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Ethnic differences in clinical outcome of patients presenting to the emergency department with chest pain

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Abstract

Background: Ethnicity, although known to influence cardiovascular outcome in assorted clinical settings, has not been investigated previously as a risk factor in patients presenting to the emergency department with suspected acute myocardial infarction.

Methods: In this multi-ethnic cohort study conducted in Singapore and The Netherlands, 2784 patients presenting to the emergency department with chest pain were enrolled (788 Caucasians, 1281 Chinese, 404 Indians and 311 Malays) and were followed up for 1 year.

Results: Although Caucasian patients on average were older and had incurred more cardiovascular adverse events, the Asian ethnic groups carried a greater burden of cardiovascular risk factors. Caucasian and Malay patients were most frequently diagnosed with acute myocardial infarction (Caucasians 11.2%, Chinese and Indians 6.4%, Malays 10.6%, $P<0.001$), also after correction for baseline differences. Chinese and Indian patients, however, more often had unstable angina. Asian patients had strikingly more extensive coronary artery disease than Caucasian patients (triple-vessel disease: Caucasians 6.5%, Chinese 22.8%, Indians 32.4%, Malays 32.8%, $P<0.001$) and Chinese patients with myocardial infarction more frequently underwent coronary revascularisation compared with Caucasian patients (Caucasians 41.4%, Chinese 67.5%, Indians 62.5%, Malay 46.7%, $P=0.005$). Ethnicity was not an independent predictor of major adverse cardiovascular events during 1-year follow-up in all chest pain patients.

Conclusions: The prevalence of myocardial infarction and unstable angina, revascularisation rate and extent of coronary artery disease differ significantly among chest pain patients of different ethnic groups. These findings have

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important clinical implications and support consideration of ethnicity in risk stratification and determination of the patient management strategy in patients with symptoms suggestive of myocardial infarction.

Keywords
Ethnicity, major adverse cardiac events, outcome, myocardial infarction, chest pain, coronary artery disease

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Introduction

Acute myocardial infarction (MI) is a major cause of morbidity and mortality worldwide. Although therapy for MI has greatly improved and mortality has declined substantially in industrialised countries over the past 40 years, mortality from MI is still rising in other parts of the world such as Africa and parts of Asia.[1–3]

Annually, millions of patients present to the emergency department (ED) with chest pain, of whom only a minority is diagnosed with MI.[4] As mortality is highest within the first hours after the onset of symptoms and early treatment greatly improves prognosis, it is crucial to recognise MI as early as possible.[5,6] The evaluation of chest pain patients is based on clinical presentation, 12-lead electrocardiogram and cardiac troponin measurements, and frequently also includes imaging modalities.[6] Patients with significant elevation of the ST-segment on the electrocardiogram (ST-segment elevation myocardial infarction; STEMI) are candidates for urgent reperfusion therapy, preferably by percutaneous coronary intervention (PCI).[7,8] The majority of patients presenting with chest pain (i.e. generally over 75%) do not have an acute coronary syndrome (ACS).[9] Among those with ACS most (i.e. generally over 60%) do not have STEMI but might have a non ST-segment elevation myocardial infarction (NSTE-ACS) ACS, further categorised as NSTEMI (a significant rise and fall of cardiac troponins) or unstable angina (no rise/fall of cardiac troponins), or have non-cardiac chest pain.[6]

Diagnosing or excluding MI at an early stage is often challenging, especially in patients presenting soon after the onset of symptoms.[5,6] The cornerstone of the initial evaluation of chest pain patients is to estimate the individual patient's risk.[6] For this purpose, risk stratification tools can be of major assistance. Risk scores such as the thrombolysis in myocardial infarction (TIMI)[10] and the global registry of acute cardiac events (GRACE)[11] scores have been developed to predict the outcome of patients with NSTE-ACS. Other risk scores, such as the HEART score, estimate cardiovascular risk in patients with suspected MI and facilitate clinical decision-making in the ED.[12] Patients at very low risk can be discharged safely, patients at low or medium risk should be observed closely and subjected to additional (non-invasive) investigations, and patients at high risk should be treated and considered for early invasive strategies.[6]

Ethnicity currently plays no formalised role in risk stratification for suspected MI, although marked inter-ethnic differences in the prevalence of cardiovascular risk factors,[13–15] the prevalence of ischaemic heart disease and in the prognosis of patients with ischaemic heart disease[13,16] are well recognised. Our current knowledge on risk stratification of chest pain patients presenting to the ED is largely based on studies conducted in western countries, involving mainly Caucasian patients. Several studies have investigated the performance of existing cardiovascular risk scores in Asian populations and concluded that recalibration is often necessary.[17,18] The relationship between ethnicity and clinical outcome in patients suspected of having MI in the ED has not previously been investigated.

