Neutrophil Count on Admission Predicts Major In-hospital Events in Patients with a Non-ST-Segment Elevation Acute Coronary Syndrome

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ABSTRACT

Background: Inflammation plays a key role in the pathogenesis of acute coronary syndromes (ACS). In this context we assessed neutrophil count as a predictor of major in-hospital events in patients admitted for a non-ST-segment elevation (NSTEMI) ACS.

Methods: We measured neutrophils on admission in 160 patients with a NSTEMI ACS and we correlated their count with the incidence of a combined in-hospital end point including: cardiac death, acute heart failure, ST-segment elevation myocardial infarction, and recurrent myocardial ischemia.

Results: Patients who had a major in-hospital event also had a higher neutrophil count ($P = 0.02$) and higher serum levels of troponin I ($P = 0.04$). In the univariate logistic regression analysis, in-hospital major events could be predicted by troponin I >0.07 ng/mL (odds ratio [OR]: 5.65, 95% confidence interval [CI]: 1.26–25.32, $P = 0.02$), white blood cell count >8650 cells/ μ L (OR: 2.68, 95% CI: 1.03–6.95, $P = 0.04$), neutrophil count >6700 cells/ μ L (OR: 7.74, 95% CI: 2.79–21.47, $P < 0.001$), and C-reactive protein >0.97 mg/dL (OR: 3.56, 95% CI: 1.13–11.19, $P = 0.02$). However, in multivariate regression, neutrophil count >6700 cells/ μ L (OR: 6.52, 95% CI: 1.56–27.22, $P = 0.01$) was the only independent in-hospital prognostic factor.

Conclusions: In patients with a NSTEMI ACS of moderate or high risk, neutrophil count on admission may identify those who are at risk of having an adverse in-hospital outcome.

Introduction

Inflammation plays a key role in the development of coronary atherosclerosis and in the pathogenesis of acute coronary syndromes (ACS).¹ Both experimental and clinical data have clearly demonstrated that inflammation at the site of the atherosclerotic lesion is associated with endothelial injury and contributes to plaque erosion or rupture and to the ensuing thrombotic process. Thus, the inflammatory reaction in ACS may not simply represent a response to tissue injury but a pathogenic villain.

Several inflammatory molecules, most commonly C-reactive protein (CRP), have been used as risk stratification markers in patients with ACS. An increase in white blood cell (WBC) count has been associated with the development of coronary artery disease (CAD).^{2,3} Moreover, WBC count is a strong independent predictor of mortality in patients with an acute myocardial infarction (AMI) with⁴ or without ST-segment elevation.⁵

Of note, neutrophils, a subpopulation of WBC directly involved in the inflammatory processes, have not received much attention so far. Clinical studies have demonstrated

that neutrophils are activated in patients with unstable angina and AMI.^{10,11} Since there is substantial evidence that neutrophils are involved in the pathophysiology of ACS, a more thorough understanding of their role is desirable. A full blood count is routinely measured in every patient on admission and neutrophil count could be a convenient risk stratification marker in patients admitted for ACS. In this context we correlated neutrophil count with the incidence of major in-hospital events in patients admitted for a NSTEMI ACS.

Methods

Patients

To be eligible for the study, patients had to fulfill all 3 of the following criteria: angina with a crescendo pattern or occurring at rest with the last episode no more than 24 hours prior to admission, elevated cardiac troponin I (≥ 0.04 ng/mL) and ischemic changes in the resting electrocardiogram defined as ST-segment depression ≥ 0.1 mV or T wave inversion ≥ 0.2 mV in 2 contiguous leads. Exclusion criteria were: AMI with ST-segment elevation during the past 30 days,

hemodynamic instability or congestive heart failure, and a history of percutaneous coronary intervention (PCI) within the past 30 days. In addition, the presence of malignancy, infection, immune disorder or connective tissue disease, recent trauma or surgery, hepatic or renal disease, or any other clinical or laboratory finding suggestive of an acute or chronic inflammatory reaction were also exclusion criteria for the study.

Approval from the ethics committee of our hospital was obtained for the initiation of the study.

Immediately after admission, all the patients had a routine clinical examination and blood tests drawn. Qualitative evaluation of left ventricular systolic function was performed by transthoracic echocardiography.

