ACUTE CORONARY SYNDROMES

Myeloperoxidase aids prognostication together with N-terminal pro-B-type natriuretic peptide in high-risk patients with acute ST elevation myocardial infarction

Sohail Q Khan, Dominic Kelly, Paulene Quinn, Joan E Davies, Leong L Ng

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See end of article for authors' affiliations

Correspondence to: Dr S Q Khan, Department of Cardiovascular Medicine, University of Leicester, Clinical Sciences Building, Leicester Royal Infirmary, Leicester LE2 7LX, UK; sqk1@le.ac.uk

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Background: Inflammation plays a critical role in acute myocardial infarction (MI). One such inflammatory marker is myeloperoxidase (MPO). Its role as a predictor of death or MI in patients with ST segment elevation myocardial infarction (STEMI) is unclear.
Aim: To investigate the role of MPO as a predictor of death or MI in patients with STEMI and to compare it with N-terminal pro-B-type natriuretic peptide (NT-BNP).
Method: 384 post STEMI patients were studied. Patients were followed up for the combined end point of death or readmission with non-fatal MI.
Results: There were 40 deaths and 37 readmissions with MI. Median MPO was raised in patients experiencing death or MI than in survivors (median (range), 50.6 (15.3–124.1) ng/ml vs 33.5 (6.6–400.2) ng/ml, p = 0.001). Using a Cox proportional hazards model, log median MPO (HR 6.91, 95% CI 1.79 to 26.73, p = 0.005) and log median NT-BNP (HR 4.21, 95% CI 1.53 to 11.58, p = 0.005) independently predicted death or non-fatal MI. MPO had predictive power in both below and above median NT-BNP levels (log rank 5.60, p = 0.020 and log rank 5.12, p = 0.024, respectively). The receiver-operating curve for median NT-BNP yielded an area under the curve (AUC) of 0.72 (95% CI 0.65 to 0.79, p<0.001); for median MPO, the AUC was 0.62 (95% CI 0.55 to 0.69, p = 0.001). The logistic model combining the two markers yielded an AUC of 0.76 (95% CI 0.69 to 0.82, p<0.001).
Conclusion: MPO and NT-BNP may be useful tools for risk stratification of all acute coronary syndromes, including patients with STEMI at higher risk.

Inflammatory mechanisms play a central role in atherosclerosis.[1] Acute myocardial infarction (AMI) occurs when an underlying atherosclerotic plaque ruptures leading to thrombus formation and occlusion of a coronary vessel.[2] As our understanding of this process has increased, our realisation of the importance of the leucocyte as being pivotal in this process has also increased.[3] Indeed, the association of the leucocyte with the extent of coronary artery disease has been known for some years.[4] The importance of the white cell enzymes, however, has only been investigated recently. One such enzyme is myeloperoxidase (MPO), which is present in the granules of the leucocyte.[5] Immunohistochemical studies have demonstrated the presence of MPO in atheromatous plaques.[6] MPO can also activate metalloproteinases and inactivate plasminogen activator inhibitor, promoting destabilisation and rupture of the atherosclerotic plaque surface.[7] Furthermore, MPO catalytically consumes endothelium-derived nitric oxide, thereby reducing the bioavailability of nitric oxide, leading to vasoconstriction[5] and endothelial dysfunction.[8]

Indeed, MPO is emerging as a useful marker for prognostication in a variety of clinical settings; recently, it was shown to be of prognostic value in patients presenting to the emergency room with chest pain,[9] and there is also an association between levels of MPO and risk of coronary artery disease.[10] Inflammation in acute coronary syndromes is thought to be widespread.[11] Its role, however, in the prognostication of AMI is unknown. In this study, we investigated whether MPO would be of benefit in determining the prognosis of AMI, particularly death and reinfarction, which remain a leading cause of mortality and morbidity. We compared this with N-terminal pro-B-type natriuretic peptide (NT-BNP), which has been shown to be of prognostic benefit in this group of patients.[12]