In this study, we sought to determine whether ethnicity is related to clinical outcome in patients suspected of having MI. If so, consideration of ethnicity may improve risk stratification and, subsequently, patient management in the ED. We studied the relationship of ethnicity to the prevalence of MI, unstable angina, revascularisation rate and major adverse cardiovascular events (MACEs) during 1-year follow-up among Caucasian, Chinese, Indian and Malay patients in The Netherlands and Singapore presenting to the ED with chest pain.

Methods

This study is a multi-ethnic cohort study involving consecutive patients presenting to the ED with symptoms suggestive of MI. Patients were enrolled in three hospitals: Meander Medical Center, Amersfoort, The Netherlands (January 2012 to January 2013); National University Hospital Singapore (December 2010 to April 2013); and Singapore General Hospital Singapore (January 2010 to September 2011). The study has been evaluated and approved by the ethics committees of all participating centres and written informed consent was obtained from all participants. The study conforms to the Declaration of Helsinki.

A detailed description of the methods can be found in the supplementary material.

Results

Study cohort

After the exclusion of patients with STEMI at the time of presentation, age younger than 21 years and those with ethnicity other than Caucasian, Chinese, Indian or Malay,

Table 1. Clinical characteristics.

n	Caucasian (788)	Chinese (1281)	Indian (404)	Malay (311)	*P* value
Demographics					
Age (years ± SD)	62.6 ± 14.3	58.3 ± 12.1[a,d]	53.0 ± 11.2[b]	52.8 ± 12.3[c,e]	<0.001
Male gender (%)	56.3	67.8[a]	70.3[b]	65.3	<0.001
Risk factors					
BMI (kg/m^2 + SD)	27.0 ± 4.7	25.1 ± 4.3[a,d]	27.3 ± 4.9	28.1 ± 5.2[c,e]	<0.001
Smoking (%)	28.6	26.5[a]	32.3	39.7[c,e]	<0.001
Hypertension (%)	48.6	53.8	50.6	49.0	0.099
Dyslipidaemia (%)	30.7	52.9[a]	49.9[b]	54.5[c]	<0.001
Diabetes (%)	14.8	21.3[a,d]	40.7[b,f]	30.0[c,e]	<0.001
Medical history					
Previous MI (%)	19.6	8.4[a,d]	15.3	13.8[e]	<0.001
Previous PCI (%)	22.9	11.8[a,d]	20.0	15.1[c]	<0.001
Previous CABG (%)	7.4	5.6	8.2	7.1	0.218
CVA/TIA (%)	1.9	3.7	2.0	2.6	0.058
Renal impairment total (%)	18.4	23.5[d]	16.4	15.5[e]	0.002
Moderate (%)	15.9	18.2	12.2	9.5[e]	0.001
Severe (%)	2.5	5.3[a]	4.2	6.1	0.014
Medication prescribed					
Aspirin (%)	40.0	16.9[a]	20.5[b]	18.7[c]	<0.001
Other antiplatelet (%)	11.7	6.9[a]	10.9	7.1	<0.001
Statins (%)	42.3	30.5[a]	29.2[b]	35.2	<0.001
Beta-blockers (%)	39.3	23.4[a]	17.3[b]	24.7	<0.001
ACE inhibitors (%)	24.7	13.3[a]	14.4[b]	18.4	<0.001
Calcium antagonists (%)	17.3	14.4	11.2	12.9	0.037
Diuretics (%)	25.3	4.5[a]	5.0[b]	8.1[c]	<0.001

Baseline characteristics of all patients (*n*=2784).
BMI: body mass index; MI: myocardial infarction; PCI: percutaneous coronary intervention; CABG: coronary artery bypass grafting; CVA: cerebrovascular accident; TIA: transient ischaemic attack.
Differences between ethnic groups were tested with χ^2 tests for categorical variables and with one-way analysis of variance for continuous variables. The last column represents overall *P* values.
[a]Caucasian vs. Chinese.
[b]Caucasian vs. Indian.
[c]Caucasian vs. Malay.
[d]Chinese vs. Indian.
[e]Chinese vs. Malay.
[f]Indian vs. Malay (*P*<0.008).

