2

Percutaneous Coronary Intervention and 30-Day Mortality: The CANADA Score

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1. Introduction

Coronary artery disease remains highly prevalent in contemporary society and over 1000000 revascularisation procedures by percutaneous coronary intervention (PCI) are performed annually worldwide. PCI has seen significant improvement in clinical outcomes with the current generation of drug eluting stents. The role of PCI in multivessel coronary disease has been expanded with current trial evidence indicating equipoise between PCI and coronary artery by-pass surgery in selected groups.

Increasingly, coronary artery by-pass surgery (CABG) or PCI is being considered as an equivalent revascularisation strategy within the same patient population. Given the options available to clinicians and patients it is important to have robust tools to accurately compare the risk and benefits of selected strategies when making management decisions. Whilst these tools have been available to the cardiac surgeons for some time (Granton & Cheng, 2008), an equivalent tool for the interventional cardiologist has only recently been published.

The CANADA Score is a risk prediction model for determining 30 day mortality risk in patients undergoing elective, urgent and emergent PCI. Its development and validation will be discussed with reference to the established cardiac surgical risk calculators currently available.

2. Risk prediction models

Risk prediction models are statistical models produced from patient databases using a combination of individual risk predication markers and are used by clinicians and patients for making treatment decisions. Model inaccuracy and ineffectiveness can therefore have negative implications on risk measurement and subsequent patient decisions and outcomes. The accuracy of the model is typically summarised in terms of the model's discrimination and calibration (Janes et al, 2008). The applicability of a risk model to a patient population is determined by validation.

2.1 Discrimination

Discrimination is the ability of the model to correctly classify outcomes (Nathanson & Higgins, 2008). The statistical measures of area under the curve (AUC) or concordance index (C-index) are commonly used to describe how well patients are classified within the model.

Patients typically are assigned a positive classification if the model predicts the probability of an outcome as >0.5. Conversely, a negative classification indicates the model predicts the probability of an outcome is <0.5. A patient is therefore correctly classified when an outcome event occurs in a patient with a positive classification, or when no event occurs in a patient with a negative classification. Sensitivity and specificity are derived from the fraction of correctly classified patients. The receiver operating characteristic (ROC) curve is derived from the plot of specificity against (1 – sensitivity), and the area under the ROC curve (AUC) measures the discriminatory ability of the model. An AUC of 0.5 indicates no discriminatory ability and 1.0 indicates perfect discrimination (Cook, 2008). A good model would have AUC 0.7 – 0.9.

2.2 Calibration

Calibration is determined by comparing the predicted and observed outcomes within subgroups of increasing risk within the dataset and applying the Hosmer-Lemeshow (H-L) statistical test (Hosmer & Lemeshow, 2000) to assess "goodness of fit". The H-L goodness of fit test divides subjects into deciles based on predicted probabilities and calculates a chi-square from observed and expected frequencies. If the H-L statistic has p-value >0.05, it implies there is no significant difference between observed and model-predicted values and therefore the model is well calibrated. Calibration plots can be used to give a graphical representation of model calibration.

2.3 Validation

Strategies to validate statistical models include (Altman & Royston, 2000):

a. Internal – evaluation from a single dataset
   Internal validation refers to the application of a model to the same cohort from which it was derived, often by splitting one dataset into separate training and validation cohorts. This can be problematic as models tend to over fit the data and calibration appears erroneously good (Vickers & Cronin, 2010). Internal validation also does not address real differences that may exist between different cohorts. Methods to improve internal validation include cross validation and bootstrap resampling.
b. Temporal – evaluation of a second dataset after the original cohort
   Temporal validation involves collecting data from the same sources but at a later time point. It is a prospective evaluation of the original model, but it may take considerable time to accrue an adequate number of events in the second dataset.
c. External – evaluation of geographically separate cohorts
   External validation addresses the generalizability of the statistical model by application to a different population from that used to derive the model. It can be performed retrospectively making it attractive for widespread application and can help address issues related to sample selection.

3. Cardiac surgical models

3.1 STS score

The Society of Thoracic Surgeons (STS) National Adult Cardiac Database was established in 1989 and currently contains over 4.5 million records. It represents >90% of adult cardiac

surgical procedures performed in the United States. In the interval 1997-1999 there were 503 478 CABG-only procedures identified from 495 participating centres. From this, 30 potential risk factors for mortality were identified on univariate screening (Table 1). The over-all 30 day mortality rate was 3.05%. Using multivariate logistic regression an STS Score model was developed that had good discrimination (c-index 0.78) and modest calibration (H-L p = 0.0016) (Table 2) (Shroyer et al, 2003).