METHODS

Study population

We studied 384 consecutive post ST segment elevation myocardial infarction (STEMI) patients who were admitted to the Coronary Care Unit of Leicester Royal Infirmary, Leicester, UK. The study complied with the Declaration of Helsinki, was approved by the local ethics committee and written informed consent was obtained from all patients. Myocardial infarction (MI) was diagnosed if a patient had chest pain lasting >20 min, diagnostic serial ECG changes consisting of new pathological Q waves or ST-segment elevation changes, and a plasma creatine kinase-MB elevation greater than twice normal or cardiac troponin I level >0.1 ng/ml.[13] Exclusion criteria were known malignancy or surgery in the previous month. Patients with ST-segment elevation of >0.1 mV in two contiguous ECG leads received thrombolytic treatment (tissue plasminogen activator or streptokinase) if they presented within a suitable time frame. Controls were age- and sex-matched and recruited from the University of Leicester, Leicester, UK, and underwent peptide measurements once.

Plasma samples

For determination of plasma MPO and NT-BNP, serial blood measurements were made at 0–24, 25–48, 49–72, 73–96 and 97–120 h after onset of chest pain. A single median value over the 5 days was used in the analysis. After a 15 min bed rest, 20 ml blood was collected into tubes containing EDTA and

Abbreviations: AMI, acute myocardial infarction; AUC, area under the curve; LVWMI, left ventricular wall motion index; MI, myocardial infarction; MPO, myeloperoxidase; NT-BNP, N-terminal pro-B-type natriuretic peptide; STEMI, ST segment elevation myocardial infarction

Table 1 Characteristics of 384 patients if this study, separated by myeloperoxidase quartiles.

	1st quartile	2nd quartile	3rd quartile	4th quartile	p Value
Age (years)	61.8 (12.3)	62.9 (12.6)	63.9 (12.0)	67.6 (11.9)	0.008
Medical history, n (%)					
AMI	11 (23.9)	14 (30.4)	13 (28.3)	8 (17.4)	0.571
Angina pectoris	9 (17.3)	18 (34.6)	15 (28.8)	10 (19.2)	0.186
Hypertension	40 (23.0)	46 (26.4)	41 (23.6)	47 (27.0)	0.609
Diabetes mellitus	20 (25.3)	22 (27.8)	21 (26.6)	16 (20.3)	0.748
High cholesterol	25 (23.1)	27 (25.0)	26 (24.1)	30 (27.8)	0.833
Current/ex-smokers	45 (31.9)	39 (27.7)	27 (19.1)	30 (21.3)	0.290
ST-elevation AMI	96 (25.0)	96 (25.0)	96 (25.0)	96 (25.0)	1.0
Thrombolysis	62 (22.8)	63 (23.2)	75 (27.6)	72 (26.5)	0.069
Territory of infarction, n (%)					0.288
Anterior	39 (40.6)	33 (34.4)	34 (35.4)	38 (39.6)	
Inferior	46 (47.9)	47 (49.0)	49 (51.0)	42 (43.8)	
Other	11 (11.5)	16 (16.7)	13 (13.5)	15 (15.6)	
Killip class on admission, n (%)					<0.001
I	57 (59.4)	52 (54.2)	49 (51.0)	54 (54.2)	
II	35 (36.5)	35 (36.5)	41 (42.7)	38 (39.6)	
III	3 (3.1)	9 (9.4)	4 (4.2)	4 (4.2)	
IV	1 (1.0)	0 (0)	2 (2.0)	0 (0)	
Peak CK (IU/l)	1177.4 (1364.1)	1405.7 (1513.3)	1582.3 (1310.1)	1587.5 (1323.7)	0.136
Creatinine (μmol/l)	95.8 (17.6)	96.2 (23.1)	98.8 (25.7)	102.5 (27.4)	0.184
NT-BNP (pmol/l)	665.2 (868.6)	926.6 (718.0)	1220.0 (1292.8)	1372.1 (981.4)	0.007
Male sex, n (%)	79 (20.5)	71 (18.5)	75 (19.5)	58 (15.1)	0.008
LVWMI	1.50 (0.36)	1.58 (0.35)	1.58 (0.39)	1.61 (0.41)	0.211
Serum cholesterol (mmol/l)	5.5 (2.9)	4.7 (1.9)	4.5 (2.1)	4.5 (2.4)	0.244
Systolic blood pressure (mm Hg)	130.3 (25.9)	134.1 (21.5)	129.5 (24.0)	131.2 (22.8)	0.560
Diastolic blood pressure (mm Hg)	77.0 (16.0)	78.7 (15.1)	77.6 (17.7)	77.0 (13.3)	0.865

AMI, acute myocardial infarction; CK, creatinine kinase; LVWMI, left ventricular wall motion index; NT-BNP, N-terminal pro-B-type natriuretic peptide.
Values are represented as mean (SD) unless indicated otherwise.

aprotinin. All plasma were stored at −70℃ until assayed in a single batch.