2784 patients were eligible for analysis. In The Netherlands 788 patients were enrolled and in Singapore 1996 patients were enrolled (162 in the National University Hospital Singapore and 1834 in the Singapore General Hospital). Of all patients, 788 (28.3%) were Caucasian, 1281 (46.0%) were Chinese, 404 (14.5%) were Indian and 311 (11.2%) were Malay.

Patient characteristics

Patient characteristics are summarised in Table 1. Indian and Malay patients were significantly younger than Caucasian and Chinese patients. Asian patients tended to carry more cardiovascular risk factors than Caucasian patients. Dyslipidaemia was more prevalent in all Asian ethnic groups compared with Caucasian groups. Diabetes was most common in Indian and Malay patients. Smoking and body mass index (BMI), however, were most favourable in Chinese patients.

Caucasian patients had a more extensive history of adverse cardiovascular events than Asian patients. Chinese patients were least likely to have experienced a previous MI, while Caucasian and Indian patients had most often undergone a previous PCI. More cardiovascular medications were prescribed for Caucasian than for Asian patients (aspirin, statins, angiotensin-converting enzyme (ACE) inhibitors, beta-blockers, calcium antagonists and diuretics). Renal impairment was most prevalent in Chinese patients. The clinical characteristics of patients diagnosed with MI can be found in the Supplementary Table 1.

Ethnicity is an independent predictor of MI during the index visit

Caucasian and Malay patients were most frequently diagnosed with MI during the index visit (Caucasians 11.2%, Chinese 6.4%, Indians 6.4%, Malays 10.6%, *P*<0.001) (Table 2). After adjusting for baseline characteristics

Table 2. Clinical outcome.

n	Caucasian (788)	Chinese (1281)	Indian (404)	Malay (311)	*P* value
Diagnosis					
MI (% of total)	11.2	6.4[a]	6.4	10.6	<0.001
NSTEMI (%)	10.9	5.9[a]	5.9[b]	10.0	<0.001
STEMI (%)	0.3	0.5	0.5	0.6	0.807
Unstable angina (%)	5.0	10.5[a]	11.4[b]	7.4	<0.001
Other (%)	83.8	83.1	82.2	82.0	0.844
NSTE-ACS (%)	16.2	16.9	17.8	18.0	0.844
Coronary revascularisation (index visit)					
All patients (%)	6.6	9.2	8.2	6.7	0.198
MI patients (%)	41.4	67.5[a]	62.5	46.7	0.005
Unstable angina patients (%)	39.5	39.5	32.6	21.7	0.373
Follow-up 1 year					
MACE (%)	12.3	8.7	8.8	8.5	0.050
Death (%)	3.0	1.7	0.8	1.1	0.032
MI (%)	3.3	1.5	1.4	1.8	0.037
Coronary revascularisation (%)	8.5	6.7	7.1	6.7	0.508

Clinical outcome of chest pain patients during index visit and during 1 year of follow-up.
MI: myocardial infarction; STEMI: ST-segment elevation myocardial infarction; NSTEMI: non-ST-segment elevation myocardial infarction; NSTE-ACS: non ST-segment elevation acute coronary syndrome; MACE: major adverse cardiovascular event.
Differences between ethnic groups were tested with χ^2 tests.
The last column represents overall *P* values.
[a]Caucasian vs. Chinese.
[b]Caucasian vs. Indian (*P*<0.008).