3.2 EuroSCORE

A European multi-national database was established in 1995 (Nashef et al, 1999) and information on risk factors and mortality was collected for 19 030 consecutive adult patients undergoing cardiac surgery under cardiopulmonary bypass in 128 surgical centres in eight European states (Roques et al, 2003). Data were collected for 68 preoperative and 29 operative risk factors proven or believed to influence mortality. From this a series of objective risk factors (Table 1) were weighted by regression analysis and developed into an additive score (additive EuroSCORE) to predict mortality. Overall, 14 799 patients were divided into a developmental cohort (n= 13 302) and validation cohort (n= 1479). The 30 day mortality was for the entire cohort was 4.7%. The additive EuroSCORE had good discrimination in both the development (c-index 0.79) and validation (c-index 0.76) cohort, as well as good calibration (H-L p value <0.40 & <0.68 respectively) (Table 2). The additive EuroSCORE was further externally validated in a North American population. Despite demographic differences the model performed well with discriminatory c-index 0.75 and excellent calibration (predicted and observed mortality 4.15%) (Nashef et al, 2002).

A limitation of the additive EuroSCORE was underestimation of risk in very high risk populations (Sergeant et al, 2001). A second model was published using the coefficient of the variables in the logistic regression data rather than additive weights to predict mortality. The logistic EuroSCORE had similar discrimination (c-index 0.785) to the additive model but superior accuracy in high risk populations. The models diverged at a predicted mortality of 8-10% (Michel et al, 2003).

	STS Score	**EuroSCORE**	**CANADA Score**
Patient Factors			
Age	X	X	X
Gender	X	X	X
Renal failure	X	X	X [a]
Critical preoperative state	X	X	X
Chronic lung disease	X	X	
PVD / CVD	X	X	
CVA / Neurological dysfunction	X	X	
Previous cardiac surgery	X	X	
Multiple reoperations	X		

	STS Score	EuroSCORE	CANADA Score
Ethnicity	X		
BSA	X		
Diabetes	X		
Hypercholesterolemia	X		
Hypertension	X		
Immunosuppressive Rx	X		
Smoker	X		
Cardiac-Related Factors			
Aortic stenosis	X		X [b]
LV dysfunction (LVEF)	X	X	X
NYHA IV	X	X	X
IABP	X	X	X [c]
LMS	X		X
Triple vessel disease	X		X
Current ACS			X
STEMI recurrent / on-going			X
Prior MI	X	X	
PTCA <6 hrs	X		
Mitral insufficiency	X		
Active endocarditis		X	
Pulmonary hypertension		X	
Operation Related Factors			
Urgent status	X	X	X
Other than isolated CABG		X	
Surgery on thoracic aorta		X	
Post infarct septal rupture		X	

a, Dialysis; b, Contraindications to left ventricular contrast angiography include significant aortic stenosis (valve area <1.0 cm^2); c, Critical pre-procedure state includes the anticipated need for IABP

Table 1. Comparison of Risk Factors Used to Predict 30-Day Mortality in Various Models.

Model	Patients	30 day mortality	C-Index	H-L p-value
STS Score development	503478	3.05%	0.78	.0016
Additive EuroSCORE development	13302	4.7%	0.783	<0.40
Additive EuroSCORE validation	1497	4.7%	0.76	<0.68
Logistic EuroSCORE	14799	4.7%	0.785	N/A
CANADA Score training set (development)	26350	1.5%	0.90	0.84
CANADA Score validation	6549	1.4%	0.91	0.12
NCDR CathPCI Risk Score subset	204111	2.94%	0.86	N/A

Table 2. Comparison of Cohort and Model Performance for Various Risk Calculators.

4. PCI models

Early models examining risk associated with percutaneous coronary interventions were well validated for the predication of in-hospital mortality (Moscucci et al, 2001; Qureshi et al, 2003; Resnic et al, 2001; Shaw et al, 2002; Singh et al, 2002; Wu et al, 2006). However, these models had the potential to miss adverse events due to the nature of contemporary PCI where many patients are discharged within 24 hours of admission. As patients may be suitable for revascularization by either CABG or PCI it was important to develop a tool to facilitate an appropriate comparison of outcomes between these strategies.

