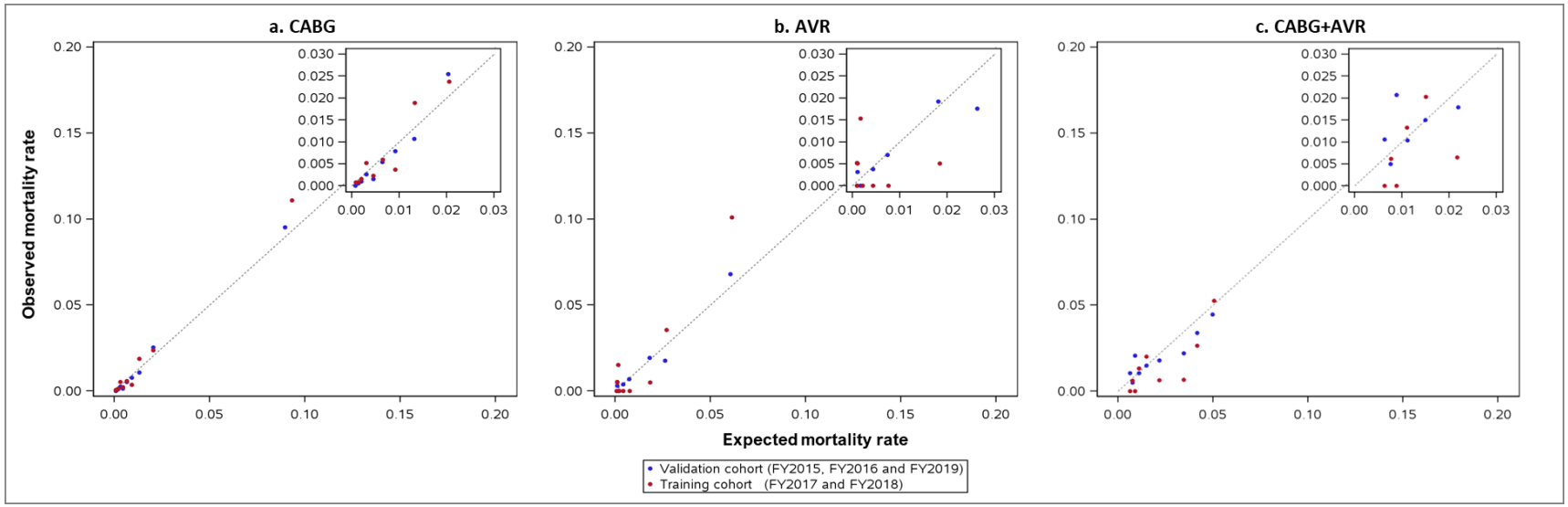
Hematocrit			
Mean (SD)	0.41 (0.05)	0.40 (0.05)	0.42 (0.04)
Median (IQR)	0 (0-0)	0 (0-0)	0 (0-0)
Missing	45 (3.0%)	18 (1.1)	21 (3.8)
Platelets ($x10^3/mm^3$)			
Mean (SD)	217.3 (71.6)	212.7 (68.8)	226.5 (68.3)
Median (IQR)	206 (172-251)	205 (168-246)	216 (186-258)
Missing	45 (3.0%)	18 (1.1)	21 (3.8)
Leukocytes ($x10^9/L$)			
Mean (SD)	7.6 (3.3)	7.6 (2.6)	7.3 (2.0)
Median (IQR)	7 (6-9)	7 (6-9)	7 (6-8)
Missing	45 (3.0%)	18 (1.1)	21 (3.8)
Previous CABG	31 (2.1)	31 (1.9)	10 (1.8)
Previous transcatheter valve	0 (0)	0 (0.0)	0 (0.0)
Previous open valve, or other open cardiac or thoracic aorta operation	38 (2.5)	42 (2.6)	18 (3.2)
Number of previous cardiovascular surgeries			
None	1468 (97.2)	1566 (97.8)	536 (96.6)
≥1	42 (2.8)	35 (2.2)	19 (3.4)
History and timing of PCI			
Within 1 day	0 (0)	0 (0)	0 (0)
>1 day prior	219 (14.5)	186 (11.6)	73 (13.2)
None	1291 (85.5)	1415 (88.4)	482 (86.8)
Previous implantable cardioverter defibrillator	9 (0.6)	8 (0.5)	*1-5 (0.2-0.9)
Shock or pre-op ECMO, IABP or CBA	12 (0.8)	16 (1.0)	6 (1.1)
Resuscitation within 1 day or on admission	27 (1.8)	28 (1.7)	11 (2.0)
Moribund	53 (3.5)	56 (3.5)	28 (5.0)
New York Heart Association (NYHA) class			
1	368 (24.4)	421 (26.3)	137 (24.7)
2	497 (32.9)	500 (31.2)	191 (34.4)
3	387 (25.6)	427 (26.7)	123 (22.2)
4	56 (3.7)	74 (4.6)	22 (4.0)
No symptoms/missing/NA/unknown	202 (13.4)	179 (11.2)	82 (14.8)
Status			
Urgent or waiting in hospital	503 (33.3)	572 (35.7)	205 (36.9)
Waiting at home	1007 (66.7)	1029 (64.3)	350 (63.1)
Cardiac presentation on admission			
STEMI	14 (0.9)	20 (1.2)	7 (1.3)
NSTEMI	153 (10.1)	155 (9.7)	53 (9.5)
Unstable angina	69 (4.6)	91 (5.7)	38 (6.8)
Other	1274 (84.4)	1335 (83.4)	457 (82.3)
Recent myocardial infarction	207 (13.7)	224 (14.0)	79 (14.2)
Atrial fibrillation or flutter			
None	1242 (82.3)	1280 (80.0)	458 (82.5)
Recent (within 30 days)	177 (11.7)	224 (14.0)	68 (12.3)
Remote (>30 days)	91 (6.0)	97 (6.1)	29 (5.2)
Heart block or bradycardia			
None	1477 (97.8)	1554 (97.1)	542 (97.7)