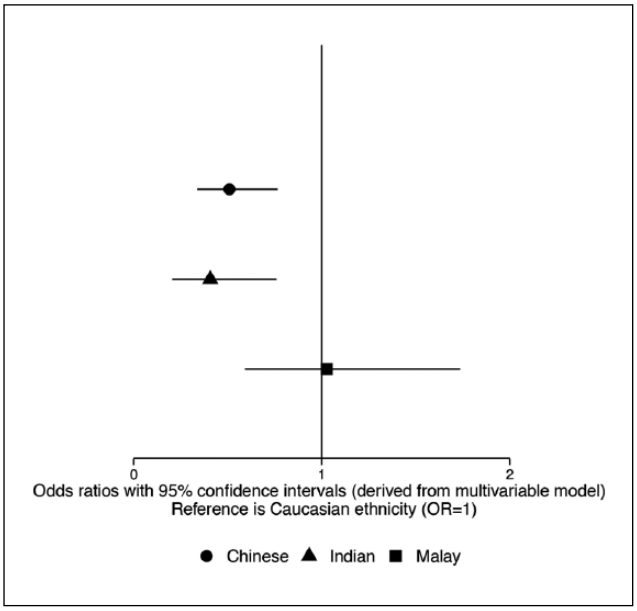

Figure 1. Forest plot depicting the odds ratios (ORs) and 95% confidence intervals (CI) of the likelihood of having myocardial infarction (index visit), with Caucasian patients set as a reference group (OR 1). ORs are adjusted for possible confounders in a logistic regression model. Chinese versus Caucasian patients: OR 0.51, 95% CI 0.34–0.77, *P*=0.001; Indian versus Caucasian patients: OR 0.41, 95% CI 0.21–0.76, *P*=0.007; Malay versus Caucasian patients: OR 1.03, 95% CI 0.59–1.74, *P*=0.924.

Chinese and Indian patients had a lower chance of having MI than Caucasian patients (Chinese vs. Caucasians: odds ratio (OR) 0.51, 95% confidence interval (CI) 0.34–0.77, *P*=0.001; Indians vs. Caucasians: OR 0.46, 95% CI 0.21–0.76, *P*=0.007; Figure 1) whereas the rate of MI in Malay patients was comparable with that in Caucasian patients. There were no significant interactions between risk factors and ethnicity for the outcome of MI.

In contrast, Chinese and Indian patients more often were diagnosed with unstable angina than Caucasian patients (Caucasians 5.0%, Chinese 10.5%, Indians 11.4%, Malays 7.4%, *P*<0.001). Consequently, the prevalence of NSTE-ACS ACS was equal across the ethnic groups (Table 2).

Of the patients diagnosed with MI, Chinese patients more often underwent coronary revascularisation during their index visit than Caucasian patients (Caucasians 41.4%, Chinese 67.5%, Indians 62.5%, Malays 46.7%, *P*=0.005). There were no differences in the rate of coronary revascularisation of unstable angina patients between the ethnic groups (Table 2).

The extent of coronary artery disease

Of all patients who underwent coronary angiography, Chinese, Indian and Malay patients had significantly more triple-vessel disease than Caucasian patients (Caucasians 6.5%, Chinese 22.8%, Indians 32.4%, Malays 32.8%, *P*<0.001; Table 3(a)). This inter-ethnic difference was also

Table 3. Angiographic findings.

	Caucasian	Chinese	Indian	Malay	*P* value
(a) All patients (*n*)	788	1281	404	311	
Coronary angiogram (%)	15.6	18.1	17.6	20.6	0.232
No/minor CAD (%)	32.5	15.5[a]	8.5[b]	17.2	<0.001
1-vessel disease (%)	28.5	29.3	22.5	18.8	0.296
2-vessel disease (%)	25.2	22.0	31.0	18.8	0.323
3-vessel disease (%)	6.5	22.8[a]	32.4[b]	32.8[c]	<0.001
LMCA disease (total) (%)	7.3	10.3	5.6	12.5	0.423
LMCA (%)	0.8	3.4	1.4	1.6	0.385
LMCA + RCA (%)	6.5	6.9	4.2	10.9	0.488
(b) MI patients (*n*)	88	82	26	33	
Coronary angiogram (%)	84.1	78.0	84.6	87.9	0.567
No/minor CAD (%)	24.3	0[a]	4.5	6.9	<0.001
1-vessel disease (%)	31.1	34.4	13.6	17.2	0.136
2-vessel disease (%)	28.4	20.3	45.5	20.7	0.114
3-vessel disease (%)	5.4	31.3[a]	31.8[b]	41.4[c]	<0.001
LMCA disease (total) (%)	10.8	14.1	4.5	13.8	0.654
LMCA (%)	1.4	0	0	3.4	0.464
LMCA + RCA (%)	9.5	14.1	4.5	10.3	0.622
(c) Unstable angina patients (n)	39	134	48	23	
Coronary angiogram (%)	59.0	89.6[a]	80.4	95.7[c]	<0.001
No/minor CAD (%)	8.7	3.3	0	9.1	0.210
1-vessel disease (%)	34.8	31.7	24.3	27.3	0.790
2-vessel disease (%)	39.1	28.3	27.0	18.2	0.480
3-vessel disease (%)	13.0	25.0	40.5	27.3	0.112
LMCA disease (total) (%)	4.3	11.7	8.1	18.2	0.459
LMCA (%)	0	5.8	2.7	0	0.374
LMCA + RCA (%)	4.3	5.8	5.4	18.2	0.178