Echocardiography

Transthoracic echocardiography was performed in patients by using a Sonos 5500 instrument (Philips Medical Systems, Reigate, UK). A 16-segment left ventricular wall motion index (LVWMI) based on the American Society of Echocardiography model[13] was derived by scoring each LV segment (1 = normal, 2 = hypokinesis, 3 = akinesis and 4 = dyskinesis (paradoxical motion), and dividing the total by the number of segments scored. Left ventricular ejection fraction was calculated using the biplane method of discs formula.[14]

NT-BNP assay

Our NT-BNP assay was based on a non-competitive assay.[15] Sheep antibodies were raised against the N-terminal of human NT-BNP, and monoclonal mouse antibodies were raised against the C-terminal of human NT-BNP. The N-terminal IgG was affinity-purified and biotinylated. Samples or NT-BNP standards were incubated in C-terminal IgG-coated wells with the biotinylated antibody for 24 h at 4℃. Detection was with methyl-acridinium ester-labelled streptavidin.[15] The lower limit of detection was 0.3 fmol/ml. There was no cross reactivity with atrial natriuretic peptide, B-type natriuretic peptide, or C-type natriuretic peptide. The results from this in-house assay are highly correlated ($r = 0.90$, $p<0.001$, $n = 86$) with those obtained on the NTproBNP assay marketed by Roche Diagnostics (Lewes, East Sussex, UK).

MPO assay

The MPO assay was based on a non-competitive assay. The capture antibody was 100 ng of a monoclonal anti-MPO (Research Diagnostics, Flanders, New Jersey, USA) coated onto ELISA plates, and detection was with a rabbit anti-MPO antibody (Merck Biosciences, Nottingham, UK). Samples or MPO standards were incubated for 24 h at 4℃. After washes, detection was performed using sequential incubations with biotinylated goat anti-rabbit IgG and methyl-acridinium ester-labelled streptavidin.[15] Intra-assay and interassay coefficients of variation were found to be <10%.

End points

We assessed the value of both MPO and NT-BNP for the prediction of mortality. We used a combined primary end point consisting of death and non-fatal MI and also investigated death and non-fatal MI as individual secondary end points. Hospitalisation for AMI was defined as above. We also investigated the secondary end point of heart failure. Hospitalisation for heart failure was defined as a hospital admission for which heart failure was the primary reason. End points were obtained by reviewing the Office of National Statistics Registry, and by contacting each patient. There was a minimum 30-day follow-up of all patients.

Statistical analysis

Statistical analyses were performed on SPSS V.12. The continuous variables in the two independent groups were compared using the Mann–Whitney U test. Spearman's

correlations were performed, and Cox proportional hazards analyses were conducted, which included baseline patient characteristics (age, sex, serum creatinine, Killip class, territory of AMI, LVWMI and whether the patient received thrombolysis or not) and peptide markers (including troponin I) to test the independent predictive power of the peptides above and below the median for death or non-fatal MI as defined above. NT-BNP and MPO were normalised by log transformation. Thus hazard ratios (HRs) refer to a tenfold rise in the levels of these markers. Kaplan–Meier survival curves were generated to visualise the relationship between the peptides NT-BNP and MPO and the composite end points. To compare the predictive value of NT-BNP and MPO, receiver-operating characteristic curves were generated and the area under the curves (AUC) was calculated. p Value <0.05 was deemed to be significant. Power calculations suggest that 318 patients were recruited over 24 months and a follow-up period of at least 1 month, with median survival probabilities of 0.8 or 0.7 at 12 months in the groups stratified by the biomarker median, would enable the hypothesis to be tested with a power of 95% at $p<0.01$ (two-sided test). We recruited 20% more patients in case follow-up was incomplete for some patients.