4.1 NCDR CathPCI risk score

Contemporary risk scores were developed from the National Cardiovascular Data Registry (NCDR) (Peterson et al, 2010). The NCDR CathPCI Registry catalogues patient characteristics, angiographic and procedural details and in-hospital outcomes. From this, various risk models to predict in-hospital mortality were derived from pre-procedural and procedural data (full model), as well as a simplified model based on pre-procedure data only. To establish 30-day mortality, the NCDR records for patients aged over 65 were linked to claims data from the national Centers for Medicare and Medicaid Services (CMS). Linked data from 204111 patients observed in-hospital mortality as 1.99% and 30 day mortality as 2.94%. The c-index for predicating 30-day mortality using the NCDR in-patient mortality model was 0.86.

5. The CANADA score

The British Columbia Cardiac Registry (BCCR) is a population based database for all invasive cardiac procedures performed in British Columbia, Canada. The registry is used for clinical, administrative and research purposes. The linkage of BCCR data with the death registry of the British Columbia (BC) Vital statistics Agency facilitates outcome research. All procedures were performed at four academic tertiary centres that collectively perform 7500 PCI annually.

All patients who had PCI performed in British Columbia (BC) from 2000 – 2005 who were BC residents were included in the study (Hamburger et al, 2009). PCI was defined as any coronary artery procedure that included balloon angioplasty, stent implantation, atherectomy, brachytherapy and thrombectomy. Second or subsequent PCI were not included for further analysis. All cause mortality data was obtained from the BC Vital Statistics Agency.

The study cohort was divided into two groups. Procedures between January 01, 2000 and December 31, 2004 formed the training set that was used to develop the multivariable predictive model for all-cause 30-day mortality. Procedures from 2005 were used to validate the model.

Variables for predicting 30-day mortality post PCI included patient demographics, co-morbidities and clinical features such as indication for procedure and disease anatomy. Variables that were significantly associated with 30-day mortality in the univariate analysis (Table 3) or that were considered to be clinically important predictors for 30-day mortality were assessed in a stepwise logistic regression analysis. Only significant predictors ($P < 0.05$) in the multiple logistic regression analysis were kept in the final predictive model (Table 4).

A total of 32 899 procedures were performed. These were divided into 26 350 in the training set and 6549 in the validation set. The overall 30-day mortality was 1.5% (n=500), with mortality in the training set 1.5% (n=406) and validation set 1.4% (n=94) respectively. Of note, overall approximately one third of deaths occurred beyond 7 days (161/500, 32.2%) with similar proportions in the training (121/406, 29.8%) and validation sets (40/94, 42.6%) (Figure 1). The discrimination of the CANADA Score was good with the c-index for the training set 0.90 (Figure 2) and 0.91 for the validation set (Figure 3). The calibration was also good (H-L p values 0.84 & 0.12 respectively) (Table 2).

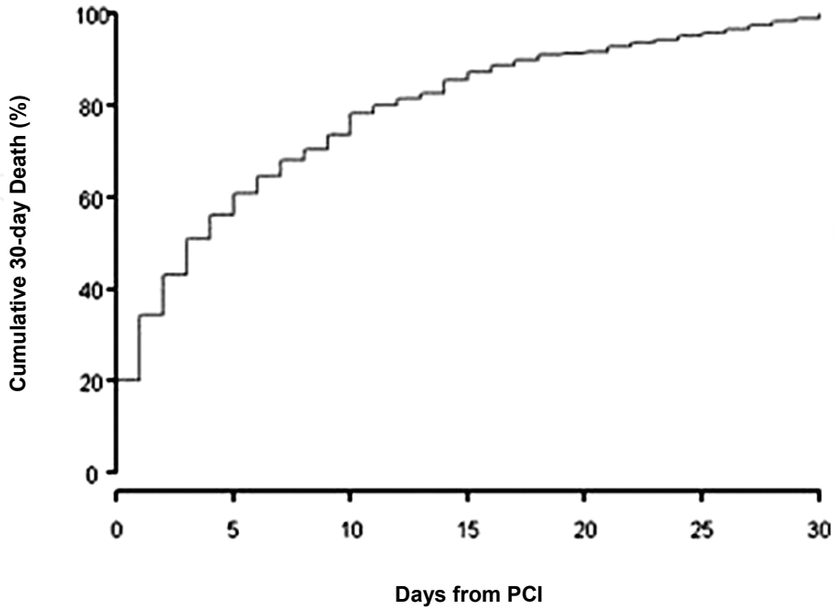

Fig. 1. Cumulative mortality versus time for all deaths in CANADA Score study population.