Angiographic findings of all patients (a), patients with MI (b) and patients with unstable angina (c).
MI: myocardial infarction; CAD: coronary artery disease; LMCA: left main coronary artery; RCA: right coronary artery.
Differences between ethnic groups were tested with χ^2 tests.
The last column represents overall *P* values.
[a]Caucasian vs. Chinese.
[b]Caucasian vs. Indian.
[c]Caucasian vs. Malay (*P*<0.008).

evident among patients diagnosed with MI (Caucasians 5.4%, Chinese 31.3%, Indians 31.8%, Malays 41.4%, *P*<0.001; Table 3(b)). Of patients with unstable angina, Chinese and Malay patients more frequently underwent coronary angiography compared with Caucasian patients (Caucasians 59.0%, Chinese 89.6%, Indians 80.4%, Malays 95.7%, *P*<0.001; Table 3(c)). In these patients there were no significant differences in the extent of CAD between the ethnic groups. Overall, there were no inter-ethnic differences in the prevalence of left main coronary artery lesions.

Ethnic differences in 1-year prognosis of patients presenting to the ED with chest pain

Complete 1-year follow-up was accomplished in 766/788 (97.2%) of Caucasian patients, 1147/1281 (89.5%) of Chinese patients, 365/404 (90.3%) of Indian patients and 282/311 (90.7%) of Malay patients. Caucasian patients had the highest absolute rate of MACEs during 1 year of follow-up. This difference was driven by a higher mortality and more MI during follow-up (Table 2). However, when adjusted for baseline differences in a Cox proportional hazards model, there were no significant differences in follow-up between the ethnic groups. A graphical representation of the adjusted survival curves based on regression estimates is depicted in Figure 2. The hazard ratios (HRs) can be found in Supplementary Table 2. Age was the most important factor influencing crude ethnicity-specific event rates. There were modest but statistically significant interactions between Chinese ethnicity and diabetes for MACEs (*P*=0.037, higher HR in Chinese patients), between Chinese ethnicity and a history of PCI for MI (*P*=0.012, lower HR in Chinese patients), and between Chinese ethnicity and

