Randomized Evaluation of the Safety and Efficacy of Enoxaparin Versus Unfractionated Heparin in High-Risk Patients With Non–ST-Segment Elevation Acute Coronary Syndromes Receiving the Glycoprotein IIb/IIIa Inhibitor Eptifibatide

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Background—Current pharmacotherapeutic options for high-risk non–ST-segment elevation acute coronary syndrome patients include aspirin, clopidogrel, heparin, and platelet glycoprotein IIb/IIIa inhibition. A key issue of uncertainty is the safety and efficacy of combination glycoprotein IIb/IIIa inhibitor and low-molecular-weight heparin therapy.

Methods and Results—We randomized 746 patients with rest ischemic discomfort within 24 hours after the onset of symptoms and ST-segment deviation and/or elevation of serum cardiac markers to receive open-label enoxaparin (1 mg/kg subcutaneously twice daily) or unfractionated heparin (70-U/kg bolus; 15 U · kg⁻¹ · h⁻¹ infusion, titrated to an activated partial thromboplastin time of 1.5 to 2 times control) for 48 hours. All patients received aspirin and eptifibatide (180-μg/kg bolus; 2 μg · kg⁻¹ · min⁻¹ infusion). Major non–coronary artery bypass surgery–related bleeding at 96 hours (primary safety outcome) was significantly lower among enoxaparin-treated patients than among heparin-treated patients (1.8% versus 4.6%, \(P = 0.03\)). Minor bleeding was more frequent in the enoxaparin group (30.3% versus 20.8%, \(P = 0.003\)). Patients in the enoxaparin group were less likely to experience ischemia as detected by continuous ECG evaluation (primary efficacy outcome) during the initial (14.3% versus 25.4%, \(P = 0.0002\)) and subsequent (12.7% versus 25.9%, \(P < 0.0001\)) 48-hour monitoring periods. Death or myocardial infarction at 30 days was significantly lower in the enoxaparin group (5% versus 9%, \(P = 0.031\)).

Conclusions—When aspirin and eptifibatide are used in high-risk non–ST-segment elevation acute coronary syndrome patients, enoxaparin improves outcomes (determined on the basis of better safety and efficacy) compared with currently recommended unfractionated heparin therapy and provides a useful novel alternative therapeutic strategy. (Circulation. 2003;107:238-244.)

Key Words: myocardial infarction ▶ angina, unstable ▶ heparin ▶ anticoagulants

Current pharmacotherapeutic options for patients with high-risk non–ST-segment elevation acute coronary syndromes (ACS) include aspirin, clopidogrel, heparin, and platelet glycoprotein IIb/IIIa inhibition. Although the low-molecular-weight heparin (LMWH) enoxaparin has been demonstrated to be superior to unfractionated heparin (UFH) in two trials,¹² these did not include concomitant therapy with glycoprotein IIb/IIIa antagonists. Hence, a key remaining issue is the safety and efficacy of combination glycoprotein IIb/IIIa inhibitor and LMWH therapy. We hypothesized that the rates of major hemorrhage would be equivalent and rates of ischemia lower in glycoprotein IIb/IIIa inhibitor–treated patients receiving enoxaparin versus UFH.

Methods

Study Patients

Patients were eligible if they were ≥18 years of age and hospitalized with ischemic chest discomfort of ≥10 minutes’ duration occurring at rest and ≥24 hours before enrollment. In addition, patients were required to have: (1) ST-segment depression ≥0.1 mV or transient

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*The INTERACT Trial investigators are listed in the Appendix.

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ST-segment elevation ≥0.1 mV in ≥2 contiguous ECG leads; and/or
(2) elevation (determined by the local laboratory) of troponin I or T
≥3 times the upper reference limit, or creatinine kinase (CK)-MB
higher than normal.