Treatment Strategy

All the patients received standard medical treatment and were treated according to a conservative strategy—a selectively invasive strategy—scheduled to undergo angiography and subsequent revascularization only if they had refractory angina, hemodynamic instability, malignant arrhythmias, or significant ischemia on the predischARGE stress test. Otherwise, they were scheduled for an elective coronary angiogram within 2 weeks. A coronary vessel was considered diseased if the lumen had >50% stenosis in the angiogram. Percutaneous coronary intervention was performed when appropriate, based on the angiographic findings.

The presence of the known risk factors for CAD, such as diabetes mellitus, hypertension, hyperlipidemia, smoking, family history of CAD, and obesity was recorded in all patients. Upon admission, all the patients were stratified with the use of the thrombolysis in myocardial infarction (TIMI) risk score, as previously described.⁸

End Points

A major in-hospital event was defined as a composite of cardiac death, acute heart failure, AMI with ST-segment elevation, and recurrent ischemia with ST-segment depression despite maximal medical therapy requiring an urgent PCI. Congestive heart failure was defined as orthopnea, rales over more than one-third of lung fields, elevated jugular venous pressure, or pulmonary congestion on chest radiogram thought to be related to cardiac dysfunction.

Blood Sampling and Laboratory Measurements

Upon their admission and prior to receiving any medication, all patients underwent venous blood sampling to assess WBC and neutrophil count (cells/ μ L) as well as serum levels of troponin I (TnI) and CRP.

Troponin I was quantitatively estimated (ng/mL) by means of magnetic microparticles enhanced sandwich chemiluminescence using a photometric system (Laison).

Abnormal values were considered those >0.04 ng/mL. C-reactive protein was quantitatively estimated (mg/dL) by means of particle enhanced immunonephelometry using a nephelometric system (Behring). The CRP detection range corresponded to values of 0.1 to 20 mg/dL. All the measurements were calibrated according to the 85/506 World Health Organization international reference standard.

Statistical Methods

Numerical variables are presented as mean $\pm$ SE and categorical variables were summarized by percentages. For continuous variables, comparisons among 2 and n groups were performed with the nonparametric Mann-Whitney test and Kruskal-Wallis test, respectively. For categorical variables, comparisons among groups were performed with the Pearson's χ^2 test. Univariate binary logistic regression analysis was used to investigate for predictors of dependent dichotomous variables (in-hospital events). Regarding multivariate binary logistic regression analysis, we used 2 models: 1 containing both continuous and categorical variables and 1 exclusively containing categorical variables. To evaluate test performance for TIMI risk score, CRP, TnI, WBC, and neutrophil count as predictors of in-hospital events, the areas under the curve of the receiver operating characteristic (ROC) curve analysis were used. An optimal cut off level was calculated in all cases using the method of maximum χ^2 . Sensitivity, specificity, positive, and negative predictive values of these cut off points for the prediction of major in-hospital events was also calculated with 2×2 contingency tables. Statistical significance was calculated with the χ^2 test. A P value < .05 was considered statistically significant. SPSS for Windows, v.10.0 (SPSS Inc., Chicago, IL) and MedCalc v 8.1.1.0, were used for the statistical analyses.

Results

Patient Characteristics

A total of 207 consecutive patients were admitted in our department for a NSTEMI ACS. However, 47 of them were excluded because of a myocardial infarction (MI) with ST-segment elevation in the past 30 days (18 patients), congestive heart failure (12 patients), a history of PCI within the past 30 days (5 patients), and a known history or a clinical or laboratory finding suggestive of an acute or chronic inflammatory disease (6 patients with a respiratory tract infection, 2 patients with a urinary tract infection, 2 patients with myelodysplastic syndrome, 1 patient with breast cancer, and 1 patient with lung cancer). The remaining 160 patients were included in the study.

The clinical characteristics of the 160 study participants are shown in Table 1. During the first 48 hours after admission, 20 patients developed a major in-hospital event before a coronary angiogram was performed as follows: 4 patients developed ST-elevation AMI and had a primary