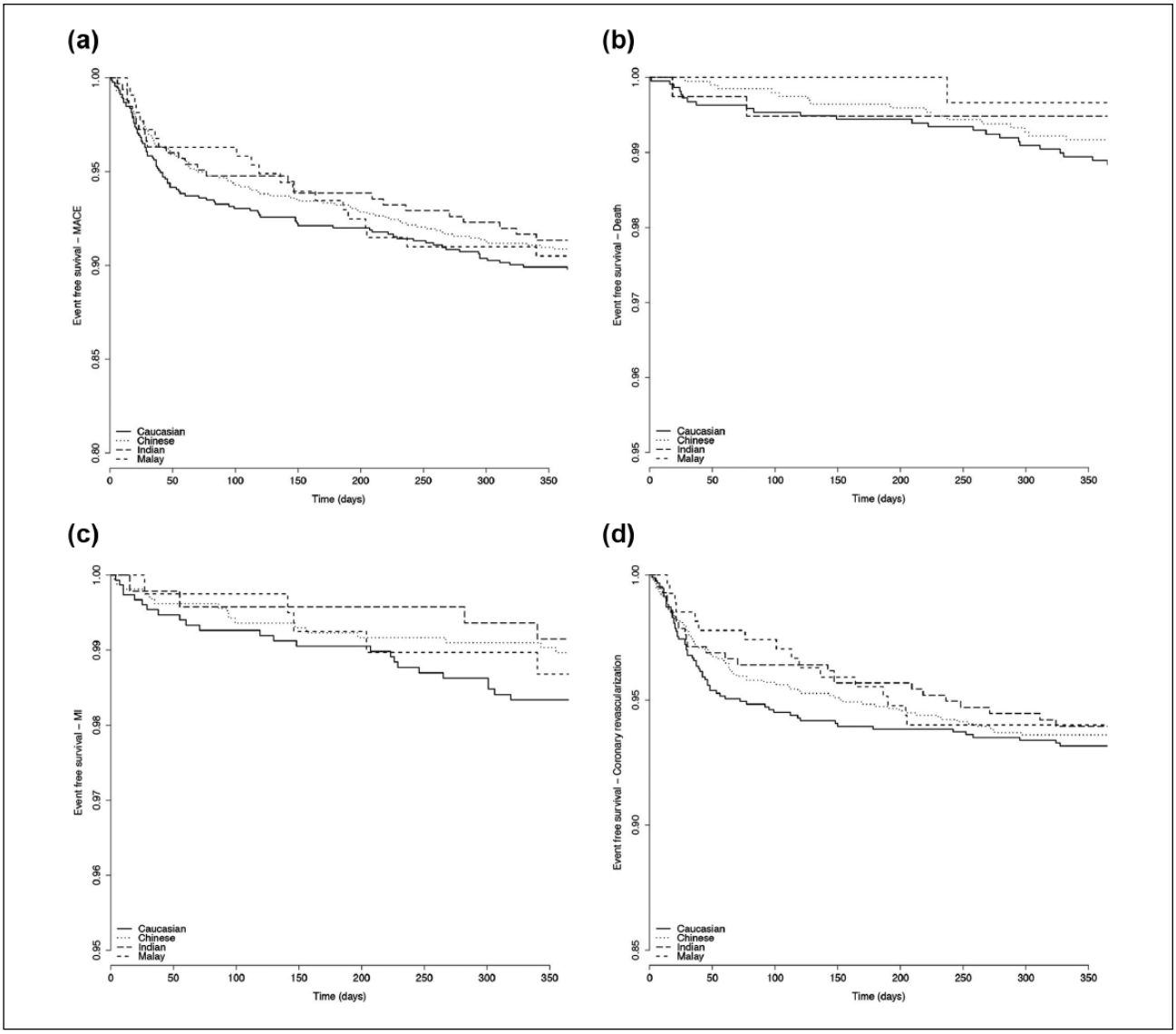

Figure 2. Graphical representation of adjusted survival curves for major adverse coronary events (MACEs), death, myocardial infarction (MI) and coronary revascularisation, derived from multivariable Cox proportional hazards models. (a) MACE-free survival probability, adjusted for age, gender, diabetes, dyslipidaemia, hypertension, glomerular filtration rate (GFR), history of MI, history of percutaneous coronary intervention (PCI), history of coronary artery bypass grafting (CABG), use of aspirin, other antiplatelet drugs, statins, angiotensin-converting enzyme (ACE) inhibitors, beta-blockers, calcium antagonists and diuretics. (b) All-cause death-free survival probability, adjusted for age, body mass index (BMI), diabetes, GFR, history of CABG, use of aspirin, ACE inhibitors, and diuretics. (c) MI-free survival probability, adjusted for age, GFR, history of MI, history of PCI, history of CABG, use of aspirin, other antiplatelet drugs, statins, beta-blockers, ACE inhibitors, calcium antagonists and diuretics. (d) Coronary revascularisation-free survival probability, adjusted for age, gender, diabetes, hypertension, current smoking, history of MI, history of PCI, use of aspirin, other antiplatelet drugs, statins, beta-blockers and calcium antagonists; There was no significant association between ethnicity and follow-up events for either of the outcomes. Hazard ratios with 95% confidence intervals and *P* values can be found in Supplementary Table 2.

diabetes and BMI for death (P=0.048 and P=0.035, respectively, lower HR in Chinese patients) compared with Caucasian patients (Supplementary Table 3).