Patients were excluded if they had any of the following findings:
(1) Cardiovascular: uninterpretable ST segment based on baseline
12-lead ECG (eg, left bundle-branch block); ischemia due to an
established precipitating cause (eg, heart failure); cardiogenic shock;
or scheduled or recent revascularization (coronary artery bypass
surgery in previous 2 months or percutaneous coronary intervention
[PCI] in previous 6 months).
(2) Bleeding risk: blood pressure >200 mm Hg systolic or
>110 mm Hg diastolic; hemoglobin <11 g/dL for men or <9 g/dL for
women; thrombocytopenia; ulcerative gastrointestinal disease in
previous 6 months; history of cerebral hemorrhage or known
intracerebral vascular disease; nonhemorrhagic stroke in previous
month; eye, spinal, or central nervous system surgery in previous
2 months; major surgery, organ biopsy, puncture of noncompressible
vessel in previous 2 weeks; or known or suspected pregnancy.
(3) Prior or concomitant therapy: treatment with abciximab in
previous 14 days or with tirofiban or eptifibatide in previous 7 days;
allergy or contraindication to aspirin or study drugs; oral anticoag-
ulation treatment in previous 5 days or INR >1.2; fibrinolysis in
previous 24 hours; or treatment with investigational agents in
previous 30 days.
(4) General: renal failure (estimated creatinine clearance <30
mL/min or creatinine >2 mg/dL) or other serious disease, including
liver failure; or inability to commence ST-segment monitoring ≤8
hours after randomization.

Initially, patients were also excluded if they had received UFH or
LMWH ≤24 hours before enrollment. However, after 265 patients
had been enrolled, the independent data and safety monitoring board
and the Therapeutics Protection Directorate of Canada approved an
amended protocol that included patients who had received UFH or
enoxaparin ≤12 hours before enrollment.

### Study Medications

After they had given written informed consent, patients were treated
with eptifibatide (Schering Canada Inc): 180–200 μg/kg bolus followed
by a 2.0–µg kg⁻¹ min⁻¹ infusion for 48 hours. All patients
received oral aspirin in a dose of ≥160 mg initially, followed by 80
to 325 mg daily. On the basis of a computer-generated randomization
code, with stratification according to center, a sequential, sealed
envelope was opened at the enrolling site and patients were random-
ized to receive either enoxaparin (Aventis Canada; 1 mg/kg of body
weight [100 anti-factor Xa units/kg]) subcutaneously every 12 hours
for 48 hours or UFH (70 U/kg intravenous bolus followed by a
15 U · kg⁻¹ · h⁻¹ continuous infusion, titrated to an activated
partial-thromboplastin time [aPTT] of 1.5 to 2 times control for 48
hours).

Use of any other medications, the decision to proceed with
angiography, and the use of revascularization were left to the
discretion of the investigator.

### Study Organization

Patients were recruited between September 1, 2000, and December
21, 2001, at 50 centers in Canada. The ethics review board at each
institution approved the study. The study was conceived, designed,
coordinated, and all the data managed and analyzed, by the Canadian
Heart Research Center. The steering committee oversaw the study
and the data were periodically reviewed by an independent data and
safety monitoring board.

### Outcome Measures

The primary safety outcome was the incidence of 96-hour, non–cor-
onary artery bypass surgery (CABG)–related major bleeding. Major
bleeding included bleeding resulting in death, or retroperitoneal
hemorrhage, or bleeding at a specific site accompanied by a drop in
hemoglobin ≥3 g/dL. Minor bleeding was defined as overt bleeding
that did not meet the criteria for major bleeding.

The primary efficacy outcome was assessed by the rate of recurrent
ischemia detected during continuous ECG monitoring. Seven-lead,
three-channel ST-segment monitoring (Applied Cardiac Systems)
was performed for 96 hours after randomization. Evaluation
within the first 48 hours and in the >48- to 96-hour window
was prespecified and based on the hypothesis that treatment differences
would be evident both during study drug administration and after
study drug discontinuation. Analysis was performed initially by use
of an automated algorithm and subsequently reviewed twice by a
cardiologist blinded to the clinical data and treatment assignment.
Significant ST-segment shift was defined as horizontal or downsloping
ST depression ≥0.1 mV below the baseline or upward ST
elevation ≥0.1 mV above the baseline, lasting ≥1 minute in
duration, and separated from other episodes of ST-segment shift by
≥1 minute.

Secondary clinical outcomes were prespecified and included the
composite of 30-day (1) death or nonfatal myocardial (re)infarction
(MI), or (2) death, MI, or recurrent angina (with ECG changes and/or
urgent revascularization). MI was considered postenrollment if
CK-MB was above the upper limit of normal (ULN), increased by
≥50% over the previous value, and not elevated ≤16 hours before
enrollment; if the troponin T or I was >3 times the upper reference
limit and not elevated ≤12 hours before enrollment; or if ≥24 hours
after coronary revascularization, the CK-MB was >3 times (PCI) or
5 times (CABG) the ULN and increased by ≥50% of the previous
value. Recurrent angina with ECG changes was defined as symptoms
of ischemia with new ECG changes detected on 12-lead ECG despite
the use of nitrates and either β-blockers or calcium-channel blockers.
Recurrence angina requiring urgent revascularization was defined as
symptoms of ischemia, either during the index hospitalization or
resulting in rehospitalization, that prompted coronary revascularization.