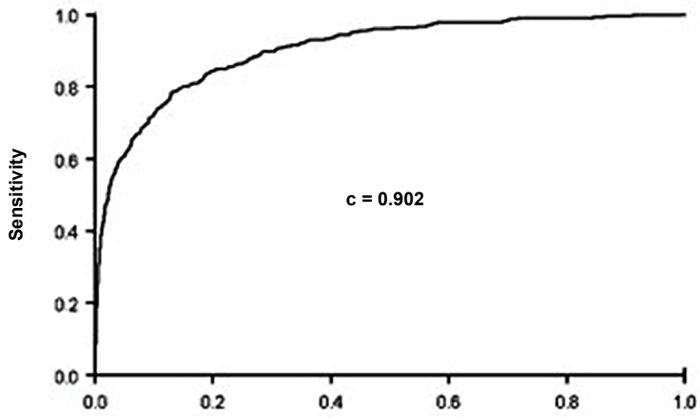

Fig. 2. Receiver operator characteristic (ROC) curve for CANADA Score training set.

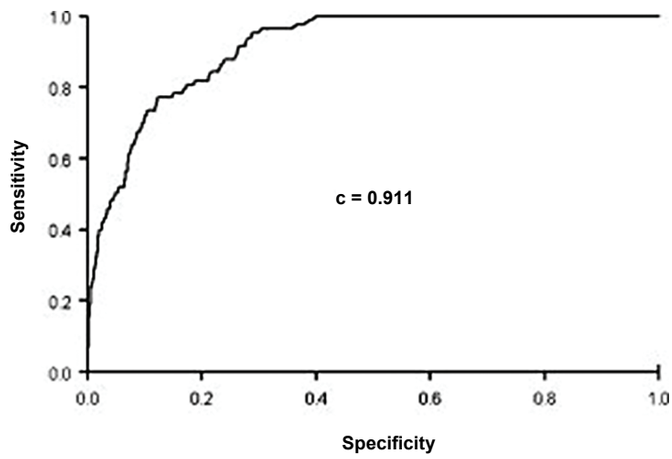

Fig. 3. Receiver operator characteristic (ROC) curve for CANADA Score validation set.

The CANADA Score was further externally validated using data sets from Alberta, Canada, and Massachusetts, United States of America.

The Alberta Provincial Project for outcome Assessment in Coronary Heart Disease (APPROACH) began 15 years ago as a cardiac catheterization and cardiac surgery database. The database includes clinical information on 126,500 patients with diagnostic cardiac catheterization and/or revascularization procedures, and 34000 hospital admissions for ACS (www.approach.org). The Canada Score model was evaluated against 9483 PCI performed from April 2005 – March 2008. The 30-day mortality was 1.8%. The c-index for this cohort was 0.88 (Kurana et al, 2010a).

The Massachusetts Department of Public Health began collecting patient specific outcome data to evaluate all cardiac surgery and coronary intervention programs in 2002. Data were submitted to the Massachusetts Data Analysis Center (Mass-DAC) with data collection for coronary interventions using the ACC-NCDR Instrument beginning in 2003 (www.massdac.org). During the period Jan 2005 – September 2007, 36 341 PCI procedures were performed. The 30-day mortality was 2.05% and c-index for the Canada Score in this cohort was 0.87 (Kurana et al, 2010b).

Category	Number of patients	Number of deaths	30-Day mortality rate (%)	Odds ratio	95% Confidence intervals	*P*
Total number of patients	26,350	406				
Age (continuous) Mean ± SD: 64.3 ± 11.5	26,350			1.05	1.04–1.06	<0.001
Gender						
Male	19,283	265	1.37	1.00	Ref.	
Female	7,064	141	2.00	1.46	1.19–1.80	<0.001
Urgency of procedure						
Non-urgent	7,626	219	0.18	1.00	Ref.	
Emergency	2,965	171	7.39	43.36	25.22–74.56	<0.001
Urgent	15,643	14	1.09	6.01	3.48–10.37	<0.001
Extent of coronary artery disease						
Single or two vessel disease	17,420	176	1.01	1.00	Ref.	
Triple-vessel disease	7,830	164	2.09	2.68	2.03–3.54	<0.001
Left main disease	1,100	66	6.00	7.99	5.70–11.22	<0.001
Left ventricular ejection fraction						
<30%	783	48	6.13	18.90	12.63–28.28	<0.001
30%–50%	5,488	82	1.49	4.39	3.08–6.25	<0.001
>50%	14,521	50	0.34	1.00	Ref.	
Clinically Contraindicated	3,989	197	4.94	15.04	11.00–20.55	<0.001
CCS class IV angina						
No	7,395	17	0.23	1.00	Ref.	
Yes	16,364	361	2.21	9.79	6.02–15.94	<0.001
NYHA dyspnoea ≥ 3 or congestive heart failure						
No	25,570	311	1.22	1.00	Ref.	
Yes	776	95	12.24	11.33	8.89–14.43	<0.0001
Indication for procedure						
Stable Angina	8,426	18	0.21	1.00	Ref.	
STEMI Ongoing	2,253	168	7.46	37.64	23.09–61.34	<0.001
STEMI Recurrent	1,216	23	1.89	9.01	4.85–16.74	<0.001
Other ACS	14,440	196	1.36	5.75	3.13–10.55	<0.001