Recent (within 30 days)	14 (0.9)	16 (1.0)	*1-5 (0.2-0.9)
Remote (>30 days)	19 (1.3)	31 (1.9)	*8-12 (1.4-2.2)
Ventricular tachycardia or fibrillation			
None	1493 (98.9)	1579 (98.6)	*550-554
Recent (within 30 days)	*1-5 (0.0-0.3)	6 (0.4)	*1-5 (0.2-0.9)
Remote (>30 days)	*12-16 (0.8-1.1)	16 (1.0)	*1-5 (0.2-0.9)
History of mediastinal radiation	0 (0)	*1-5 (0.06-0.3)	0 (0)
Left ventricular ejection fraction (LVEF)			
≥50%	1175 (77.8)	1215 (75.9)	419 (75.5)
35-49%	193 (12.8)	99 (6.2)	34 (6.1)
20-34%	90 (6.0)	13 (0.8)	6 (1.1)
<20%	10 (0.7)	39 (2.4)	14 (2.5)
Missing	42 (2.8)	39 (2.4)	14 (2.5)
Left main disease	241 (16)	258 (16.1)	110 (19.8)
Proximal LAD stenosis	416 (27.5)	441 (27.5)	199 (35.9)
Number of diseased coronary vessels			
Unknown	191 (12.6)	206 (12.9)	63 (11.4)
1	191 (12.6)	464 (29.0)	144 (25.9)
2	445 (29.5)	519 (32.4)	162 (29.2)
3	462 (30.6)	412 (25.7)	186 (33.5)
Mitral regurgitation	16 (1.1)	22 (1.4)	*1-5 (0.2-0.9)
Aortic stenosis or regurgitation	1330 (88.1)	1448 (90.4)	469 (84.5)
Severe tricuspid insufficiency	*1-5 (0.0-0.3)	0 (0.0)	0 (0.0)
Thoracic aorta disease	7 (0.5)	*1-5 (0.06-0.3)	*1-5 (0.2-0.9)
ICU or CCU admission within 48 hours	33 (2.2)	34 (2.1)	8 (1.4)
Hospital Frailty Risk Score			
Mean (SD)	3.4 (4.3)	3.9 (4.7)	3.5 (4.3)
Median (IQR)	2 (0-5)	2 (0-6)	2 (0-5)