### TABLE 1. Baseline Characteristics, Medical History,
Electrocardiographic Changes, and Cardiac Marker Status

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Eptifibatide and Enoxaparin (n=380)</th>
<th>Eptifibatide and UFH (n=366)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>64 (54, 72)</td>
<td>64 (54, 73)</td>
</tr>
<tr>
<td>Female sex</td>
<td>121 (31.8)</td>
<td>112 (30.6)</td>
</tr>
</tbody>
</table>
| Time from onset of symptoms to
randomization, h                       | 4.4 (2.8, 7.7)                      | 4.4 (2.8, 6.7)               |
| Prior MI                             | 110 (29.0)                          | 103 (28.1)                   |
| Prior PCI                            | 36 (9.5)                            | 41 (11.2)                    |
| Prior CABG                           | 39 (10.3)                           | 31 (8.5)                     |
| Prior stroke/transient ischemic attack| 24 (6.3)                            | 29 (7.9)                     |
| Hypertension                         | 186 (49.0)                          | 178 (48.6)                   |
| Hyperlipidemia                       | 171 (45.0)                          | 163 (44.5)                   |
| Diabetes                             | 84 (22.1)                           | 85 (23.2)                    |
| Current smoker                       | 105 (27.6)                          | 111 (30.3)                   |
| Heart rate, bpm                      | 70 (61, 81)                         | 72 (63, 82)                  |
| Systolic blood pressure, mm Hg       | 134 (120, 150)                      | 134 (120, 151)               |
| Diastolic blood pressure, mm Hg      | 77 (66, 87)                         | 77 (66, 87)                  |
| Killip class                         |                                     |                              |
| I                                    | 340 (89.7)                          | 321 (88.0)                   |
| II to IV                             | 39 (10.3)                           | 44 (12.0)                    |
| Transient ST elevation               | 24 (6.4)                            | 24 (6.7)                     |
| ST depression                        | 63 (16.8)                           | 54 (15.0)                    |
| CK-MB and/or troponin elevation      | 311 (81.8)                          | 312 (85.3)                   |

Data are shown as n (%) or *median (25th, 75th percentiles).
Safety and efficacy outcomes were adjudicated independently on two separate occasions by a cardiologist who was blinded to treatment assignment, and included review of all laboratory tests (regardless of whether an end point was identified by the site investigator), ECGs, and reports of bleeding and ischemia.

Statistical Analysis

Safety
This was a noninferior safety comparison between the two treatment groups, designed to show that the 96-hour incidence of major hemorrhage after eptifibatide and enoxaparin did not exceed by \( \frac{2}{100} \) that after eptifibatide and UFH therapy. The estimated sample size of 720 patients was determined with a one-sided 95% confidence interval for the difference between the two treatments, assuming an equal major bleeding rate of 2% and an upper limit of 4% for the confidence interval.

Efficacy
This was a superiority efficacy comparison between the two treatment groups consistent with our previous finding\(^5\) and was designed to show that treatment with enoxaparin would reduce the incidence of ischemia monitored during the initial 48- and >48- to 96-hour periods of continuous electrocardiographic monitoring from 30% to 21% with a power ranging from 69% to 74% (with an estimated nonevaluable/dropout rate ranging from 10% to 20%; 2-sided \( \chi^2 \) test, \( \alpha=0.05 \)).

All safety and efficacy analyses were based on the intention-to-treat principle and used either the log-rank or \( \chi^2 \) statistic. Follow-up to 30 days was complete in all patients.

Results
The baseline characteristics, medical history, ECG changes, and drug therapies of the patients were similarly distributed in the two treatment groups and are shown in Table 1. Treatments and procedures are listed in Table 2.

