Annals of Internal Medicine | ORIGINAL RESEARCH

Characteristics and Short-Term Prognosis of Perioperative Myocardial Infarction in Patients Undergoing Noncardiac Surgery

A Cohort Study

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Background: Each year, millions of patients worldwide have a perioperative myocardial infarction (MI) after noncardiac surgery.

Objective: To examine the characteristics and short-term outcome of perioperative MI.

Design: Cohort study. (ClinicalTrials.gov registration number: NCT00182039)

Setting: 190 centers in 23 countries.

Patients: 8351 patients included in the POISE (PeriOperative ISchemic Evaluation) trial.

Measurements: Four cardiac biomarker or enzyme assays were measured within 3 days of surgery. The definition of perioperative MI included either autopsy findings of acute MI or an elevated level of a cardiac biomarker or enzyme and at least 1 of the following defining features: ischemic symptoms, development of pathologic Q waves, ischemic changes on electrocardiography, coronary artery intervention, or cardiac imaging evidence of MI.

Results: Within 30 days of random assignment, 415 patients (5.0%) had a perioperative MI. Most MIs (74.1%) occurred within 48 hours of surgery; 65.3% of patients did not experience ischemic symptoms. The 30-day mortality rate was 11.6% (48 of 415 patients) among patients who had a perioperative MI and 2.2% (178 of 7936 patients) among those who did not ($P < 0.001$). Among patients with a perioperative MI, mortality rates were elevated and similar between those with (9.7%; adjusted odds ratio, 4.76 [95% CI, 2.68 to 8.43]) and without (12.5%; adjusted odds ratio, 4.00 [CI, 2.65 to 6.06]) ischemic symptoms.

Limitation: Cardiac markers were measured only until day 3 after surgery, and additional asymptomatic MIs may have been missed.

Conclusion: Most patients with a perioperative MI will not experience ischemic symptoms. Data suggest that routine monitoring of troponin levels in at-risk patients is needed after surgery to detect most MIs, which have an equally poor prognosis regardless of whether they are symptomatic or asymptomatic.

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A recent study (1, 2), which used surgical data from 56 countries, suggested that more than 200 million patients worldwide have major noncardiac surgical procedures each year. Millions of these patients will have a major vascular complication (vascular death, nonfatal myocardial infarction [MI], nonfatal cardiac arrest, or nonfatal stroke) within 30 days after surgery (2). Myocardial infarction is the most common major perioperative vascular complication (3). We recently completed a randomized, controlled trial (RCT), the POISE (PeriOperative ISchemic Evaluation) trial (3), in which we randomly assigned 8351 patients to receive extended-release metoprolol succinate or placebo starting 2 to 4 hours before surgery and continuing for 30 days. Of these patients, 1.6% died of vascular causes, 0.7% had a stroke, 0.5% had a nonfatal cardiac arrest, and 5.0% had an MI in the first 30 days (3).

We have proposed a definition for perioperative MI among patients undergoing noncardiac surgery elsewhere (4). More recently, an international consensus panel (5) recommended a new definition for MI. Although this consensus definition does not directly address the diagnosis of MI after noncardiac surgery, their definition is similar to our proposed definition. The characteristics and short-term prognosis of nonoperative MI have evolved over the past 2 decades (6). Fewer patients with nonoperative MI have ST-segment elevation MI than have non–ST-segment elevation MI, and the short-term mortality rate is decreasing (6). Little is known about the current characteristics and short-term prognosis of perioperative MI in patients having noncardiac surgery. We performed this study to gather information about these issues.

METHODS

This was a cohort study of participants in the POISE trial. A POISE methods paper has been published elsewhere, and the main results paper further describes our methods (3, 7).

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Context

We know little about perioperative myocardial infarction (MI) in patients who have noncardiac surgery.

Contribution

In this study, 5% of patients had a perioperative MI, and the 30-day mortality rate was higher for patients who had an MI (12%) than for those who did not (2%). Of the patients who had an MI, 65% did not have ischemic symptoms, and the mortality rate was similar between those who did and did not have symptoms.

Caution

Investigators may have missed MIs that occurred more than 3 days after surgery.

