Comparative Outcomes for Patients Who Do and Do Not Undergo Percutaneous Coronary Intervention for Stable Coronary Artery Disease in New York

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Background—Little is known about what treatments patients receive after being diagnosed with stable coronary artery disease or what the comparative outcomes are for routine medical treatment (RMT) versus percutaneous coronary intervention (PCI) with RMT for patients in a setting apart from randomized controlled trials.

Methods and Results—Patients with stable coronary artery disease undergoing cardiac catheterization in New York State between 2003 and 2008 were followed up to determine the treatment they received. Patients receiving RMT and patients receiving PCI with RMT were propensity matched through the use of 20 factors that could have a bearing on outcomes. The resulting cohort of 933 matched pairs was used to compare mortality/myocardial infarction (MI), mortality, MI, and subsequent revascularization rates. A total of 89% of all patients underwent PCI with RMT. PCI/RMT patients had significantly lower adverse outcome rates at 4 years for mortality/MI (16.5% versus 21.2%; P=0.003), mortality (10.2% versus 14.5%; P=0.02), MI (8.0% versus 11.3%; P=0.007), and subsequent revascularization (24.1% versus 29.1%; P=0.005). Adjusted RMT versus (PCI with RMT) hazard ratios were 1.49 (95% confidence interval, 1.16–1.93) for mortality/MI and 1.46 (95% confidence interval, 1.08–1.97) for mortality. There were no differences for patients ≥65 years of age or for patients with single-vessel disease.

Conclusions—Most patients with stable coronary artery disease in New York undergoing catheterization between 2003 and 2008 received PCI. Patients who received PCI experienced lower mortality, mortality/MI, and revascularization rates. The reasons for this finding need to be better understood, including the possible role of low medication adherence rates that have been found in other studies. (Circulation. 2012;125:1870-1879.)

Key Words: comparative effectiveness research ▪ coronary artery disease ▪ medicine ▪ coronary angioplasty

The Clinical Outcomes Utilizing Revascularization and Aggressive Drug Evaluation (COURAGE) Trial, in which patients with stable coronary artery disease (CAD) were randomly treated with either optimal medical treatment (OMT) or percutaneous coronary intervention (PCI) with OMT, reported that PCI with OMT as an initial management strategy did not reduce rates of mortality, myocardial infarction (MI), or other major cardiovascular events compared with an initial strategy of OMT alone.1 There were small benefits of PCI compared with medical therapy in angina control that disappeared by 36 months.2 The OMT was supported by training nurse-managers to counsel patients to help them achieve lifestyle and risk factor reduction goals, providing medications at no cost to patients, and following up with patients at 1, 2, 4, and 6 months and every 6 months thereafter. The resulting adherence to lifestyle and medication prescription was quite high (eg, 96% adherence to antiplatelets, 85% to β-blockers, 93% to statin use).3–6

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However, little is known about how often patients with stable CAD undergo PCI in routine medical practice or how their outcomes compare with those of patients who do not undergo PCI. The purpose of this study is to compare outcomes for PCI with routine medical treatment (RMT) versus RMT in a setting with usual care, not as part of a clinical trial that focused on ensuring/improving adherence to medications or lifestyle changes.
Methods

End Points
End points in the study were 4-year mortality, MI, readmission for MI, and subsequent revascularization.

Databases
The primary database used in the study was New York State’s Cardiac Diagnostic Catheterization Database (CD2), a voluntary data system in New York maintained by the New York State Department of Health. For patients undergoing cardiac catheterization in New York, the database contains information on demographics, comorbidities, payer, angina type and class, stress test results, previous MI, previous revascularization procedures, ejection fraction, ongoing ischemia, vessels diseased, ejection fraction, congestive heart failure, diabetes mellitus, shock, hemodynamic instability, and area of viable myocardium at risk. Important variables that are also included are whether the patient’s anatomy was suitable for PCI or for CABG surgery and whether the patient had a noncardiac comorbidity contraindicating PCI.

Completeness of data reporting is monitored by matching CD2 to the New York acute care hospital discharge database, the Statewide Planning and Research Cooperative System (SPARCS); the Department of Health’s Ambulatory Surgery Database; and the New York PCI registry (Percutaneous Coronary Interventions Reporting System); and identifying cases reported with a diagnostic catheterization in those databases that were not reported to CD2. Hospitals are required to provide data for those missing cases. In addition, missing or invalid data elements are returned to hospitals for review and correction on an ongoing basis.

Matching CD2 with the PCI registry and SPARCS enabled us to identify those catheterization patients who underwent PCI within 30 days of the catheterization without having experienced an MI in the interim. The match between CD2 data and SPARCS was also done for 2 purposes other than ensuring completeness. First, for patients who did not undergo PCI within 30 days of catheterization, SPARCS was used to confirm that the patient identification was correct for linking with other databases. Second, SPARCS data were used to identify readmissions for MI, using acute MI (International Classification of Disease, ninth edition, clinical modification code 410.x1 as a principal diagnosis, with the fifth digit of 1 to ensure that it was the first episode of care for a newly diagnosed MI). The fourth database used in the study was the Social Security Administration Death Master File. Patient identifiers in CD2 were used to index the catheterization to the Death Master File data to identify deaths after discharge for the purpose of identifying longer-term mortality.