### Table 2. Treatments and Procedures

<table>
<thead>
<tr>
<th>Treatment/Procedure</th>
<th>Eptifibatide and Enoxaparin (n=380)</th>
<th>Eptifibatide and UFH (n=366)</th>
<th>( P )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time to eptifibatide discontinuation,* h</td>
<td>48 (48, 48)</td>
<td>48 (48, 48)</td>
<td>0.87</td>
</tr>
<tr>
<td>Time to enoxaparin/UFH discontinuation,* h</td>
<td>44 (36, 50)</td>
<td>52 (48, 93)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Concomitant medications</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aspirin</td>
<td>364 (95.8)</td>
<td>350 (95.6)</td>
<td>0.91</td>
</tr>
<tr>
<td>Intravenous ( \beta )-blocker</td>
<td>63 (16.6)</td>
<td>52 (14.2)</td>
<td>0.37</td>
</tr>
<tr>
<td>Oral ( \beta )-blocker</td>
<td>322 (84.7)</td>
<td>290 (79.2)</td>
<td>0.05</td>
</tr>
<tr>
<td>Calcium-channel blocker</td>
<td>37 (9.7)</td>
<td>44 (12.0)</td>
<td>0.32</td>
</tr>
<tr>
<td>Angiotensin-converting enzyme inhibitor</td>
<td>213 (56.1)</td>
<td>206 (56.3)</td>
<td>0.95</td>
</tr>
<tr>
<td>Intravenous nitrate</td>
<td>146 (38.4)</td>
<td>129 (35.3)</td>
<td>0.37</td>
</tr>
<tr>
<td>Oral nitrate</td>
<td>181 (47.6)</td>
<td>215 (58.7)</td>
<td>0.002</td>
</tr>
<tr>
<td>Lipid-lowering agent</td>
<td>191 (50.3)</td>
<td>188 (51.4)</td>
<td>0.76</td>
</tr>
<tr>
<td>Procedures within 30 d</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coronary angiography</td>
<td>236 (62.1)</td>
<td>237 (64.8)</td>
<td>0.45</td>
</tr>
<tr>
<td>Time to angiography,* h</td>
<td>100 (65, 164)</td>
<td>101 (60, 168)</td>
<td>0.70</td>
</tr>
<tr>
<td>PCI</td>
<td>103 (27.1)</td>
<td>111 (30.3)</td>
<td>0.33</td>
</tr>
<tr>
<td>Time to PCI,* h</td>
<td>132 (76, 232)</td>
<td>109 (60, 232)</td>
<td>0.39</td>
</tr>
<tr>
<td>CABG</td>
<td>48 (12.6)</td>
<td>45 (12.3)</td>
<td>0.89</td>
</tr>
<tr>
<td>Time to CABG,* h</td>
<td>326 (188, 462)</td>
<td>304 (157, 456)</td>
<td>0.75</td>
</tr>
</tbody>
</table>

Data are shown as n (%) or *median (25th, 75th percentiles).

### Table 3. Bleeding

<table>
<thead>
<tr>
<th>Variable</th>
<th>Eptifibatide and Enoxaparin (n=380)</th>
<th>Eptifibatide and UFH (n=366)</th>
<th>( P )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major bleeding, n (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non–CABG-related</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>48 h</td>
<td>4 (1.1)</td>
<td>14 (3.8)</td>
<td>0.014</td>
</tr>
<tr>
<td>96 h</td>
<td>7 (1.8)</td>
<td>17 (4.6)</td>
<td>0.03</td>
</tr>
<tr>
<td>30 d</td>
<td>11 (2.9)</td>
<td>21 (5.7)</td>
<td>0.055</td>
</tr>
<tr>
<td>All</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>48 h</td>
<td>4 (1.1)</td>
<td>16 (4.4)</td>
<td>0.0050</td>
</tr>
<tr>
<td>96 h</td>
<td>8 (2.1)</td>
<td>20 (5.5)</td>
<td>0.016</td>
</tr>
<tr>
<td>30 d</td>
<td>20 (5.3)</td>
<td>32 (8.7)</td>
<td>0.062</td>
</tr>
<tr>
<td>Transfusions,* n (%)</td>
<td>16 (4.2)</td>
<td>19 (5.2)</td>
<td>0.53</td>
</tr>
<tr>
<td>CABG-related</td>
<td>4 (1.1)</td>
<td>7 (1.9)</td>
<td>0.33</td>
</tr>
<tr>
<td>Minor bleeding, n (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>48 h</td>
<td>102 (26.8)</td>
<td>67 (18.3)</td>
<td>0.005</td>
</tr>
<tr>
<td>96 h</td>
<td>115 (30.3)</td>
<td>76 (20.8)</td>
<td>0.003</td>
</tr>
<tr>
<td>30 d</td>
<td>121 (31.8)</td>
<td>89 (24.3)</td>
<td>0.22</td>
</tr>
</tbody>
</table>