Implication

Clinicians should routinely monitor for MI when at-risk patients have noncardiac surgery.

—The Editors

Patients

We recruited patients between October 2002 and July 2007 from 190 hospitals in 23 countries. Patients were eligible if they were having noncardiac surgery, were aged 45 years or older, had an expected length of hospital stay of 24 hours or longer, and had or were at risk for atherosclerotic disease. All patients provided written informed consent. All participating sites obtained ethical approval before recruiting patients.

Follow-up

All patients received electrocardiography (ECG) 6 to 12 hours as well as on the 1st, 2nd, and 30th days after surgery, and troponin levels were measured 6 to 12 hours as well as on the first, second, and third days after surgery. (Creatine kinase–MB levels were measured if troponin testing was unavailable.) These measurements were recorded on the case report forms, forwarded to the POISE project office, and reviewed centrally. If a patient's biomarker or cardiac enzyme levels were elevated but an MI case report form was not submitted, we asked the center to review the case to ensure that an MI was not missed. Centers were encouraged to obtain ECGs more frequently and to measure cardiac biomarker levels if they suspected MI. Patients were followed throughout their hospital stay and contacted at 30 days after random assignment. The 30-day follow-up was complete for 8331 of the 8351 randomly assigned patients (99.8%).

Outcomes

We evaluated MIs within 30 days of randomization. Our definition of perioperative MI included elevated cardiac biomarker or enzyme levels (a typical increase in troponin level, a typical decrease of an elevated troponin level detected at its peak, or a rapid increase and decrease in creatine kinase–MB level), and 1 or more of the following defining features: ischemic symptoms (such as chest, epigastric, arm, wrist, or jaw discomfort or shortness of breath), development of pathologic Q waves in 2 contiguous leads during ECG, ischemic changes detected with ECG (new or presumed-new ST-segment elevation or depression or T-wave inversion in at least 2 contiguous leads during ECG), coronary artery intervention (such as percutaneous coronary intervention or coronary artery bypass graft surgery), or evidence of MI on cardiac imaging (a new or presumed-new cardiac wall–motion abnormality on echocardiographic imaging or a new or presumed-new fixed defect on radionuclide imaging). We also diagnosed perioperative MI if a patient's autopsy findings demonstrated acute MI. Outcome adjudicators evaluated all potential MIs, and their decisions were used in the statistical analyses.

Statistical Analysis

We determined the baseline characteristics (such as age category) among patients who did or did not have a perioperative MI, and compared the proportions across these groups by using a chi-square test. The proportion of patients with perioperative MI who experienced each defining feature of our MI definition (such as ischemic symptoms or Q waves) was then calculated.

We determined the proportion of patients who had an MI with or without ischemic symptoms, compared the outcomes (such as nonfatal cardiac arrest) for each of these groups with those of patients who did not have a perioperative MI, and we determined the odds ratios and 95% CIs. Multivariable logistic regression analysis was conducted on the entire data set to see whether perioperative MI affected mortality regardless of the presence of ischemic symptoms. In our multivariable regression analysis, the dependent variable was mortality at 30 days and the independent variables were the independent predictors of mortality established in the primary POISE publication on the basis of preoperative characteristics and drug use (no use of a statin in the 24 hours before surgery, age >70 years, emergency or urgent surgery, serum creatinine level >175 μmol/L [>2.0 mg/dL], history of congestive heart failure, or use of low-molecular-weight heparin in the 24 hours before surgery), intraoperative and postoperative events (clinically important hypotension, serious bleeding, stroke, or clinically important bradycardia), in-hospital use of various cardiovascular drugs (such as statins), and perioperative MI with or without ischemic symptoms (3). We also performed conditional logistic regression to adjust for any potential site-clustering effect.