Category	Number of patients	Number of deaths	30-Day mortality rate (%)	Odds ratio	95% Confidence intervals	*P*
Hemodynamically unstable prior to procedure						
No	26,168	349	1.33	1.00	Ref.	
Yes	167	56	33.53	37.33	26.62–52.35	<0.001
Cardiogenic shock						
No	26,149	322	1.23	1.00	Ref.	
Yes	186	83	44.62	64.64	47.44–88.07	<0.001
Anticipated need for IABP						
No	26,065	324	1.24	1.00	Ref.	
Yes	285	82	28.77	32.09	24.28–42.42	<0.001
Critical preprocedural state						
No	25,876	261	1.01	1.00	Ref.	
Yes	474	145	30.59	43.26	34.36–54.47	<0.001
Treated with IIb/IIIa inhibitor preprocedure						
No	25,419	376	1.48	1.00	Ref.	
Yes	931	30	3.22	2.22	1.52–3.24	<0.001
Lytic therapy preprocedure						
No	24,485	358	1.46	1.00	Ref.	
Yes	1,865	48	2.57	1.78	1.31–2.42	<0.001
Ongoing dialysis or serum creatinine >200 μmol/L						
No	25,641	361	1.41	1.00	Ref.	
Yes	604	37	6.13	4.57	3.23–6.47	<0.001
Diabetes mellitus						
No	20,324	283	1.39	1.00	Ref.	
Yes	5,924	115	1.94	1.40	1.13–1.75	0.003
Hypertension						
No	12,022	207	1.72	1.00	Ref.	
Yes	14,226	191	1.34	0.78	0.64–0.95	0.013
Hyperlipidaemia						
No	10,903	266	2.44	1.00	Ref.	
Yes	15,345	132	0.86	0.35	0.28–0.43	<0.001

Category	Number of patients	Number of deaths	30-Day mortality rate (%)	Odds ratio	95% Confidence intervals	*P*
Peripheral vascular disease						
No	24,192	350	1.45	1.00	Ref.	
Yes	2,056	48	2.33	1.63	1.20–2.21	0.002
Cerebrovascular disease						
No	24,433	343	1.40	1.00	Ref.	
Yes	1,815	55	3.03	2.20	1.64–2.93	<0.001
Cigarette smoker						
No	10,137	225	2.22	1.00	Ref.	
Yes	4,542	55	1.21	0.54	0.40–0.73	<0.001
Exsmoker > 3 months	11,569	118	1.02	0.45	0.36–0.57	<0.001
Previous myocardial infarction						
No	18,444	274	1.49	1.00	Ref.	
Yes	7,804	124	1.59	1.07	0.87–1.33	0.531
Previous PCI						
No	19,588	313	1.60	1.00	Ref.	
Yes	6,674	86	1.29	0.80	0.63–1.02	0.075
Previous CABG						
No	23,121	345	1.49	1.00	Ref.	
Yes	3,132	53	1.69	1.14	0.85–1.52	0.3901
History of chronic pulmonary disease requiring treatment						
No	24,235	348	1.44	1.00	Ref.	
Yes	2,013	50	2.48	1.75	1.30–2.36	<0.001
Potentially life-limiting hepatobiliary or gastrointestinal disease						
No	24,923	368	1.48	1.00	Ref.	
Yes	1,325	30	2.26	1.55	1.06–2.25	0.023
Diagnosis of malignancy						
No	24,757	372	1.50	1.00	Ref.	
Yes	1,491	26	1.74	1.16	0.78–1.74	0.460

Table 3. Baseline Variables in CANADA Score Univariate Analysis.