CABG indicates coronary artery bypass graft; CBA, catheter-based assist device; CCU, critical care unit; ECMO, extracorporeal membrane oxygenation; IABP, intra-aortic balloon pump; ICU, intensive care unit; IQR, interquartile range; LAD, left anterior descending artery; NSTEMI, non-ST-elevation myocardial infarction; PCI, percutaneous coronary intervention; SD, standard deviation; STEMI, ST-elevation myocardial infarction.

* Data suppressed due to small counts.

Supplemental Figure 1. Calibration plots for observed versus expected 30-day mortality rates by decile of expected rate and surgery type



AVR indicates aortic valve replacement; CABG, coronary artery bypass graft; FY, fiscal year.

References

1. Shah B, Chiu M, Amin S, Ramani M, Sadry S, Tu JV. Surname lists to identify South Asian and Chinese ethnicity from secondary data in Ontario, Canada: a validation study. *BMC Med Res Methodol.* 2010;10(1):42.
2. Kokotailo RA, Hill MD. Coding of stroke and stroke risk factors using International Classification of Diseases, Revisions 9 and 10. *Stroke.* 2005;36(8):1776-1781.
3. Hussain MA, Mamdani M, Saposnik G, et al. Validation of carotid artery revascularization coding in Ontario health administrative databases. *Clin Invest Med.* 2016;39(2):E73-78.
4. Quan H, Parsons GA, Ghali WA. Validity of information on comorbidity derived from ICD-9-CCM administrative data. *Med Care.* 2002;40(8):675-685.
5. Hussain MA, Al-Omran M, Salata K, et al. Population-based secular trends in lower-extremity amputation for diabetes and peripheral artery disease. *CMAJ.* 2019;191(35):E955-e961.
6. O'Brien SM, Feng L, He X, et al. The Society of Thoracic Surgeons 2018 Adult Cardiac Surgery Risk Models: Part 2-Statistical Methods and Results. *Ann Thorac Surg.* 2018;105(5):1419-1428.
7. Tu JV, Chu A, Donovan LR, et al. The Cardiovascular Health in Ambulatory Care Research Team (CANHEART): Using big data to measure and improve cardiovascular health and health care services. *Circ Cardiovasc Qual Outcomes.* 2015;8:204-212.
8. Tu K, Campbell NR, Chen ZL, Cauch-Dudek KJ, McAlister FA. Accuracy of administrative databases in identifying patients with hypertension. *Open Med.* 2007;1(1):e18-e26.
9. Clarke EA, Marrett LD, Kreiger N. Cancer registration in Ontario: a computer approach. *IARC Scientific Publications.* 1991;95:246-257.
10. Canadian Institute for Health Information. Data Quality Documentation for Users: Canadian Organ Replacement Register, 2010 to 2019 Data. Ottawa, ON: CIHI; 2020.
11. Lee DS, Stitt A, Wang X, et al. Administrative hospitalization database validation of cardiac procedure codes. *Med Care.* 2013;51(4):e22-e26.
12. Donio PJ, Freitas C, Austin PC, et al. Comparison of readmission and death among patients with cardiac disease in northern vs southern Ontario. *Can J Cardiol.* 2019;35(3):341-351.
13. Qirjazi E, McArthur E, Nash DM, et al. Risk of ventricular arrhythmia with Citalopram and Escitalopram: a population-based study. *PLOS ONE.* 2016;11(8):e0160768.
14. Scales DC, Guan J, Martin CM, Redelmeier DA. Administrative data accurately identified intensive care unit admissions in Ontario. *J Clin Epidemiol.* 2006;59(8):802-807.
15. Gilbert T, Neuburger J, Kraindler J, et al. Development and validation of a Hospital Frailty Risk Score focusing on older people in acute care settings using electronic hospital records: an observational study. *The Lancet.* 2018;391(10132):1775-1782.