Among patients who did not fulfill our MI definition, we determined the proportion of patients who had elevated levels of an isolated cardiac biomarker or enzyme. In patients who did not have a perioperative MI, 30-day outcomes of patients who had elevated levels of an isolated cardiac biomarker or enzyme were compared with those

who did not, and odds ratios and 95% CIs were determined. We performed multivariable regression analysis to see whether elevated levels of an isolated cardiac biomarker or enzyme were prognostically relevant. This analysis included only patients who did not have a perioperative MI. The dependent variable was mortality at 30 days, and the independent variables were the previously listed independent predictors of mortality and an elevated level of troponin or creatine kinase–MB, on the basis of quartiles above the upper limit of normal.

The POISE trial demonstrated that patients randomly assigned to receive metoprolol had a statistically significant reduction in mean heart rate at hospital discharge and risk for MI at 30 days. To determine whether a patient's baseline heart rate before surgery was an independent predictor of MI after surgery, we performed a multivariable regression analysis that included only patients randomly assigned to the placebo group, because of the known effect of metoprolol on heart rate and MI. The dependent variable was MI at 30 days and the independent variables included baseline eligibility criteria, history of hypertension, smoking status, baseline heart rate, age by deciles, baseline cardiac medications, and perioperative serious bleeding (bleeding that was disabling or required ≥2 units of blood).

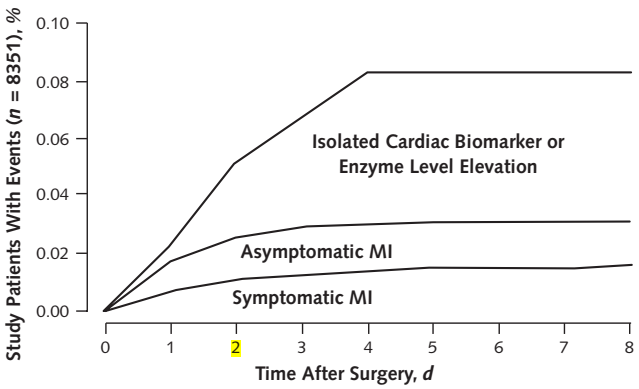
For patients with a perioperative MI, we used generalized estimating equations for repeated measures to determine whether the use of various cardiovascular drugs varied significantly across any of the 3 periods we evaluated (before surgery, in the hospital, or at hospital discharge). The potential effect of these drugs on patients with a perioperative MI was assessed by using a multivariable regression analysis that included only patients with a perioperative MI. The dependent variable was mortality at 30 days and the independent variables included in-hospital use of various cardiovascular drugs (acetylsalicylic acid, clopidogrel or ticlopidine, a statin, an angiotensin-converting enzyme inhibitor or angiotensin-receptor blocker, and intravenous or low-molecular-weight heparin).

For regression models, we assessed model assumptions and calibration with a goodness-of-fit test. The statistical analyses were performed by using SAS, version 9.1 for UNIX (SAS Institute, Cary, North Carolina).

Role of the Funding Source

The POISE trial was funded by peer-reviewed grants from Canada, Australia, Spain, and the United Kingdom. AstraZeneca provided the study drug and funding for drug labeling, packaging, and shipping and helped support the cost of some national POISE investigator meetings. These funding sources had no role in the study design, conduct, data collection, analyses, data interpretation, or writing of this manuscript. The Population Health Research Institute, Hamilton Health Sciences and McMaster University, Hamilton, Ontario, Canada, coordinated the study, managed the data, and performed analyses, under the supervision of the Operations Committee.

Figure 1. **Timing of perioperative MI and elevated levels of an isolated cardiac biomarker or enzyme.**



An isolated elevation refers to a patient who had elevated levels of a cardiac biomarker or an enzyme but did not fulfill our definition of MI. MI = myocardial infarction.

RESULTS

A total of 415 patients (5.0%) were judged to have had a perioperative MI within 30 days of random assignment. Most patients (96.6%) fulfilled our definition of MI by having elevated levels of a cardiac biomarker or an enzyme and a defining feature (such as ST-segment depression); 3.4% of patients were judged to have had an MI on the basis of autopsy findings. Among patients who had a perioperative MI, 94.2% had elevated troponin levels and 3.4% had elevated creatine kinase–MB levels; centers measured either troponin or creatinine kinase–MB. **Appendix Table 1** (available at www.annals.org) reports the baseline characteristics among patients who did or did not have a perioperative MI. Patients who had an MI were older and had more cardiovascular risk factors than those who did not.