	β Coefficient	Adjusted OR	95% Confidence intervals	
Intercept	−9.89			
Age (per 10 year increase)	0.39	1.48	1.32	1.65
Gender	0.23	1.26	0.98	1.61
Emergency	0.95	2.58	1.87	3.57
Left main disease	1.09	2.98	2.06	4.29
Triple-vessel disease	0.45	1.57	1.22	2.02
LVEF < 30%	1.84	6.27	4.02	9.77
LVEF 30–50%	0.86	2.36	1.63	3.39
LVEF Clinically Contraindicated	1.55	4.71	3.33	6.66
NYHA ≥ 3/CHF	0.82	2.26	1.65	3.10
Critical preprocedural state	1.97	7.20	5.33	9.74
STEMI Ongoing	2.00	7.40	4.07	13.46
STEMI Recurrent	1.43	4.19	2.08	8.43
Other ACS	1.35	3.87	2.30	6.53
Dialysis/Creatinine > 200 μmol/L	0.76	2.13	1.40	3.23

LVEF, Left ventricular ejection fraction; NYHA, New York Heart Association; CHF, Congestive heart failure; STEMI, ST-elevation myocardial infarction; ACS, acute coronary syndrome; Critical preprocedural state, Hemodynamically unstable prior to procedure or Cardiogenic shock or Anticipated need for IABP.

Table 4. Predictors of Mortality in the CANADA Score Multivariable Model.

6. Comparison of risks – Surgical versus percutaneous revascularisation

Increasingly it has become relevant to select the optimal revascularization strategy for patients deemed appropriate for revascularisation by either coronary artery bypass grafting or percutaneous intervention. Published studies of coronary anatomy alone have shown to predict the need for future revascularisation (Serruys et al, 2009; Sianos et al, 2005), but not mortality. The scores derived from an anatomical assessment alone has been shown to have only modest correlation to predicted risk using either surgical (logistic EuroSCORE) or percutaneous (CANADA Score) risk calculators that incorporate clinical and anatomical factors (Hoole & Hamburger, 2011). The same study found comparative risk assessment using either logistic EuroSCORE or CANADA Score has good correlation (R=0.80) and importantly recognised that patients with high predicted risk for surgery may have higher risk for a percutaneous revascularisation strategy (Figure 4). This implies patients declined for surgery should not necessarily default to a PCI treatment strategy. It must be noted that the definition of risk factors in different models may vary and must be considered when applying multiple models to individual patients (Table 5).

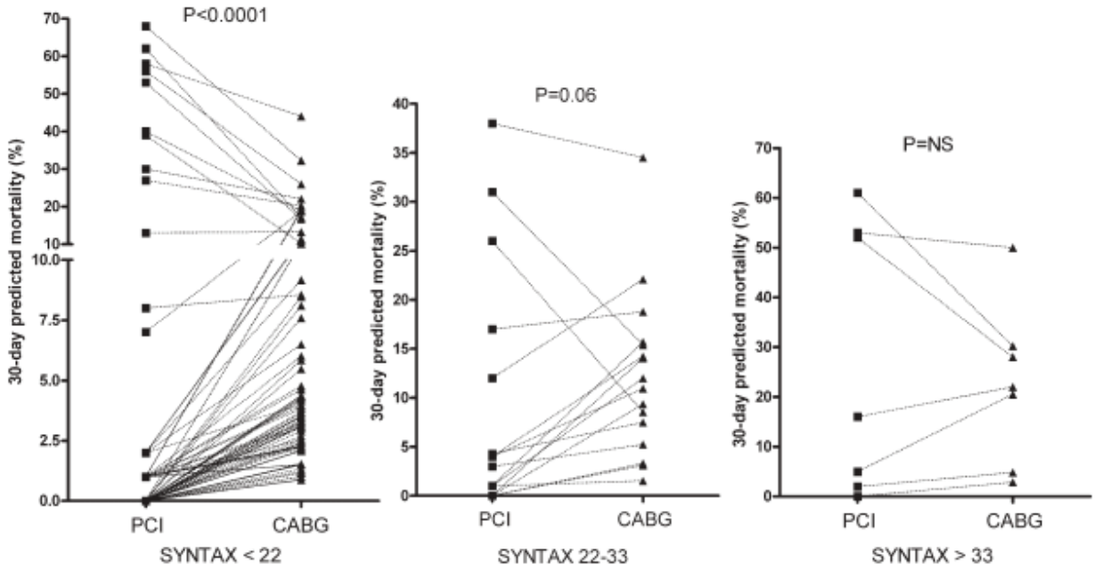

Fig. 4. Comparison of predicted PCI (CANADA Score) and CABG (EuroSCORE) mortality relative to tertiles of subject's anatomical risk (SYNTAX Score).