RESULTS

Patient characteristics

Table 1 shows the demographic features of the patient population separated into quartiles. There were 257 controls (132 men), mean (SD) age was 61.8 (14.3) years. Median (range) length of follow-up was 330 (0–644) days (0 was due to death). Of the patients enrolled, 70.8% received thrombolysis during the index admission. No patient was lost to follow-up. During follow-up, 40 (10.4%) patients died, 37 (9.6%) patients were readmitted with AMI and there were 23 (6.0%) readmissions with heart failure. Echocardiographic data were available for 334 (87.0%) of the 384 patients and it was performed at a median (range) of 3.5 (2–5) days after presentation with AMI. In all, 39 echocardiograms were unanalysable (owing to off-axis apical views, and/or poor image quality) and 11 patients did not receive an echocardiogram.

MPO levels in patients and controls

Plasma levels of MPO in patients with AMI ranged from 4.0 to 405.2 ng/ml. Median level over the 5 days was 35.9 ng/ml, 25th and 75th centile were 18.0 and 61.2 ng/ml. These levels were significantly higher than those observed in the controls (median (range) 26.7 (8.0–79.0) ng/ml, $p<0.005$). Plasma median MPO was raised in patients experiencing the primary end point of death or MI compared with survivors without recurrent MI (median (range), 50.6 (15.3–124.1) ng/ml vs 33.5 (6.6–400.2) ng/ml, $p = 0.001$). The time course of secretion of MPO revealed a significant difference over the 5 days ($p<0.001$) and is shown in fig 1.

Although MPO levels in the first 48 h after an AMI weakly correlated with peak troponin I levels ($r = 0.183$, $p = 0.025$), this was not true for the later plasma levels ($r = 0.109$, $p = 0.179$). There was no correlation of MPO with age ($r = -0.04$, $p>0.247$), LVWMI ($r = 0.131$, $p>0.147$) or neutrophil count at presentation ($r = 0.089$, $p>0.307$). MPO did not differ significantly according to sex, smoking status, the presence or absence of diabetes mellitus, hypertension, previous diagnosis of MI, hypercholesterolaemia or whether a patient received thrombolysis or not. However, there was no correlation between NT-BNP and MPO ($r = 0.068$, $p = 0.401$).

NT-BNP levels in patients and controls

NT-BNP was significantly higher in patients with AMI than in controls (median (range), 1459.94 (0.3–11779.03) fmol/ml vs 10.1 (0.3–134.4) fmol/ml; $p<0.001$) and was significantly higher in patients who died (5815.86 (20.1–11269.92) vs 767.6 (0.30–11779.03); $p<0.001$) or reinfarcted in the first 72 h (1271.104 (2.64–11779.03) vs 767.6 (0.30–11779.03); $p = 0.031$). The time course of secretion of NT-BNP revealed a significant difference over the 5 days ($p<0.001$) and is shown in fig 2.

Relationship between MPO and echocardiographic parameters

For the whole population, mean (range) LVWMI was 1.53 (1.08–2.83) and median (range) ejection fraction was 36% (8–49%). The LVWMI score in those subjects with anterior AMI was higher than in those with inferior AMI (1.8 (1.08–2.75) vs 1.4 (1.00–2.83), $p<0.001$) and left ventricular ejection fraction was lower in anterior AMI than in inferior AMI (37% (8–48%) vs 40.1% (14–49%), $p = 0.05$). There was no correlation of MPO with LVWMI ($r = 0.104$, $p>0.147$). However, NT-BNP correlated with LVWMI ($r = 0.434$, $p<0.001$) at all time points.

MPO and NT-BNP as predictors of death or non-fatal MI

When clinical and demographic characteristics (age, sex, serum creatinine, Killip class, territory of AMI, LVWMI, whether the patient received thrombolysis or not, troponin I, MPO and NT-BNP) were entered into a Cox proportional hazards model, the