Appendix Table 2 (available at www.annals.org) reports the defining features of the MIs. Fewer than one half of patients (34.7%) experienced ischemic symptoms. Non–ST-segment elevation MI was more common (ST-segment depressions were present in 31.3% and T-wave inversions in 21.7% of the MIs) than ST-segment elevation MI, which occurred in 10.6% of the MIs; Q waves developed in 12.3% of the MIs. Of the patients who had an MI, 47.5% had more than 1 defining feature (for example, 14 of the 51 patients who developed Q waves also had ST-segment elevation).

Figure 1 shows the timing of patients who had symptomatic (with ischemic symptoms) or asymptomatic (no ischemic symptoms) MI or an elevated level of an isolated cardiac biomarker or enzyme (a patient with an elevated cardiac biomarker or enzyme level that did not

Table 1. **Outcomes**

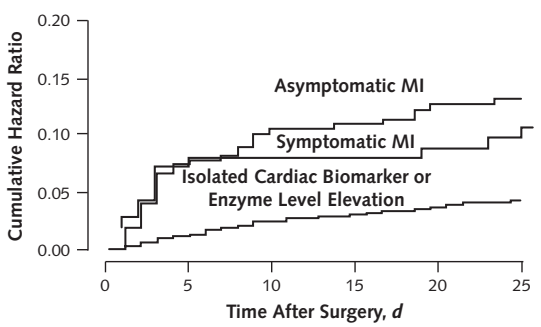
Outcome	Patients With No Perioperative MI (n = 7936), n (%)	Perioperative MI With Ischemic Symptoms (n = 144)		Perioperative MI Without Ischemic Symptoms (n = 271)		No Perioperative MI But Elevated Cardiac Biomarker or Enzyme Levels (n = 697)	
		Patients, n (%)	Unadjusted Odds Ratio (95% CI)*	Patients, n (%)	Unadjusted Odds Ratio (95% CI)*	Patients, n (%)	Unadjusted Odds Ratio (95% CI)†
Nonfatal cardiac arrest	26 (0.3)	3 (2.1)	6.48 (1.94–21.64)	11 (4.1)	12.87 (6.29–26.33)	6 (0.9)	3.93 (1.51–10.27)
Congestive heart failure	171 (2.2)	35 (24.3)	14.58 (9.68–21.97)	42 (15.5)	8.33 (5.80–11.96)	22 (3.2)	1.55 (0.98–2.45)
Stroke	52 (0.7)	1 (0.7)	1.06 (0.15–7.72)	7 (2.6)	4.02 (1.81–8.94)	5 (0.7)	1.11 (0.44–2.82)
Coronary revascularization	5 (0.1)	19 (13.2)	241.09 (88.63–655.85)	14 (5.2)	86.41 (30.89–241.71)	2 (0.3)	9.14 (1.29–64.97)

MI = myocardial infarction.
* Compared with patients who did not have perioperative MI.
† Compared with patients who did not have either perioperative MI or an elevated cardiac biomarker or enzyme level.

fulfill our MI definition). Most symptomatic (64.6%) and asymptomatic (79.3%) MIs and elevated levels of isolated cardiac biomarkers or enzymes (61.8%) occurred within 48 hours of surgery.

The 30-day mortality rate was 11.6% (48 of 415 patients) among patients who had a perioperative MI and 2.2% (178 of 7936 patients) among patients who did not ($P < 0.001$). Patients with symptomatic perioperative MI had more nonfatal cardiac arrests and congestive heart failure and more coronary revascularizations than those with no perioperative MI (**Table 1**), and patients with asymptomatic perioperative MI had more cardiovascular complications than those with no perioperative MI. A total of 697 patients (8.3%) had elevated levels of an isolated cardiac biomarker or enzyme; such patients had a greater risk for nonfatal cardiac arrest and nonacute coronary revascularization than patients with no perioperative MI and no elevated cardiac biomarker or enzyme levels.

