

LETTER TO THE EDITOR

Impact of risk stratification on cardiovascular outcomes in patients with stable chest pain

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Dear Editor,

Chest pain is a common presenting complaint among patients visiting primary care¹ and is a frequent reason for referral to the outpatient cardiology clinic. The European Society of Cardiology (ESC) and American College of Cardiology/American Heart Association (ACC/AHA) guidelines advocate estimating pre-test probability (PTP) of obstructive coronary artery disease (CAD) in the evaluation of stable chest pain in order to guide the need for and type of downstream investigations.^{2,3} The PTP of obstructive CAD depends on the clinical characteristics of the patient and disease prevalence. Since the introduction of the Diamond-Forrester model in 1979,⁴ contemporary risk scores, such as the CAD consortium score⁵ (CCS) and the ESC 2019 PTP risk score,² have been developed.

These risk scores predict the risk of having obstructive CAD and not clinical outcomes like mortality, myocardial infarction and stroke. Subsequent studies have shown that having a low PTP of obstructive CAD confers a good prognosis with low adverse clinical outcomes and in this group of patients, additional cardiac testing such as stress testing and coronary imaging may be safely deferred.^{2,3,6} This could potentially translate to time and cost savings to the patient and healthcare system.

The majority of these risk scores were designed for Western cohorts, with subsequent clinical outcomes also validated in similar populations. In Singapore, the Predictive Risk score for CAD In Southeast Asians with chest pain (PRECISE) was recently developed as a risk prediction tool for obstructive CAD in Southeast Asians presenting with stable chest pain.⁷ We aim to report on the incidence of cardiac testing, as well as objective cardiovascular outcomes, across the different strata of PTP of obstructive CAD.

The detailed methodology has previously been described.⁷ In summary, the PRECISE cohort

comprises patients who attended primary care for stable chest pain and were referred to the National Heart Centre Singapore, Cardiology clinic for further assessment between July 2013 and December 2016. Patients with prior CAD, acute coronary syndrome and under the age of 30 years were excluded. Ethical approval was obtained. All participants provided written informed consent.

Patients were classified according to their PTP of obstructive CAD, using both the PRECISE simple risk and CCS clinical risk scores. These risk scores use variables including age, sex, cardiovascular risk factors (e.g. hypertension, diabetes mellitus, dyslipidaemia and smoking status), type of chest pain and whether the pain radiated to the neck, and have been previously published.^{5,7} Additional cardiac stress or anatomical testing (decided by the managing cardiologist) was performed on some patients, and these included treadmill electrocardiogram, stress echocardiogram, myocardial perfusion imaging, computed tomography coronary angiogram, and invasive coronary angiography. Outcomes that were studied include mortality and major adverse cardiovascular events (MACE) defined as a composite of cardiovascular death, non-fatal myocardial infarction, non-fatal stroke and revascularisation (percutaneous coronary intervention [PCI] and/or coronary artery bypass graft surgery). All patients were followed-up for 1 year.

A total of 1658 patients were included with 1469 patients (88.6%) undergoing cardiac testing (stress testing or anatomical evaluation). Using the PRECISE risk score, 793 patients (47.8% of the whole cohort) had a PTP of <5%; within this group, the 1-year mortality and MACE rates were 0.0% and 1.4% respectively, and 86.0% had tests performed. A total of 512 patients (30.9% of the whole cohort) had a PTP of 5%–14.99%; in this group, the 1-year mortality and MACE rates were 0.2% and 6.4% respectively, and 88.9% had tests

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Table 1. Incidence of cardiac testing and cardiovascular outcomes at 1 year in the PRECISE population across the strata of PTP of obstruction CAD using both the PRECISE simple risk and CCS risk clinical scores.

PTP	Total n (%)	No test n (%)	1 test n (%)	>1 test n (%)	All-cause mortality n (%)	MACE n (%)	CV mortality n (%)	MI n (%)	Stroke n (%)	Revascularisation n (%)
PRECISE simple risk score	<5%	793 (100)	111 (14)	628 (79.2)	54 (6.8)	0 (0)	11 (1.4)	0 (0)	1 (0.1)	10 (1.3)
	5%–9.99%	351 (100)	42 (12)	289 (82.3)	20 (5.7)	0 (0)	19 (5.4)	4 (1.1)	3 (0.9)	15 (4.3)
	10%–14.99%	161 (100)	15 (9.3)	132 (82)	14 (8.7)	1 (0.6)	14 (8.7)	1 (0.6)	1 (0.6)	12 (7.5)
	15%–24.99%	190 (100)	10 (5.3)	145 (76.3)	35 (18.4)	0 (0)	20 (10.5)	1 (0.5)	0 (0)	20 (10.5)
	25%–49.99%	144 (100)	10 (6.9)	108 (75)	26 (18.1)	1 (0.7)	24 (16.7)	2 (1.4)	1 (0.7)	21 (14.6)
	≥50%	19 (100)	1 (5.3)	15 (78.9)	3 (15.8)	0 (0)	9 (47.4)	1 (5.3)	0 (0)	9 (47.4)
CCS clinical score risk	<5%	326 (100)	47 (14.4)	260 (79.8)	19 (5.8)	0 (0)	2 (0.6)	0 (0)	0 (0)	2 (0.6)
	5%–9.99%	313 (100)	38 (12.1)	255 (81.5)	20 (6.4)	0 (0)	6 (1.9)	0 (0)	1 (0.3)	5 (1.6)
	10%–14.99%	191 (100)	21 (11)	149 (78)	21 (11)	0 (0)	10 (5.2)	1 (0.5)	1 (0.5)	9 (4.7)
	15%–24.99%	241 (100)	24 (10)	193 (80.1)	24 (10)	1 (0.4)	18 (7.5)	3 (1.2)	2 (0.8)	14 (5.8)
	25%–49.99%	247 (100)	21 (8.5)	197 (79.8)	29 (11.7)	0 (0)	28 (11.3)	0 (0)	1 (0.4)	27 (10.9)
	≥50%	106 (100)	7 (6.6)	76 (71.7)	23 (21.7)	1 (0.9)	26 (24.5)	3 (2.8)	1 (0.9)	23 (21.7)