Table 1. Patient Characteristics

	n = 160
Age >65 y	92 (57.5%)
Male	112 (70%)
BMI (>30 kg/m ²)	22 (13.7%)
Hypertension	114 (71.2%)
Diabetes	48 (30%)
Hyperlipidemia	76 (47.5%)
Smokers	78 (48.7%)
Family history of CAD	36 (22.5%)
Previous history of CAD	96 (60%)
History of episodes of angina before admission	64 (40%)
Diseased vessels (>50% stenosis)	
0	12 (7.5%)
1	24 (15%)
2	31 (19.3%)
3	89 (55.6%)
CAD risk factors ≥3	78 (48.7%)
Left ventricular ejection fraction >40%	132 (82.5%)
TIMI risk score = 0-2	10 (6.2%)
TIMI risk score = 3-4	60 (37.5%)
TIMI risk score ≥5	90 (56.2%)
Age (yrs)	66.12 ± 10.92 (45-90)
Left ventricular ejection fraction (%)	50.49 ± 11.75 (15-70)
Troponin I (ng/mL)	0.66 ± 1.19 (0.04-7.9)
White blood cells (cells/μL)	7755 ± 1841 (4500-12 250)
Neutrophils (cells/μL)	4933 ± 1701 (1965-11 147)
CRP (mg/dL)	2.4 ± 3.85 (0.09-20.4)
Abbreviations: BMI, body mass index; CAD, coronary artery disease; CRP, C-reactive protein; TIMI, thrombolysis in myocardial infarction flow.	

coronary angioplasty; 8 patients had recurrent ischemia with marked ST-depression requiring an emergency PCI; 4 patients had an acute pulmonary edema and after medical stabilization were also sent to the catheterization laboratory; and 4 patients died suddenly (due to MI as documented by autopsy). Ten out of 16 of these patients were submitted

for percutaneous coronary angioplasty whereas the rest (6) were sent for bypass surgery (Table 2). Regarding the group of patients without an in-hospital major event, 75 patients had a percutaneous coronary angioplasty in-hospital, 12 had a percutaneous coronary angioplasty within 2 weeks after discharge, and 41 patients were sent for bypass surgery (Table 2).

Tn I and CRP Levels, WBC and Neutrophil Counts: The patients who experienced a major in-hospital event were more often males and frequently had a previous history of CAD as well as episodes of angina during the last few days prior to admission (Table 2). Moreover, in comparison with those who had an uneventful hospitalization they had higher serum levels of TnI (0.67 ± 1.26 ng/mL vs 0.62 ± 0.35 ng/mL, $P = 0.04$) and neutrophil count (6290 ± 2775 cells/μL vs 4739 ± 1398 cells/μL, $P = 0.02$; Table 2). No differences were identified between the 2 groups regarding serum levels of CRP (2.47 ± 4.07 mg/dL vs 1.85 ± 1.66 mg/dL, $P = \text{NS}$) and WBC count (7634 ± 1707 cells/μL vs 8604 ± 2485 cells/μL, $P = \text{NS}$; Table 2).

ROC Curve Analysis: According to the ROC curve analysis both neutrophil count (area under the curve [AUC]: 0.65, 95% CI: 0.58-0.73, standard error [SE]: 0.07, $P = 0.02$ Figure 1A) and TIMI risk score (AUC: 0.65, 95% CI: 0.57-0.72, SE: 0.07, $P = 0.03$) could reliably discriminate those patients with NSTEMI ACS who had a major in-hospital event. Pair wise comparison between the AUC for neutrophil count and TIMI risk score did not identify any difference (difference between areas: 0.007, SE: 0.08, 95% CI: -0.16-0.17, $P = 0.93$, Figure 1B).

On the other hand, TnI (AUC: 0.62, 95% CI: 0.54-0.7, SE: 0.07, $P = 0.07$), WBC count (AUC: 0.61, 95% CI: 0.53-0.68, SE: 0.07, $P = 0.11$), or CRP (AUC: 0.54, 95% CI: 0.46-0.62, SE: 0.07, $P = 0.52$) did not have any predictive value for major in-hospital events (Figure 1C). Finally, ROC curve analysis identified the cut off points of TIMI risk score, CRP, TnI, WBC, and neutrophils counts with the highest accuracy in discriminating those patients with a major in-hospital event as shown in Table 3.