Figure 2. **Cumulative hazard ratios for mortality among patients who had symptomatic or asymptomatic MI or an isolated elevated level of a cardiac biomarker or enzyme after surgery.**



Patients at risk, n					
Symptomatic MI	144	130	126	118	106
Asymptomatic MI	271	238	234	226	214
Isolated cardiac biomarker or enzyme level elevation	697	665	658	645	624

An isolated elevation refers to a patient who had elevated levels of a cardiac biomarker or an enzyme but did not fulfill our definition of MI. MI = myocardial infarction.

Perioperative MI was an independent predictor of death at 30 days, both with (9.7%; adjusted odds ratio, 4.76 [95% CI, 2.68 to 8.43]) and without (12.5%; adjusted odds ratio, 4.00 [CI, 2.65 to 6.06]) ischemic symptoms (goodness-of-fit test $P = 0.84$). Conditional logistic regression produced similar results. **Figure 2** demonstrates the timing of mortality among patients with symptomatic or asymptomatic perioperative MI or an elevated level of an isolated cardiac biomarker or enzyme. More than 50% of the patients who died after having symptomatic or asymptomatic MI did so within 48 hours, whereas the median time to death was 8 days for those with an elevated level of an isolated cardiac biomarker or enzyme.

Table 2 reports the independent predictors of perioperative MI among patients assigned to the placebo group of the POISE trial (proportional hazards assumption met; goodness-of-fit test $P > 0.32$). After adjustment for baseline characteristics, every 10-beats/min increase in prerandomization heart rate was associated with a 31% relative increase in the odds of perioperative MI (adjusted odds ratio, 1.31 [CI, 1.12 to 1.52]).

Appendix Table 3 (available at www.annals.org) shows use of cardiovascular medication before surgery, in the hospital, and at hospital discharge among patients with a perioperative MI. Although some patients with a perioperative MI had increased use of cardiovascular drugs compared with their preoperative use, only 64.8% of patients were receiving acetylsalicylic acid, 17.8% were receiving clopidogrel or ticlopidine, 52.0% were receiving a statin, and 55.4% were receiving an angiotensin-converting enzyme inhibitor or angiotensin-receptor blocker at hospital discharge. Multivariable regression analysis among patients who had an MI suggested that acetylsalicylic acid and statin use were each associated with a reduction in the risk for 30-day mortality (adjusted odds ratios, 0.54 [CI, 0.29 to 0.99] and 0.26 [CI, 0.13 to 0.54], respectively; proportional hazards assumption met; goodness-of-fit test $P > 0.100$).

Among the 697 patients with elevated levels of an isolated cardiac biomarker or enzyme, 360 had elevated troponin levels and 337 had elevated creatine kinase–MB levels. The highest quartile (a troponin or creatine kinase–MB level ≥3.6 times the upper limit of normal) for an isolated cardiac biomarker or enzyme elevation was an independent predictor of 30-day mortality (adjusted odds ratio, 2.54 [CI, 1.65 to 3.90]; proportional hazards assumption met; goodness-of-fit test $P = 0.24$).

DISCUSSION

In this cohort study of more than 8000 patients who participated in an international perioperative RCT, 415 patients (5.0%) had a perioperative MI within 30 days of random assignment. Most MIs (74.1%) occurred within 48 hours of surgery and 65.3% were asymptomatic. Patients who had perioperative MI (symptomatic or asymptomatic) were at higher risk for both another cardiovascular event and death within 30 days. Of the patients who had a perioperative MI, 11.6% died within 30 days; most of them (58.3%) died within 48 hours of this event. A substantial proportion of patients with a perioperative MI did not receive cardiovascular medications known to be effective in managing patients with nonoperative MI. Among patients who did not fulfill our definition of perioperative MI, a troponin or creatine kinase–MB level greater than or equal to 3.6 times the upper limit of normal was an independent predictor of 30-day mortality.

The strengths of our study include our evaluation of a large sample of patients, who had a broad range of noncardiac surgeries and were drawn from 190 centers in 23 countries. All patients were actively monitored for perioperative MI, using both ECG and cardiac biomarker or enzyme measurements for several days after surgery. Of the patients enrolled, 99.8% completed the 30-day follow-up. All suspected MIs were centrally adjudicated by independent physicians with expertise in perioperative medicine, using a standardized definition. Our regression models fulfilled the underlying assumptions and demonstrated good calibration (all goodness-of-fit $P > 0.05$).