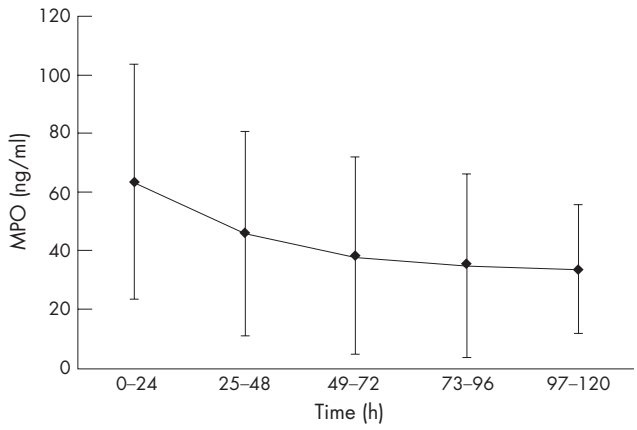

Figure 1 Time-dependent changes in myeloperoxidase (MPO; mean (SD)) after onset of acute myocardial infarction.

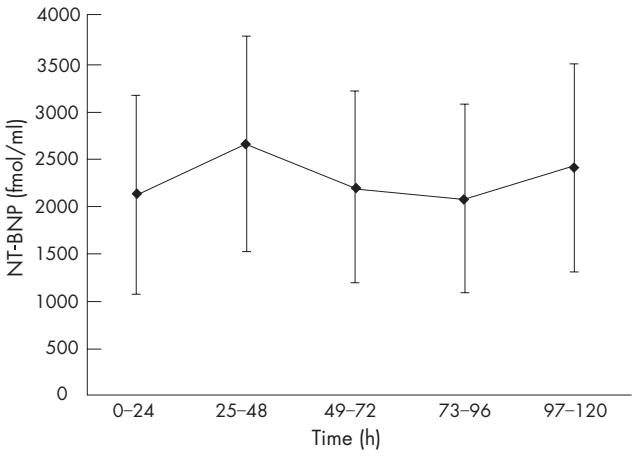

Figure 2 Time-dependent changes in N-terminal pro-B-type natriuretic peptide (mean (SD)) after onset of acute myocardial infarction.

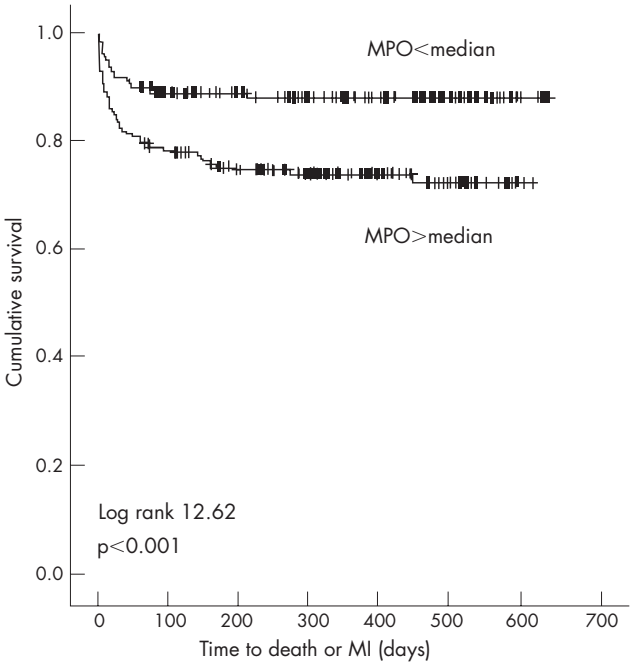

Figure 3 Kaplan–Meier curve: time to primary outcome related to median serum myeloperoxidase (MPO). MI, myocardial infarction.