Risk Factor	EuroSCORE	STS Score	CANADA Score
Age	Per 5 years or part thereof over 60 years	Per 5 years or part thereof over 60 years	Per 10 year increase
Sex	Female	Female	Female
Chronic pulmonary disease	Long-term use of bronchodilators or steroids for lung disease	Patient required pharmacologic therapy for the treatment of chronic pulmonary compromise, or patient has a FEV1 <75% of predicted value	
Extracardiac arteriopathy	Any one or more of the following: claudication, carotid occlusion or >50% stenosis, previous or planned intervention on the abdominal aorta, limb arteries or carotids	Patient has peripheral vascular disease as indicated by claudication either with exertion or rest; amputation for arterial insufficiency; aorto-iliac occlusive disease reconstruction; peripheral vascular bypass surgery, angioplasty or stent; documented AAA, AAA repair, or stent; positive non-invasive testing documented – or –	

Risk Factor	EuroSCORE	STS Score	CANADA Score
		Patient has cerebrovascular disease, documented by any one of the following: Unresponsive coma >24 h; CVA (symptoms >72 h after onset); RIND (recovery within 72 h); TIA (recovery within 24 h); or noninvasive carotid test with >75% occlusion	
Neurological dysfunction disease	Severely affecting ambulation or day to day functioning	A central neurologic deficit persisting more than 24 h	
Previous cardiac surgery	Requiring opening of the pericardium	Prior cardiac surgical operation(s) with or without the use of cardiopulmonary bypass	
Serum creatinine / renal insufficiency	> 200 mmol/l preoperatively	> 200 mmol/l preoperatively	> 200 umol/l or dialysis
Active endocarditis	Patient still under antibiotic treatment for endocarditis at the time of surgery	Patient currently under antibiotic treatment for endocarditis at the time of surgery	
Critical preoperative state	Any one of more of the following: ventricular tachycardia or fibrillation or aborted sudden death, preoperative cardiac massage, preoperative ventilation before arrival in the anaesthetic room, preoperative inotropic support, intra-aortic balloon counterpulsation or preoperative acute renal	Any one or more of the following: sustained ventricular tachycardia or ventricular fibrillation requiring cardioversion and/or IV amiodarone, preoperative inotropic support, preoperative intra-aortic balloon pump, or patient required cardiopulmonary resuscitation within 1 h before the start of the operative procedure	Cardiogenic shock (a systolic blood pressure of <90 mmHg for at least 30 min and/or the need for supportive measures to maintain a systolic blood pressure of >90 mmHg, clinical evidence of end-organ hypoperfusion) or hemodynamic

Risk Factor	EuroSCORE	STS Score	CANADA Score
	failure (anuria or oliguria <10 ml/ h)		instability prior to the procedure (transient hypotension not fulfilling the definition for cardiogenic shock, or caused by sustained arrhythmia) or the anticipated need for an intra-aortic balloon pump.
Unstable angina	Rest angina requiring iv nitrates until arrival in the anaesthetic room	Preoperative use of iv nitrates	STEMI on-going, STEMI recurrent or other ACS
LV dysfunction	Moderate or LVEF 30–50%; Poor or LVEF ,30%	LVEF 30–50%; LVEF <30%	LVEF 30–50%; LVEF <30% or LVEF contraindicated*
Recent myocardial infarction	< 90 days	< 21 days	
Pulmonary hypertension	Systolic PA pressure >60 mmHg	Systolic PA pressure >30 mmHg	
Emergency	Carried out on referral before the beginning of the next working day	Procedure status is emergent or salvage. *Emergent:* The patient's clinical status includes any of the following. a. Ischaemic dysfunction (any of the following): (1) ongoing ischaemia including rest angina despite maximal medical therapy (medical and/or IABP); (2) acute evolving myocardial infarction within 24 h before surgery; or (3) pulmonary oedema requiring intubation. b. Mechanical dysfunction	Procedure has to be done without delay

Risk Factor	EuroSCORE	STS Score	CANADA Score
		(either of the following): (1) shock with circulatory support; or (2) shock without circulatory support. *Salvage: The patient is undergoing CPR en route to the OR or prior to anaesthesia induction*	
Other than isolated CABG	Major cardiac procedure other than or in addition to CABG	Any valve procedure in addition to or separate from CABG	
Surgery on thoracic aorta	For disorder of ascending, arch or descending aorta	Aortic aneurysm/dissection repair	
Post-infarct septal rupture		Ventricular septal defect	
3 vessel disease			Greater than 50% lesion in any three vessels
Left main disease		>= 50% compromise of vessel diameter preoperatively	Greater than 50% lesion
NYHA			≥ 3

*LVEF contraindicated = comorbid conditions preclude left ventricular contrast angiography (significant aortic stenosis (valve area <1.0 cm^2), presence of aortic valve prosthesis, impaired renal function (serum creatinine >200umol/L), a critical preprocedural clinical state, NYHA IV dyspnoea, grossly elevated left ventricular end diastolic pressure (>30 mmHg).