Our study has limitations. We measured cardiac markers only until day 3 after surgery, and we may have missed additional asymptomatic MIs. Our analysis of the effect of cardiovascular drugs on mortality in patients with a perioperative MI was based on observational data. Although our regression model evaluated more than 10 deaths per drug, our findings should be viewed only as hypothesis generators for future RCTs. Many different troponin assays were used across centers, and confirmatory evaluations of specific troponin assays are therefore needed for our analysis evaluating an isolated cardiac biomarker or creatine kinase-MB elevations. We did not collect data on length of surgery or postoperative pain management, and therefore we could not include these variables in our multivariable analysis for predicting perioperative MI.

Table 2. **Independent Predictors of Perioperative MI**

Independent Predictor	Adjusted Odds Ratio (95% CI) for Association With Perioperative MI
Every 10-beats/min increase in baseline heart rate	1.29 (1.13–1.50)
History of stroke	2.24 (1.20–4.20)
Undergoing major vascular surgery	2.21 (1.15–4.25)
Preoperative serum creatinine level >175 μmol/L (>2.0 mg/dL)	4.33 (2.32–8.09)
Age, per decile increase	1.53 (1.20–1.95)
Emergency or urgent surgery	2.94 (1.65–5.26)
Serious bleeding*	3.62 (2.07–6.36)

MI = myocardial infarction.
* Disabling or requiring ≥2 units of blood.

To our knowledge, no previous study has evaluated more than 100 perioperative MIs among a group of patients who had systematic monitoring of cardiac biomarker or enzyme levels and ECG after noncardiac surgery. Several smaller studies have similarly suggested that most perioperative MIs occur within 48 hours of surgery (8–10) and that most perioperative MIs occur without ischemic symptoms (8, 11, 12).

Perioperative MI is the most common major perioperative vascular complication, and it is associated with poor prognosis. Most patients who have a perioperative MI will not experience ischemic symptoms; however, asymptomatic perioperative MI is as strongly associated as symptomatic MI with 30-day mortality. Therefore, routine monitoring of cardiac biomarkers after surgery is essential.

The highest risk for death after perioperative MI is in the first 48 hours, regardless of whether the patient experiences ischemic symptoms. This highlights the need to quickly diagnose and intensely monitor and implement treatments for perioperative MI, just as with nonoperative MI. Because most patients with a perioperative MI have some degree of underlying coronary artery stenosis (13–15), until definitive perioperative MI RCTs are conducted offering such patients long-term management with secondary prophylaxis cardiac interventions known to be beneficial (such as a statin or an angiotensin-converting enzyme inhibitor) seems reasonable. A substantial proportion of patients with a perioperative MI were neither treated nor discharged from the hospital with these medications.

Every 10-beats/min increase in baseline heart rate and serious bleeding were independent predictors of perioperative MI. These risk factors are potentially modifiable, and interventions that can safely prevent them are needed. Emergency or urgent surgery was also associated with perioperative MI, and some aspects of these cases (such as timing of surgery) are also potentially modifiable (16).

A substantial proportion of patients (8.3%) had elevated levels of an isolated cardiac biomarker or enzyme after surgery. The highest-quartile elevation of an isolated cardiac biomarker

or enzyme level (≥3.6 times the upper limit of normal) was an independent predictor of 30-day mortality, which suggests that the definition of perioperative MI should also include this criterion when no alternative diagnosis (such as pulmonary emboli) can explain the elevated level.

Most patients who have a perioperative MI will not experience ischemic symptoms, and physicians should therefore require perioperative troponin monitoring to avoid missing these prognostically important MIs. Patients who have a perioperative MI have a substantial risk for both serious cardiovascular events and short-term mortality. Randomized, controlled trials to establish effective treatments for perioperative MI are urgently needed.