Logistic Regression Analysis: In the univariate logistic regression analysis, in-hospital major events could be predicted by serum levels of TnI >0.07 ng/mL (but not by TnI as a continuous variable; OR: 5.65, 95% CI: 1.26-25.32, $P = 0.02$), WBC count (OR: 1, 95% CI: 1-1.001, $P = 0.03$), WBC count >8650 cells/μL (OR: 2.68, 95% CI: 1.03-6.95, $P = 0.04$), neutrophil count (OR: 1, 95% CI: 1-1.001, $P = 0.001$), neutrophil count >6700 cells/μL (OR: 7.74, 95% CI: 2.79-21.47, $P < 0.001$), and serum levels of CRP >0.97 mg/dL (but not by CRP as a continuous variable; OR: 3.56, 95% CI: 1.13-11.19, $P = 0.02$; Table 4). However, multivariate regression analyses showed that neutrophil count as a continuous variable in model 1 (expB: 1.002, 95% CI: 1.001-1.003 $P = 0.007$) and neutrophil count >6700

Table 2. Characteristics of Patients with and Without a Major In-hospital Event

	In-hospital Events (–) n = 140	In-hospital Events (+) n = 20	P
Age >65 y (n = 92)	80 (57.1%)	12 (60%)	NS
Male (n = 112)	94 (67.1%)	18 (90%)	.03
BMI (>30 kg/m ²) (n = 22)	20 (14.2%)	2 (10%)	NS
Hypertension (n = 114)	96 (68.5%)	18 (90%)	NS
Diabetes mellitus (n = 48)	40 (28.5%)	8 (40%)	NS
Hyperlipidemia (n = 76)	68 (48.5%)	8 (40%)	NS
Smoking (n = 78)	72 (51.4%)	6 (30%)	NS
Family history (n = 36)	32 (22.8%)	4 (20%)	NS
Previous history of CAD (n = 96)	80 (57.1%)	16 (80%)	.05
Episodes of angina before admission (n = 64)	50 (35.7%)	14 (70%)	.006
Diseased vessels (50% stenosis)			
0	12 (8.5%)	0 (0%)	
1	24 (17.1%)	0 (0%)	NS
2	26 (18.5%)	5 (25%)	
3	78 (55.7%)	11 (55%)	
CAD risk factors ≥3 (n = 78)	70 (50%)	8 (40%)	NS
Left ventricular ejection fraction >40% (n = 132)	115 (82.1%)	17 (85%)	NS
TIMI risk score <2 (n = 10)	10 (7.1%)	0	
TIMI risk score = 3–4 (n = 60)	54 (38.5%)	6 (30%)	NS
TIMI risk score ≥5 (n = 90)	76 (54.2%)	14 (70%)	
Medication prior to admission			
Aspirin	109 (77.8%)	19 (95%)	NS
Statin	66 (47.14%)	8 (40%)	NS
β-Blocker	76 (54.28%)	16 (80%)	NS
ACE inhibitors	72 (51.42%)	10 (50%)	NS
Calcium blockers	52 (37.14%)	8 (40%)	NS
Any diuretic	42 (30%)	7 (35%)	NS
Medication in-hospital			
Aspirin	140 (100%)	20 (100%)	NS
Clopidogrel	140 (100%)	20 (100%)	NS
Statin	130 (92.85%)	18 (90%)	NS
β-Blocker	128 (91.42%)	18 (90%)	NS
ACE inhibitors	76 (54.28%)	8 (40%)	NS

Table 2. (Continued)

	In-hospital Events (–) n = 140	In-hospital Events (+) n = 20	P
Calcium blockers	42 (30%)	5 (25%)	NS
Any diuretic	40 (28.5%)	7 (35%)	
Percutaneous coronary intervention in-hospital	75 (53.57%)	10 (50%)	NS
Bypass surgery suggested	41 (29.28%)	6 (30%)	NS
Age (yrs)	65.88 ± 11.01 (45–90)	67.8 ± 10.39 (48–85)	NS
Heart rate on admission (Beats per minute)	71.96 ± 17.02 (47–135)	79.12 ± 18.26 (54–110)	NS
Left ventricular ejection fraction (%)	50.8 ± 12 (15–70)	48.12 ± 9.63 (25–55)	NS
Troponin I (ng/mL)	0.62 ± 0.35 (0.04–1.33)	0.67 ± 1.26 (0.04–7.9)	.04
White blood cell count (cells/μL)	7634 ± 1707 (4570–11 100)	8604 ± 2485 (4500–12 250)	.1
Neutrophil count (cells/μL)	4739 ± 1398 (1965–7912)	6290 ± 2775 (2700–11 147)	.02
CRP (mg/dL)	2.47 ± 4.07 (0.09–20.46)	1.85 ± 1.66 (0.09–5.91)	.51
<i>Abbreviations:</i> BMI, body mass index; ACE, angiotensin-converting enzyme; CAD, coronary artery disease; CRP, C-reactive protein; NS, not significant; TIMI, thrombolysis in myocardial infarction flow.			