Discussion

In this multi-ethnic cohort study, we found significant inter-ethnic differences in cardiovascular risk profile, the prevalence of MI and unstable angina, revascularisation rates and the severity of CAD in patients presenting to the ED with chest pain.

Previous studies have shown Asian patients generally harbour more cardiovascular risk factors and experience their first MI at a younger age than Caucasian patie nts.[13–15,19–21] We report that this also holds true for patients presenting to the ED with chest pain. Indian and Malay

patients were far younger than Caucasian patients (up to 10 years), whereas the difference was less marked in Chinese patients. Despite their younger age, we found that Indian and Malay patients, in particular, had a more unfavourable risk profile than Caucasian patients, with more dyslipidaemia and diabetes. Chinese patients, however, had the lowest smoking rates and the lowest BMI.

This study reports marked inter-ethnic differences in the likelihood of the presence of an acute MI among patients presenting to the ED with chest pain. These inter-ethnic distinctions are independent of differences in other patient characteristics including cardiovascular risk factors. Caucasian and Malay patients had a 1.7–1.8-fold higher MI rate than Chinese and Indian patients. In the general population the incidence of MI tends to be higher in Indian and lower in Chinese patients, compared with Caucasian patients.[13,16] These previous reports, however, were population based and did not investigate the MI rate among chest pain patients presenting to the ED, the setting in which risk stratification is most urgent.

The low MI rate among Chinese and Indian patients seems to be balanced by higher rates of unstable angina in these groups. In fact, the total prevalence of NSTE-ACS did not differ between the ethnic groups. This finding shows that although Chinese and Indian patients have a relatively low MI rate, they do experience severe CAD leading to unstable angina. It is also possible that this distinction partly reflects differing troponin thresholds (derived mainly from studies in Caucasian patients) applied using different assays in different centres. It is also conceivable, although intuitively unlikely, that the relationship of the timing and extent of cardiac injury to the associated change in plasma cardiac troponin is influenced by ethnicity. This will require further assessment using identical troponin assays across ethnicities.

We observed important inter-ethnic differences in the extent of CAD among MI patients, as assessed by coronary angiography. MI patients of all Asian ethnic groups had more triple-vessel disease than Caucasian patients, despite being younger. These findings are in line with observations from previous studies, showing that South Asian patients have more severe CAD and different anatomical patterns of CAD at younger ages than Caucasian patients.[22–24]

Of the patients diagnosed with MI, Chinese patients most often underwent coronary revascularisation during the index visit (67.5% of Chinese vs. 41.4% of Caucasian patients, $P<0.001$). The revascularisation rate of MI patients during the index visit seems to be relatively low, especially in Caucasian patients. Several reasons may account for these low rates and inter-ethnic differences. First of all, it is important to appreciate that this percentage only accounts for the patients undergoing coronary revascularisation during their index admission. Elective revascularisations after initial hospital discharge were counted as follow-up events. The MI population in our cohort almost exclusively consists of NSTEMI patient, so no immediate reperfusion therapy was applied. CAD was less severe in Caucasian patients and this most likely contributes to the lower revascularisation rate during the index visit in Caucasian compared to Asian ethnicities. In 24% of Caucasian MI patients there were no or only minor coronary lesions, and fewer Caucasian patients had triple-vessel disease than Asian MI patients. In addition, age and comorbidity might also influence revascularisation rates. Caucasian MI patients in general were older and had more comorbidity than Asian MI patients. Procedural risk in elderly patients and patients with extensive comorbidity is higher and may have resulted in opting for optimal medical therapy instead of an early invasive strategy more frequently.