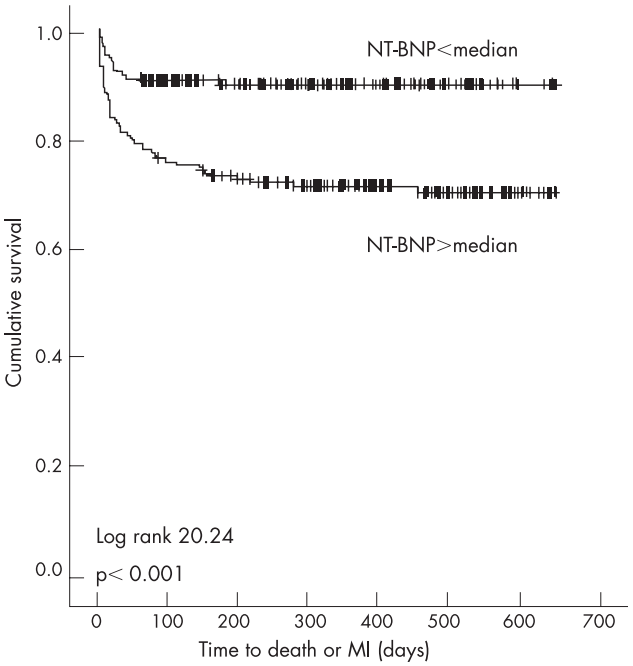

Figure 4 Kaplan–Meier curve: time to primary outcome related to median serum N-terminal pro-B-type natriuretic peptide (NT-BNP). MI, myocardial infarction.

independent predictors of the primary end point were log median MPO (HR 6.91, 95% CI 1.79 to 26.73, p = 0.005) and log median NT-BNP (HR 4.21, 95% CI 1.53 to 11.58, p = 0.005; table 2). The Kaplan–Meier survival curve revealed a significantly better clinical outcome in patients with median MPO below the median than in those with median MPO above the median (log rank 12.62, p<0.001, fig 3); this was also true for NT-BNP (log rank 20.24, p<0.001, fig 4). MPO had predictive power in patients with NT-BNP levels below or above the median (log rank 5.60, p = 0.020; log rank 5.12, p = 0.024, respectively). In addition there was a grading to the primary end point, which increased as the levels of MPO or NT-BNP increased. A positive MPO and NT-BNP (ie, both above their respective median values) was associated with a significantly higher rate of the primary end point than having either peptide level above their medians, or both peptides below their medians (log rank 30.73, p<0.001, fig 5). When patients were examined for one or more raised MPO or NT-BNP peptide levels, the receiver-operating curve for median NT-BNP yielded an AUC of 0.72 (95% CI 0.65 to 0.79, p<0.001); for median MPO the AUC was 0.62 (95% CI 0.55 to 0.69, p = 0.001). The logistic model combining the two markers yielded an AUC of 0.76 (95% CI 0.69 to 0.82, p<0.001), which exceeded that of either peptide alone (fig 6). Discharge MPO and NT-BNP was better at predicting death or non-fatal MI than admission measurements (discharge AUC for MPO 0.62, p = 0.05, for NT-BNP 0.66, p = 0.013 vs admission AUC for MPO 0.56, p>0.05, for NT-BNP 0.69, p<0.001).

Secondary end points: MPO and NT-BNP as predictors of death

Plasma median MPO was higher in patients experiencing death than in survivors (median (range), 43.4 (8.1–132.1) ng/ml vs 34.5 (6.6–400.2) ng/ml, p = 0.011). This was also true for median NT-BNP (median (range), 5755.1 (10.3–10552.8) fmol/ml vs 1099.2 (2.43–9570.6) fmol/ml, p<0.001).

On the Cox proportional hazards model, the only independent predictor of death was log median NT-BNP (HR 2.993, 95% CI 1.171 to 7.655, p = 0.022).

The Kaplan–Meier survival curve revealed a significantly better clinical outcome in patients with median NT-BNP below the median than in those with median NT-BNP above the median (log rank 11.47, p<0.001, graph not shown). A positive MPO and NT-BNP was associated with a significantly higher rate of the death than having one raised peptide level or two low peptide levels (log rank 22.63, p<0.001).

Secondary end points: MPO and NT-BNP as predictors of non-fatal MI

Plasma median (range) MPO was no different in patients experiencing non-fatal MI than in survivors (44.7 (8.1–105.6) ng/ml vs 34.5 (6.6–400.2) ng/ml, p = 0.091). This was also true for median (range) NT-BNP (2219.7 (2.6–9316.3) fmol/ml vs 1180.0 (2.43–10552.8) fmol/ml, p = 0.119). Multivariate statistics did not reveal any significant differences; however, the Kaplan–Meier curve showed that a positive MPO and NT-BNP was associated with a significantly higher rate of non-fatal MI than having one raised peptide level or two low peptide levels (log rank 7.46, p = 0.006).