Table 5. Definition of Risk Factors for Various Risk Calculators.

7. Conclusion

Predicting procedural risk enables the correct treatment decisions to be made and allows valid informed consent and accurate patient counselling. This is particularly important as PCI has become accepted as a viable alternative to established surgical intervention. Early assessment of risk with PCI was limited to short term events that ignored important late events and prevented direct comparison with surgical risk predication tools. The CANADA Score was developed to accurately predict 30 day mortality risk and has been externally validated in large North American cohorts demonstrating broad applicability to varied patient groups. The CANADA Score confirms that both anatomical and clinical data are required to provide accurate and discriminatory 30 day mortality risk prediction and it therefore allows comparison with well validated surgical risk prediction models to guide optimal revascularisation strategy. Application of the CANADA Score to patients with high surgical risk demonstrates the potential for equal or greater risk with a percutaneous

strategy and challenges the traditional notion that percutaneous revascularization should be a default strategy for these patients. The CANADA Score is available as an on-line calculator (www.canadascore.org) (Figure 5) facilitating easy integration into regular clinical practice.

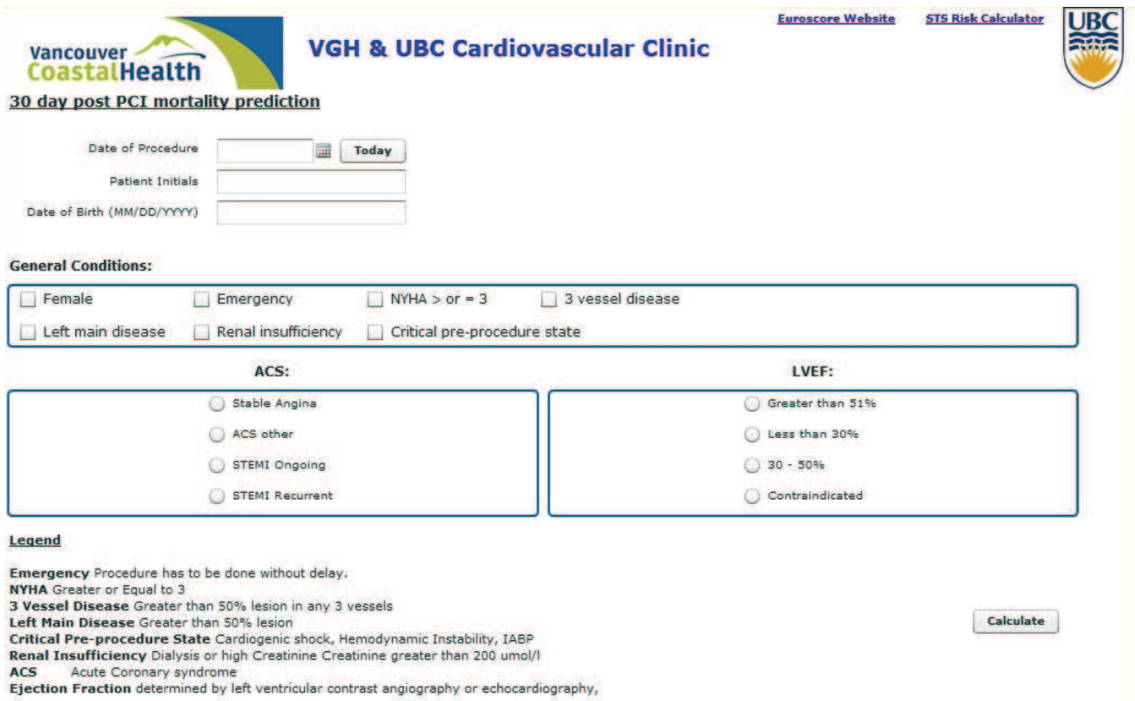

Fig. 5. On-line CANADA Score Calculator. Available at www.canadascore.org

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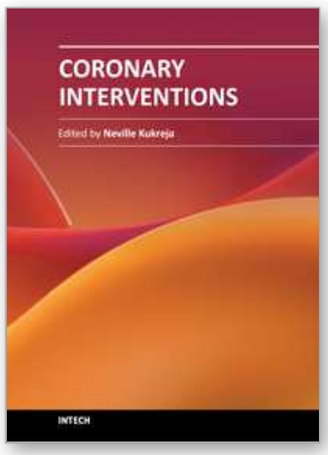

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