Tests include treadmill electrocardiogram, stress echocardiogram, myocardial perfusion imaging, computed tomography (CT) coronary angiogram, and invasive coronary angiography (excludes CT calcium score). “No test” includes patients who were not offered and those who declined testing. Revascularisation refers to percutaneous coronary intervention and/or coronary artery bypass graft surgery. CAD: coronary artery disease; CCS: coronary artery disease consortium score; CT: computed tomography; CV: cardiovascular; MACE: major adverse cardiovascular event; MI: myocardial infarction; PRECISE: Predictive Risk score for CAD In Southeast Asians with chest pain; PTP: pre-test probability

The total number of patients classified by the CCS clinical risk score is smaller than the total number of patients classified by the PRECISE simple risk score, due to missing data for the CCS risk clinical score in the original cohort.

performed. Additionally, 190 patients (11.5% of the whole cohort) had a PTP of 15%–24.99%; in this group, the 1-year mortality and MACE rates were 0.0% and 10.5% respectively, and 94.7% had tests performed. Moreover, 163 patients (9.8% of the whole cohort) had a PTP of $\geq 25\%$; in this group, the 1-year mortality and MACE rates were 0.6% and 20.2% respectively, and 82.8% had tests performed. The majority of MACE rates were driven by revascularisation. Table 1 shows the breakdown of the individual outcomes by risk strata. In a previous publication,⁷ the PRECISE risk score was found to be more accurate with the CCS clinical risk score overclassifying risk in our Singapore cohort. The results from the CCS clinical risk score are shown in Table 1 for reference.

According to the ESC guidelines, while it may be overall safe to defer testing in patients classified to have a PTP $< 15\%$,² further testing may be considered in a patient with a PTP of 5%–15% depending on patient preference, local resources, availability of tests, clinical judgement and appropriate patient information.² The ACC/AHA guidelines also advocate deferring testing in patients classified to be low risk. In our Singapore cohort, the 1-year MACE rate in those at very low risk ($< 5\%$) was low at 1.4% driven predominantly by revascularisation. However, testing was performed in the vast majority ($> 80\%$). In those at low risk (5%–14.99%), the 1-year MACE rate was slightly higher at 6.4%, once again driven predominantly by revascularisation, but the vast majority (about 90%) underwent testing. Additional cardiac testing may be over-utilised, especially in the very low-risk group (PTP $< 5\%$). The reasons for these tests are unclear but could be due to multiple reasons, such as patient request, physician preference and perceived malpractice risk. The benefits of cardiac testing in the very low-risk population remain unclear, and reduction of such testing may alleviate the burden on the patient and healthcare system. Unnecessary testing may increase the financial burden on patients, create anxiety and lead to unintended consequences with false positive tests. With regard to the healthcare system, the avoidance of unnecessary testing would free up available limited resources to patients who truly require them, alleviating manpower and resource constraints. This very low-risk patient group accounts for a large majority of referrals, and savings may be substantial. Similar findings have been noted. In a Brazilian study, while lower than in the private sector, there was still a significant amount of inappropriate treadmills (about 57%) ordered in the public sector with the majority of patients having low or very low PTP of CAD.⁸

Another study in the US estimated that about a third of cardiac stress tests were inappropriate, resulting in increased annual costs and harm.⁹

Some limitations exist. Whether cardiac testing could have potentially improved cardiovascular outcomes by facilitating the initiation of medical therapy is unknown, as medication data were not readily available. In addition, whether testing led to subsequent revascularisation and consequently reduced mortality or myocardial infarction is unclear. Moreover, many studies have not shown improvement of survival with revascularisation (especially PCI) in stable chest pain.¹⁰ Also, in the very low-risk group (PTP $< 5\%$), the number of revascularisations is low. Finally, selection bias may exist as not all subjects agreed to take part in the study.

In conclusion, while the incidence of adverse cardiovascular outcomes increased with higher PTP risks, absolute numbers remain low. In the very low-risk strata (PTP $< 5\%$), incidence of adverse cardiovascular outcomes is low, and efforts could potentially be made towards reduction in unnecessary testing in this group.

Disclosure

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Ethics statement

The manuscript was approved by the SingHealth Centralised Institutional Review Board (CIRB2018/2851).

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