Safety
The primary safety outcome of 96-hour non–CABG-related major hemorrhage was significantly lower in eptifibatide and enoxaparin as compared with eptifibatide and UFH-treated patients (1.8% versus 4.6%; \( P=0.03 \)) (Table 3). This difference was already evident during the initial 48-hour treatment period (1.1% versus 3.8%; \( P=0.014 \)). All major hemorrhage, including CABG-related bleeding, was lower in the enoxaparin as compared with UFH group at 96 hours (2.1% versus...
5.5%; \( P=0.016 \)) and at 30 days (5.3% versus 8.7%; \( P=0.062 \)). There were no intracranial hemorrhages. Rates of major bleeding among patients undergoing PCI (1 of 20 versus 5 of 57 patients, \( P=1.0 \)) and CABG (1 of 1 versus 6 of 7 patients, \( P=1.0 \)) within 12 hours of receiving enoxaparin or UFH were similar. Transfusion rates were similar in the two treatment groups, including those who underwent CABG (Table 3). There were no major CABG-related bleeds that required surgical reexploration.

Minor bleeding was more frequent in the enoxaparin than in the UFH group at 96 hours (30.3% versus 20.8%; \( P=0.003 \)) (Table 3). The higher rate of 96-hour minor bleeding mainly was due to more local skin injection site ecchymoses (8.9% versus 4.1%; \( P=0.01 \)) and oropharyngeal bleeding (predominantly epistaxis; 15.8% versus 11.2%; \( P=0.07 \)).

Within the first 12 hours, only 16.7% of patients receiving UFH had an aPTT within the therapeutic range (1.5 to 2 times control); 69% were above the therapeutic range (2 times control) and the median aPTT was 97 (25th, 75th percentiles: 61, 48) seconds. By 24 hours, 46.7% of UFH patients were in the therapeutic range; the median aPTT was 67 (54, 90) seconds.

**Continuous ECG Monitoring**

Patients receiving eptifibatide and enoxaparin compared with eptifibatide and UFH had lower rates of ischemia during the first 48 hours (14.3% versus 25.4%; \( P=0.0002 \)) and subsequent 48 hours (12.7% versus 25.9%; \( P<0.0001 \)) (Figure 1). Regardless of treatment, patients experiencing ST-segment shift compared with those without ST shift during continuous monitoring had a significantly higher 30-day rate of death or MI (15% versus 3.6%; \( P<0.0001 \)), or death, MI, or recurrent angina with ECG changes (22.3% versus 6%; \( P<0.0001 \)).

**Clinical Outcomes**

Death, MI, and recurrent angina events are listed in Table 4. The 30-day composite end point of death or MI was significantly lower in the eptifibatide- and enoxaparin-treated group as compared with eptifibatide- and UFH-treated group (5% versus 9%; \( P=0.031 \)) (Figure 2). The composite end point of death, MI, or recurrent angina with adjudicated 12-lead ECG changes tended to be lower in the enoxaparin group (9% versus 12.6%; \( P=0.11 \)) (Figure 3). The composite end point of death, MI, or recurrent angina requiring urgent revascularization was similar in the two treatment groups (12.4% versus 12.6%; \( P=0.93 \)).

**Discussion**

In this high-risk group of non–ST-segment elevation ACS patients receiving aspirin and the glycoprotein IIb/IIIa inhibitor eptifibatide, the addition of the LMWH enoxaparin as compared with UFH resulted in lower rates of major bleeding and recurrent ischemia during and immediately after treatment, and lower 30-day rates of the composite of death or MI.