Table 3. Validity of Cut Off Values for CRP, Troponin I, WBC Count, and Neutrophil Count in Discriminating Patients with Major In-hospital Events From Those Without Major In-hospital Events

Cut-off Levels	Sensitivity %	Specificity %	PPV %	NPV %	χ ² , P
Troponin I >0.07 (ng/mL)	90%	40%	17.6%	96.6%	6.27
					.01
WBC count >8650 (cells/μL)	50%	74.3%	21.7%	91.2%	4.35
					.03
Neutrophil count >6700 (cells/μL)	50%	91.4%	45.5%	92.8%	19.1
					<.001
CRP >0.97 (mg/dL)	80%	48.6%	18.2%	94.4%	5.23
					.02
<i>Abbreviations:</i> CRP, C-reactive protein; PPV, positive predictive value; NPV, negative predictive value; WBC, white blood cell.					

cells/μL as a categorical variable in model 2 (OR: 6.52, 95% CI: 1.56–27.22, $P = 0.01$) were the only independent predictors of major in-hospital events (Table 4).

Discussion

The major finding of this study was that in patients with an NSTEMI ACS of moderate or high risk neutrophil count on admission may identify those who are at risk of having an adverse in-hospital outcome. More importantly, this association was found independent of other clinical variables. Interestingly, inclusion of the classic risk stratifying markers (WBC, CRP, and TnI) in the model did not have any

effect on the predictive ability of neutrophil count. A 100 cells/μL increase in the neutrophil count was associated with a 20% increase in the risk for an adverse event, whereas this risk showed an almost 6.5-fold increase for a count of >6700 cells/μL. Increases of WBC count, CRP, and TnI serum levels were also associated with a higher risk, but this relationship was abolished in multivariate analysis when neutrophil count was introduced in the model. The cut off levels of TnI (>0.07 ng/mL) and CRP (>0.97 mg/dL) on admission were highly sensitive, whereas neutrophil and WBC count were highly specific in predicting major

Figure 1.

in-hospital events. All of the above parameters were also characterized by high negative predictive value.

All of our patients were in the high risk category since all of them had angina at rest, marked ischemic changes in the electrocardiogram, and increased serum levels of TnI. Moreover, 30% of them had diabetes, 60% had previous history of coronary artery disease, and 93.7% were at moderate or severe risk according to the TIMI risk

stratification system (TIMI risk score ≥ 3 ; Table 1). It has been demonstrated⁹ that risk scores for risk stratification in ACS are accurate enough and superior to clinical assessment, but they are more complicated, with a high degree of variability among them. From this point of view, risk stratification of these patients remains an open issue and the list of high risk features needs further enrichment with new, more practical parameters. Neutrophil count on admission could be helpful in everyday clinical judgment.

Markers of myocardial injury, like troponins, are clearly associated with marked increase in the risk of cardiac death and MI in patients with ACS.^{10,11} On the other hand, WBC or neutrophil count have not been thoroughly evaluated as prognostic indicators in this patient population. In this study, we demonstrated that patients with a NSTEMI ACS who did not experience a major in-hospital event had significant lower serum levels of TnI compared to those who did. Serum levels of TnI >0.07 ng/mL were predictive of a 5.65-fold increase of the probability of an event. However, this relationship was no more significant once neutrophil count was forced into the model, indicating a dependent relationship between TnI and occurrence of major in-hospital events, although levels of TnI did not correlate with neutrophil count.

As inflammation plays a key role in the pathogenesis of ACS, inflammation markers have also been used for risk stratification of these patients. Emerging evidence suggests that serum markers of inflammation may be important predictors of CAD. Indeed, baseline plasma levels of CRP appear to be a strong predictor of CAD¹² and has been proposed as an index of increased cardiovascular risk. Moreover, CRP has been shown to be an independent predictor of recurrent events and mortality in patients with ACS.^{13,14} However, no study has shown so far that CRP levels can predict in-hospital events. This was also confirmed in our study where CRP levels on admission were not independent predictors of an adverse in-hospital outcome.

The association of leukocyte count with coronary heart disease has been demonstrated for many years. An increasing number of prospective studies conducted in healthy populations have shown a positive correlation between the leukocyte count and risk of CAD.^{15–17} Moreover, in patients with stable CAD,¹⁸ leukocyte count has also been strongly associated with prognosis.