Secondary end points: MPO and NT-BNP as predictors of heart failure

Plasma median (range) MPO was no different in patients who were readmitted with heart failure than in survivors who were not admitted (46.6 (6.8–84.7) ng/ml vs 35.1 (6.6–400.2) ng/ml, p = 0.244). Plasma median (range) NT-BNP was significantly higher in those readmitted with heart failure than in survivors who were not admitted (3622.4 (2.4–9053.1) fmol/ml vs 1180.0 (2.6–10552.8) fmol/ml, p = 0.002). In a Cox proportional hazards model, however, only age (HR 1.04, p = 0.09), Killip class (HR 2.39, p = 0.08) and history of MI (HR 3.37, p = 0.007), were found to be independent predictors of heart failure.

DISCUSSION

The aim of this study was to assess the use of MPO and NT-BNP in determining the prognosis of patients with AMI. The results

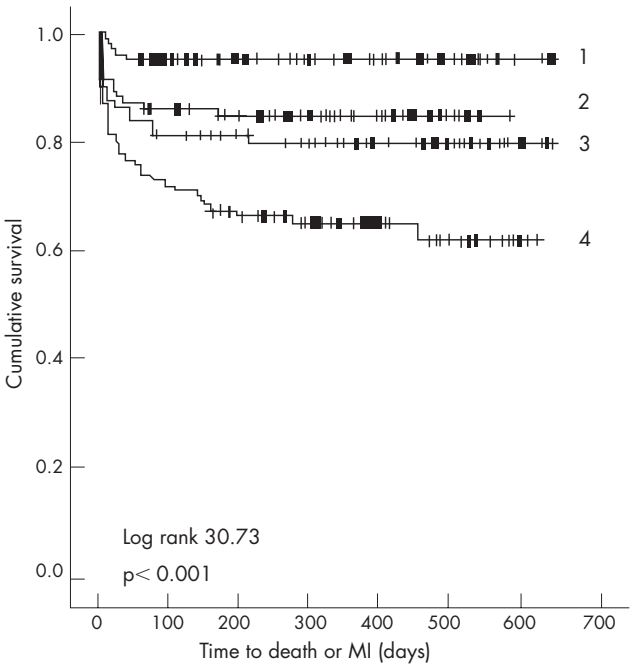

Figure 5 Kaplan–Meier curve: time to primary outcome related to low or high median serum myeloperoxidase (MPO) and N-terminal pro-B-type natriuretic peptide (NT-BNP) levels. (1) Low MPO and NT-BNP, (2) Low MPO and high NT-BNP, (3) High MPO and low NT-BNP and (4) High MPO and NT-BNP. MI, myocardial infarction.

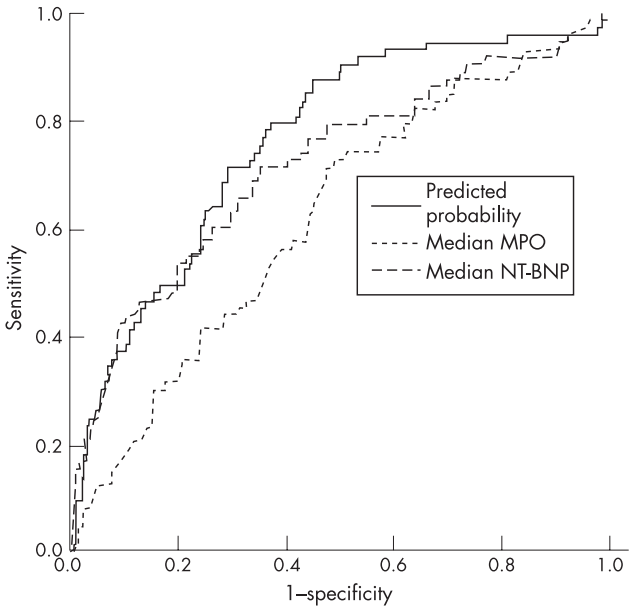

Figure 6 Combined receiver-operating curve comparing median N-terminal pro-B-type natriuretic peptide (NT-BNP), median myeloperoxidase (MPO) and the combined predicted probabilities of primary outcome.

of this study confirm the independent prognostic value of MPO and NT-BNP in determining death or non-fatal MI in patients who have an acute STEMI. The predictive value of MPO provides risk prediction independent of NT-BNP and other known clinical predictors of death or non-fatal MI. Our study showed only weak correlation between MPO and peak troponin I, and no correlation between MPO and LVWMI, reiterating the fact that MPO is not a marker of myocardial necrosis. Recruitment and degranulation of the neutrophil leading to the release of MPO is seen as a key step in AMI.[16] Both MPO and NT-BNP are raised after an AMI and their secretion patterns differ over the 5 days after an AMI, with significant differences noted for both peptides. It is clear that MPO is raised very early after an AMI with levels falling rapidly after the first 24 h, suggesting that neutrophil activation plays a role very early in AMI, and may even precede the onset of AMI.