<table>
<thead>
<tr>
<th>Event</th>
<th>Eptifibatide and Enoxaparin (n=380)</th>
<th>Eptifibatide and UFH (n=366)</th>
<th>( P )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death or (re)MI</td>
<td>19 (5.0)</td>
<td>33 (9.0)</td>
<td>0.031</td>
</tr>
<tr>
<td>MI peri-revascularization</td>
<td>2 (0.5)</td>
<td>7 (1.9)</td>
<td>0.10</td>
</tr>
<tr>
<td>Death, (re)MI, or RA with ECG changes</td>
<td>34 (9.0)</td>
<td>46 (12.6)</td>
<td>0.11</td>
</tr>
<tr>
<td>Death, (re)MI, or RA requiring urgent revascularization</td>
<td>53 (14.0)</td>
<td>59 (16.1)</td>
<td>0.41</td>
</tr>
<tr>
<td>Death</td>
<td>9 (2.4)</td>
<td>15 (4.1)</td>
<td>0.18</td>
</tr>
<tr>
<td>(Re)MI</td>
<td>15 (4.0)</td>
<td>21 (5.8)</td>
<td>0.25</td>
</tr>
<tr>
<td>RA with ECG changes</td>
<td>7 (1.8)</td>
<td>15 (4.1)</td>
<td>0.069</td>
</tr>
<tr>
<td>RA requiring urgent revascularization</td>
<td>28 (7.4)</td>
<td>20 (5.5)</td>
<td>0.29</td>
</tr>
</tbody>
</table>

Data are shown as \( n \) (%). RA denotes recurrent angina.
This is the largest randomized trial of combination glycoprotein IIb/IIIa inhibitor and LMWH therapy as part of initial medical management in a high-risk non–ST-elevation population to date and demonstrates that this combination is superior, not only as it relates to safety, but also in reducing objective ECG and clinical measures of ischemia. Previous studies demonstrating the value of IIb/IIIa inhibition have utilized UFH as the main antithrombotic therapy.4,6 The Antithrombotic Combination Using Tirofiban and Enoxaparin (ACUTE) II study7 was a double-blind, randomized comparison of enoxaparin versus UFH in 525 patients with non–ST-segment ACS who were receiving aspirin and tirofiban. It demonstrated a similar safety profile (major hemorrhage 0.3% versus 1.0%) and 30-day rates of death (2.5% versus 1.9%) and MI (6.7% versus 7.1%). Cohen et al.7 did observe a significant reduction in the incidence of refractory ischemia requiring urgent intervention (0.6% versus 4.3%, P = 0.01) and rehospitalization for unstable angina (1.6% versus 7.1%, P = 0.002) in the enoxaparin group.

The INTERACT study results may differ from the ACUTE II study findings in part because of differences in patient population, sample size, antithrombin treatment duration, and definitions of end points. For example, the high-risk nature of the larger INTERACT trial cohort is highlighted by the finding that 22.5% of patients with core laboratory–evaluated baseline ECGs had significant ST-segment deviation and 83.5% sustained an index MI. Other experiences with combination LMWH and IIb/IIIa inhibition as initial medical management in non–ST-elevation ACS patients are limited to either registry or other nonrandomized comparisons within clinical trials.

Patients in the epifibatide plus UFH group had their intravenous study drug stopped after a median of 52 hours, whereas those in the epifibatide plus enoxaparin group received their last subcutaneous administration at a median of 44 hours. However, it is unlikely that this difference accounts for the observation of a higher 96-hour rate of major bleeding in the UFH group. First, the actual therapeutic duration of enoxaparin, based on a much longer half-life of antithrombotic action, was quite similar to that experienced by the UFH group. Second, the difference in major hemorrhage between the two treatment groups was already evident within the first 48 hours of treatment.

Importantly, the majority of patients receiving UFH were supratherapeutic within the first 24 hours according to the aPTT measurements. Despite strict adherence to the currently recommended dosing and administration of UFH in non–ST-elevation ACS patients,1 and consistent with previous large-scale trials utilizing UFH, the minority of patients are in the therapeutic range during the critically important first day of therapy. Thus, the strategy of combining potent antiplatelet therapies with UFH as compared with enoxaparin may lead to a higher risk of both major bleeding and thrombosis when a substantial number of patients are outside of the narrow therapeutic range.8

Although our study was not powered to definitively address clinical outcomes, the lower rate of death or MI and trend toward a lower incidence of death, MI, or recurrent angina with 12-lead ECG changes is consistent with the blinded continuous ECG monitoring findings in this and previous studies.5,9–12 In addition to being an important predictor of outcome, continuous ST-segment monitoring has identified superior antiplatelet/thrombotic therapies in the management of non–ST-elevation ACS.5,13,14 Furthermore, the recurrence of ischemic events (“rebound”) after UFH withdrawal portends a worse prognosis.15–17 Because combination aspirin, epifibatide, and enoxaparin therapy resulted in significantly lower rates of recurrent ischemia (during initial management and after treatment withdrawal), it is not surprising that the incidence of manifest myocardial necrosis and death was also reduced.