In the setting of ACS, leukocyte counts at presentation have been found significantly higher in patients with AMI.¹⁹ Leukocyte count in patients with ACS has been strongly correlated with increased mortality both in-hospital and after discharge.^{18,20} Moreover, increased WBC count has been associated with lower rates of coronary patency and increased thrombus burden in patients with AMI treated with thrombolytics²¹ decreasing the chance of successful reperfusion. As far as we know, the predictive value of neutrophil count has not been examined separately from WBC count, although there is growing evidence from

Table 4. Univariate and Multivariate Logistic Regression Analysis of Continuous and Categorical Variables as Predictors of Major In-hospital Events

	Univariate Analysis			Multivariate Analysis			
				Model 1		Model 2	
	Exp(B)	95% CI	P	Exp(B)	P	Exp(B)	P
Age	1.01	0.97–1	NS	1	NS		
Sex	4.40	0.98–19.79	.05	5.46	NS	5.46	NS
DM	1.66	0.63–4.38	NS	1.73	NS	1.73	NS
HTN	4.12	0.91–18.55	NS	2319.68	NS	2319.68	NS
CHOL	0.7	0.27–1.83	NS	0.55	NS	0.23	NS
SM	0.40	0.14–1.11	NS	0.34	NS	0.72	NS
OB	0.66	0.14–3.09	NS				
FH	0.34	0.07–1.57	NS				
Previous History of CAD	2.99	0.95–9.42	NS				
TIMI risk score	2.04	0.81–510	NS	1.94	NS	1.64	NS
EF	0.98	0.94–1.02	NS	1.01	NS		
EF >40%	1.54	0.32–7.26	NS			0.96	NS
Age >65y	1.12	0.43–2.92	NS			1.12	NS
TnI	0.96	0.62–1.47	NS	2.33	NS		
TnI >0.07 (ng/mL)	5.65	1.26–25.32	.02			3.74	NS
WBC count	1	1–1.001	.03	0.99	.04		
WBC count >8650 (cells/ μ L)	2.68	1.03–6.95	.04				
Neutrophil count	1	1–1.001	.001	1.002	.007		
Neutrophil count >6700 (cells/ μ L)	7.74	2.79–21.47	.000			6.52	.01
CRP	0.94	0.8–1.11	NS	0.77	NS		
CRP >0.97 (mg/dL)	3.56	1.13–11.19	.02			2.03	NS

Abbreviations: CAD, coronary artery disease; CHOL, hypercholesterolemia; CI, confidence interval; CRP, C-reactive protein (mg/dL); DM, diabetes mellitus; EF, ejection fraction of the left ventricle; Exp(B), FH, family history of CAD; HTN, hypertension; NS, not significant; OB, obesity; SM, smoking; TIMI, thrombolysis in myocardial infarction flow; TnI, troponin I (ng/mL); WBC, white blood cell count (cells/ μ L), TIMI risk score: low (0–2), moderate (3–4), high (5–7).

experimental data that suggests that much of the activity of leukocytes during ACS could be attributed to neutrophils.

Leukocytes may cause infarct expansion²² during reperfusion of ischemic myocardium as neutrophils and platelets can plug capillaries in the coronary microcirculation, resulting in the no-reflow phenomenon.^{23–25} In patients with ACS the leukocytosis that follows necrotic injury usually²⁶ renders leukocytes less deformable, thus aggravating ischemia, extending the infarct area, and leading

to further complications. Stimulated neutrophil can cause proteolytic and oxidative damage to coronary arteries through mechanisms involving secretion of proteolytic neutral proteases.^{27,28} Finally, neutrophils contribute to the pathogenesis of plaque rupture in human atherosclerotic plaques. Neutrophils have been found in atherectomy specimens in patients with unstable angina. There is supporting evidence^{29,30} that neutrophils are activated in eroded plaques, likewise as in the inflammatory state, thus

suggesting a probable contribution to the pathogenesis of ACS.

Study Limitations

The study was not designed to assess a causal relationship between neutrophil count and in-hospital events. So whether neutrophil count is a risk factor for major in-hospital events or simply a risk marker remains inconclusive. Moreover, the population study is of limited size. A larger study could potentially offer more conclusive evidence about the value of neutrophil count in predicting in-hospital mortality.

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