Reperfusion therapy has improved mortality after MI; however, the outcome of patients despite this is still poor.[17] For this reason risk stratification remains important and may be useful for selecting treatment regimens in the future.

We used MPO, an inflammatory marker from the leucoctye and NT-BNP, which is a more stable byproduct in the production of B-type natriuretic peptide.[18] We have clearly shown the benefit of using each peptide alone at predicting death or MI. In addition, MPO had predictive power even in patients with NT-BNP levels above the median, suggesting that further risk stratification of this high-risk group is possible. Furthermore, a positive MPO and NT-BNP was associated with a significantly higher rate of the primary end point than having one raised peptide level or two low levels of peptides. Using a combination of MPO and NT-BNP in a multimarker risk stratification approach in patients with STEMI gives an increased area under the ROC curve and more predictive power. The use of MPO as a prognostic marker has been borne out previously in patients with acute coronary syndromes,[19] where it was found to be an independent predictor of death or non-fatal MI in this population group. In another study, the usefulness of MPO in patients presenting to the emergency room with chest pain was examined.[9] Here it was found to be useful as an independent predictor of early MI and major adverse cardiac events in the ensuing 30 days and at 6 months. Brennan *et al*'s study recruited all patients presenting with chest pain and the study included 23.5% of patients with a final diagnosis of AMI; in comparison, our study has examined only patients with a diagnosis of STEMI, a relatively high-risk group.

In univariate analysis, both MPO and NT-BNP were significantly raised in patients who subsequently died compared with survivors. However, on multivariate analysis, NT-BNP retained independent prognostic information but MPO did not. This concurs with previous studies on the use of NT-BNP in predicting death.[20 21] However, neither peptide marker had utility in predicting non-fatal MI in univariate or multivariate analysis. One of the limitations of this study and the reason why the secondary end points of death and MI did not achieve statistical significance may well have been due to the number of patients recruited. A larger study may be appropriate to detect the use of this combination of markers in predicting death and MI individually. The re-infarction rate is also high and this may be due in part to the fact that reperfusion was obtained with

Table 2 Multivariate Cox proportional-hazards regression model of predictors of death and non-fatal myocardial infarction

Variable	HR (95% CI)	p Value
Log median MPO	6.91 (1.79 to 26.73)	0.005
Log median NT-BNP	4.21 (1.53 to 11.58)	0.005

MPO, myeloperoxidase; NT-BNP, N-terminal pro-B-type natriuretic peptide. Predictors of death and non-fatal myocardial infarction are age, sex, serum creatinine, Killip class, territory of acute myocadial infarction, left ventricular wall motion index, whether the patient received thrombolysis or not, NT-BNP, troponin I and MPO.

thrombolysis. Care must be taken when extrapolating these findings to patients undergoing mechanical reperfusion.

Previous multimarker strategies have used combinations of markers, including inflammatory markers, myocardial necrosis markers and markers of left ventricular systolic dysfunction[22] in formulating a risk-assessment profile in patients without STEMI. This is the first study, however, reporting the use of MPO in combination with NT-BNP in patients with STEMI.

In conclusion, this study reveals that MPO is a predictor of death or non-fatal MI in patients with STEMI. This study confirms previous findings that MPO is involved during an AMI and it may be useful in a multimarker approach with NT-BNP for risk stratification in patients with STEMI. MPO and NT-BNP may be useful tools for risk stratification of all acute coronary syndromes, including STEMI for patients at higher risk.

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Authors' affiliations

Sohail Q Khan, Dominic Kelly, Paulene Quinn, Joan E Davies, Leong L Ng, Department of Cardiovascular Sciences, University of Leicester, Clinical Sciences Building, Leicester Royal Infirmary, Leicester, UK

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