**Study Limitations**

Our study was open label; however, the continuous ECG monitoring results were blinded, and all bleeding and clinical end points were adjudicated independently. The sample size was modest for evaluation of clinical outcomes, but the results are consistent with all previous comparisons of enoxaparin and UFH in the spectrum of ACS syndromes.2,3,18–20 Optimal management of high-risk non–ST-elevation ACS patients includes an early invasive strategy,1,21,22 and the median duration of combination therapy (48 hours) was shorter than the time to angiography (100 hours) and subsequent revascularization. Thus, the minority of patients in INTERACT received uninterrupted randomized treatment until the time of coronary angiography or revascularization. Therefore, the results of the Aggrastat to Zocor (A-to-Z)23 and Superior Yield of the New strategy of Enoxaparin, Revascularization, and GIYcprotein IIb/IIIa inhibitors (SYNERGY)24 trials will better define the efficacy and safety of combination therapy in non–ST-elevation ACS patients managed with an early invasive approach.

In addition to aspirin, all patients in Fast Revascularization during InStability in Coronary artery disease (FRISC) II21 received LMWH therapy for about 96 hours, and all patients in Treat angina with Aggrastat and determine Costs of Therapy with Invasive or Conservative Strategies (TACTICS)25 received UFH and glycoprotein IIb/IIIa inhibition about 22 hours.
before angiography; thus, even an invasive strategy requires initial medical management with potent antplatelet/thrombotic therapy. The role of clopidogrel has also been clearly established in non–ST-elevation ACS patients, enoxaparin improves outcomes (determined on the basis of better safety and efficacy) compared with currently recommended UFH therapy and provides a useful novel alternative therapeutic strategy.

Conclusions
When aspirin and eptifibatide are used in high-risk non–ST-segment elevation ACS patients, enoxaparin improves outcomes (determined on the basis of better safety and efficacy) compared with currently recommended UFH therapy and provides a useful novel alternative therapeutic strategy.

Appendix
The following persons participated in the INTERACT trial.

Steering Committee
Shaun Goodman (Principal Investigator), David Fitchett, Paul Armstrong, Anatoly Langer (Chair).

Data and Safety Monitoring Committee Co-Chairs
Graham Turpie, Peter Liu.

Canadian Heart Research Center
Mary Tan, Mona Oh, Caroline Spindler, Glennis Taylor, Janet Wawrzyniak, Aiala Barr, Damir Boras, David Burry, Diane Camara, Sue Francis, Etienne Grima, Quramul Hassan, Tricia Hugh, Gail Karaim, Amy Lavorato, Pathmini Moharajan, Mary Triantafillou, Nalin Walgama.

Investigators (in Italic) and Coordinators Who Participated (in Order of Enrollment)
Centenary Health Center, Toronto, Ontario: Narendra Singh, Bev Bozek, Pauline Parsons, Kim Brown; Hospital Charles LeMoyn, Greenfield Park, Quebec: Jean Robert Timothee, Denise Racicot; Gray Nun’s Hospital, Edmonton, Alberta: Manohara Senaratne, Kim Heck, Marion Andreas; St Michael’s Hospital, Toronto, Ontario: David Fitchett, Mona Oh; Thunder Bay Regional Hospital–McKellar Site, Thunder Bay, Ontario: Andrew Weeks, Sandra Stoger, Gloria Russak; Medicine Hat Regional Hospital, Medicine Hat, Alberta: Michael Weigel, Paula Chisholm; Hotel-Dieu Hospital, Cornwall, Ontario: J. Paul DeYoung, Mona Burrows; Center Hospitalier de la Region de l’Amiante, Tbedford Mines, Quebec: Claude Launon, Francisque Ouimet; Royal Alexandra Hospital, Edmonton, Alberta: William Hui, Linda Kvill, Ross Nichol; Saskatoon City Hospital, Saskatoon, Saskatchewan: Naval Sharma, Dolores Bayne; Naman Research Institute, Naman, British Columbia: Kevin Lai, Francine Kernachan, Jana Stoger.

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Randomized Evaluation of the Safety and Efficacy of Enoxaparin Versus Unfractionated Heparin in High-Risk Patients With Non-ST-Segment Elevation Acute Coronary Syndromes Receiving the Glycoprotein IIb/IIIa Inhibitor Eptifibatide
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for the Integrilin and Enoxaparin Randomized Assessment of Acute Coronary Syndrome Treatment (INTERACT) Trial Investigators

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