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Appendix Table 1. **Baseline Characteristics of Patients Who Did or Did Not Have Perioperative MI**

Characteristic	Patients Who Had Perioperative MI (n = 415)	Patients Who Did Not Have Perioperative MI (n = 7936)	*P* Value
Age			<0.001
Median (25th, 75th percentiles), *y*	75 (67, 80)	70 (61, 76)	
45–54 y, *n (%)*	22 (5.3)	855 (10.8)	
55–64 y, *n (%)*	55 (13.3)	1744 (22.0)	
65–74 y, *n (%)*	130 (31.3)	2770 (34.9)	
75–84 y, *n (%)*	167 (40.2)	2159 (27.2)	
≥85 y, *n (%)*	41 (9.9)	404 (5.1)	
Women, *n (%)*	139 (33.5)	3550 (44.7)	<0.001
Patients fulfilling eligibility criteria, *n (%)*			
Coronary artery disease	212 (51.1)	3377 (42.6)	<0.001
Peripheral arterial disease	175 (42.2)	3236 (40.8)	0.57
Stroke thought to be due to atherothrombotic disease	74 (17.8)	1189 (15.0)	0.114
Hospitalized for CHF within 3 y of random assignment	16 (3.9)	204 (2.6)	0.111
Undergoing major vascular surgery	164 (39.5)	2821 (35.6)	0.100
Risk factors			
Had 3 of 7 risk factors	99 (23.9)	1454 (18.3)	0.005
Intrathoracic or intraperitoneal surgery	108 (26.0)	1984 (25.0)	0.64
Any history of CHF	33 (8.0)	502 (6.3)	0.190
Diabetic and currently receiving an oral hypoglycemic agent or insulin	135 (32.5)	2292 (28.9)	0.111
Preoperative serum creatinine level >175 μmol/L (>2.0 mg/dL)	35 (8.4)	366 (4.6)	<0.001
Age >70 y	276 (66.5)	4035 (50.8)	<0.001
History of transient ischemic attack	54 (13.0)	828 (10.4)	0.096
Emergency or urgent surgery	63 (15.2)	815 (10.3)	0.002
Other cardiovascular risk factors			
History of hypertension	289 (69.6)	4973 (62.7)	0.004
Current smoker	66 (15.9)	1533 (19.3)	0.085
Surgery, *n (%)*			
Vascular	179 (43.2)	3286 (42.0)	0.49
Intraperitoneal	83 (20.1)	1732 (22.1)	0.38
Orthopedic	113 (27.3)	1643 (21.0)	0.002
Other	39 (9.4)	1163 (14.7)	0.003

CHF = congestive heart failure; MI = myocardial infarction.

Appendix Table 2. Defining Features of Perioperative MI

Feature	Patients With Perioperative MI Who Had This Feature, *n (%)**
Ischemic symptoms	144 (34.7)
Q waves	51 (12.3)
ST-segment elevation	44 (10.6)
ST-segment depression	130 (31.3)
T-wave inversion	90 (21.7)
Coronary artery intervention	29 (7.0)
Cardiac imaging evidence of MI	108 (26.0)

MI = myocardial infarction.
* Patients had perioperative MI, an elevated cardiac biomarker or enzyme level, and 1 or more of these defining features for perioperative MI.

Appendix Table 3. Medication Use Among Patients With Perioperative Myocardial Infarction

Medication	Preoperative Use, *n (%)*	In-Hospital Use, *n (%)*	Prescribed at Discharge From Hospital, *n (%)*	*P* Value*
Acetylsalicylic acid	162 (39.0)	307 (74.0)	267 (64.8)	<0.001
Clopidogrel or ticlopidine	29 (7.0)	99 (23.9)	74 (17.8)	<0.001
Statin	139 (33.5)	229 (55.2)	216 (52.0)	<0.001
ACE inhibitor or ARB	215 (51.8)	272 (65.5)	230 (55.4)	<0.001

ACE = angiotensin-converting enzyme; ARB = angiotensin-receptor blocker.
* Indicates whether statistically significant variations in use of various cardiovascular drugs occurred across any of the evaluated periods (before surgery, in the hospital, or at hospital discharge).