The fact that Caucasian patients experienced more MIs than Chinese and Indian patients even after adjustment for older age, and despite less extensive CAD, suggests there are inter-ethnic differences in the underlying pathophysiology. NSTEMI is usually caused by acute, platelet rich and partially occlusive thrombus formation at the site of a vulnerable plaque.[25] Unstable angina is a dynamic syndrome, often characterised by interplay between multiple non-occlusive plaques, intermittent non-occlusive thrombosis on existing plaques, progressive mechanical obstruction, inflammation and increased myocardial oxygen demand.[26] Although ethnic differences in coronary plaque composition have not been studied, ethnic differences in the composition and morphology of atherosclerotic carotid artery lesions in symptomatic patients have been observed.[27] Also inter-ethnic differences in other processes involved in the pathogenesis of MI, such as thrombogenicity, response to antiplatelet therapy[28] and endothelial dysfunction,[29] might play a role in the observed differences in the prevalence of MI among chest pain patients. Despite the clear inter-ethnic differences in the prevalence of MI, unstable angina and extent of CAD among chest pain patients, ethnicity did not relate significantly to the adjusted incidence of MACEs during 1-year follow-up. Although the mortality and crude MI rates were higher during follow up in Caucasian than in Asian patients, these differences disappeared after adjustment for baseline differences in a Cox proportional hazards model. In fact, the higher absolute mortality in Caucasian patients following MI compared with Asian patients is in line with other reports.[30] Previous studies have also indicated a higher mortality in Malay patients compared with Chinese and Indian patients.[16,31] In our cohort, however, no differences were observed between the Asian groups, which might be explained by the limited number of MI patients in our study and the relatively short follow-up time and/or by universally improved care of acute MI, regardless of ethnicity, over recent years.

Interactions were found between ethnicity and risk factors for follow-up events. The influence of diabetes on the occurrence of 1-year MACEs was larger in Chinese patients compared with Caucasian patients. Furthermore, a previous history of PCI was more strongly associated with the incidence of MI during follow-up in Caucasian than in Chinese

patients. These interactions indicate that the relative contribution of certain risk factors to the occurrence of future adverse cardiovascular events might differ between ethnic groups.

Clinical implications

There are substantial inter-ethnic differences in the prevalence of MI and unstable angina, revascularisation rate and the extent of CAD among patients presenting to the ED with suspected MI. These findings potentially have important implications for risk stratification and the management of these patients. Caucasian patients have a higher chance of MI, despite less severe CAD (only no/minor CAD or single-vessel disease in the majority of cases), compared with Chinese and Indian patients. The underrepresentation of MI in Chinese and Indian chest pain patients potentially lowers the risk of adverse outcomes at any given level of risk scores such as the TIMI, GRACE and HEART scores in these ethnic groups. This in turn might lead to an underestimation of their cardiovascular risk. Despite a lower prevalence of acute MI they frequently harbour severe and diffuse CAD, however, leading to unstable angina requiring coronary revascularisation. The relationship between ethnicity and clinical outcome demonstrated in this study supports the consideration of ethnicity in the risk stratification process and clinical decision-making in patients with chest pain. The extent to which ethnicity impacts on the performance of accepted risk stratification tools and therefore on the clinical management of these patients warrants further investigation.

Limitations

Singapore and The Netherlands are highly developed countries with good, accessible healthcare systems[32] and a comparable standard of living.[33] However, possible confounding factors such as the environment, cultural differences, socioeconomic status, healthcare quality and healthcare accessibility cannot be ruled out. Cultural and socioeconomic differences between the countries and between the ethnic groups are important possible confounders that could not be corrected for and might influence our observations.[34,35] For example, a selection bias caused by differences in the policy of referral of chest pain patients to the ED cannot be ruled out. Although we corrected for all major confounders using all the information available, we cannot exclude that confounders remain that were not corrected for in our models.

Furthermore, different troponin assays were used across the recruiting centres and differences in the test characteristics and performance of the assays used might influence our interpretations. We only studied Asian and Caucasian groups, not other large ethnic groups such as Hispanics and blacks.

Conclusions

There are significant inter-ethnic differences in the prevalence of MI and unstable angina, coronary revascularisation rate and the extent of CAD in patients presenting to the ED with chest pain. This may have important implications for risk stratification and patient management in the ED. We propose the consideration of ethnicity in risk stratification in order to ensure the optimal management of chest pain patients in the ED. Additional studies are warranted to investigate possible differences in the underlying mechanisms of unstable CAD among different ethnicities.

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Conflict of interest

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