Patients, Hospitals, and Outcomes
Patients in the study were New York State residents who underwent cardiac catheterization and were judged to have stable CAD. Entry criteria included being asymptomatic or having stable angina with Canadian Cardiovascular Society class I through III and at least 70% stenosis in a proximal epicardial coronary artery or its major branch. Exclusion criteria included left main coronary disease with ≥50% stenosis, life-threatening ventricular arrhythmia within a week before the procedure, concomitant valvular heart disease likely to require surgery, class IV angina, a negative or a high-risk stress test, cardiogenic shock, a recent (<21 days) acute MI, severe left ventricular dysfunction (ejection fraction <30% or ejection fraction <35% and proximal left anterior descending artery disease), revascularization within the previous 6 months, CABG surgery as the choice for revascularization, coronary anatomy not suitable for PCI (including chronic total occlusion), and a noncardiac comorbidity contraindicating PCI. The study was limited to New York State residents because the subsequent revascularization information was obtained from the PCI registry and the MI outcome was obtained from the SPARCS data.

Remaining patients were included in the study as PCI/RMT patients if they underwent PCI within a month of the index catheterization without having experienced an MI in the interim. Patients were included as RMT patients in the study if they were alive 30 days after the index catheterization without having undergone PCI or CABG surgery or suffered an MI and if they could be identified in SPARCS to ensure that they could be tracked in SPARCS and the Social Security Administration Death Master File (30 patients could not be tracked). A subsequent sensitivity analysis was conducted by defining PCI patients as the group of patients undergoing PCI in the index admission and RMT patients as the group who did not undergo PCI in the index admission. A total of 20 hospitals were represented in the database, and 18 of these hospitals were represented after propensity matching (see below). All were hospitals with Certificate of Need approval to perform cardiac catheterization, and 8 were certified to perform PCI. Outcomes of the study include 4-year mortality, mortality/MI (mortality and/or MI), MI, and subsequent revascularization.

Statistical Analyses
Because patients were not randomized to PCI/RMT versus RMT, we identified patient characteristics that were potentially related to the type of treatment selected as well as being potential predictors of adverse outcomes. We first compared the prevalences of these risk factors among PCI and RMT patients using χ² tests.

Because many of the prevalences proved to be significantly different, propensity score matching was used to identify a set of matched PCI/RMT and RMT pairs so that confounding could be reduced. Patients were matched on the basis of time interval of catheterization, age, Canadian Cardiovascular Society angina class, ejection fraction, area of viable myocardium at risk, renal failure (on dialysis or creatinine >2.5 mg/dL), extent of cardiovascular disease, primary payer, demographics, body mass index, median per capita income of the patient’s ZIP code, congestive heart failure, left ventricular function, previous MI, previous PCI >6 months previously (more recent PCIs were excluded from the study), CABG surgery >6 months previously, and a few comorbidities (cerebrovascular disease, peripheral vascular disease, diabetes mellitus). The propensity score was derived by using a logistic regression model to predict the probability of undergoing PCI with RMT rather than RMT alone for each patient as a function of the risk factors just noted.

A global optimization matching algorithm (one that picks pairs of RMT and PCI/RMT patients so that the sum of distances between the propensity scores of the paired patients is minimized) was used, with matching allowed only if the difference in the logits of the matched propensity scores was <0.6 times the SDs of the scores.¹⁻¹⁰ Matching was on a 1:1 basis; each matched pair was unique, and data for unmatched patients were not used in subsequent analyses. The balance between patient characteristics in the paired groups was tested by computing the standardized differences between the 2 groups (RMT and PCI/RMT) for each of the matched characteristics. A difference <0.1 (10%) was regarded as acceptable.¹¹

The propensity-matched pairs were then used to analyze differences in outcomes between the 2 groups. Methods were used to compare RMT and PCI/RMT for a 4-year follow-up period for each of the outcomes by use of Kaplan Meier survival curves with Klein and Moeschberger tests in view of the fact that the samples were matched.¹² After the proportional hazards assumption was confirmed to be valid, Cox proportional hazards models were fit to the matched pairs to adjust for any remaining differences in patient characteristics, and adjusted RMT/PCI with RMT hazard ratios were obtained for each of the adverse outcomes.

The impact of treatment type on mortality/MI for a few preselected risk factor subgroups of interest (age, extent of CAD, angina class, and area of viable myocardium at risk) was also tested to determine whether the differential in outcomes for PCI and RMT differed according to these preselected risk factors and if there was
<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>All Patients (n=9586)</th>
<th>RMT (n=1100, 11%)</th>
<th>PCI (n=8486, 89%)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year of the index catheterization, %</td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.001</td>
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<tr>
<td>2003–2004</td>
<td>20.54</td>
<td>25.82</td>
<td>19.86</td>
<td></td>
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<tr>
<td>2005–2006</td>
<td>37.13</td>
<td>31.91</td>
<td>37.80</td>
<td></td>
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<tr>
<td>2007–2008</td>
<td>42.33</td>
<td>42.27</td>
<td>42.34</td>
<td></td>
</tr>
<tr>
<td>Age, mean (SD), y</td>
<td>65.1 (11.0)</td>
<td>67.9 (10.9)</td>
<td>64.9 (10.9)</td>
<td>&lt;0.001</td>
</tr>
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<td>Age categories, %</td>
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<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>≤65 y</td>
<td>46.58</td>
<td>40.73</td>
<td>47.34</td>
<td></td>
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<td>65–74 y</td>
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<td>31.70</td>
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</tr>
<tr>
<td>75–84 y</td>
<td>19.09</td>
<td>23.64</td>
<td>18.50</td>
<td></td>
</tr>
<tr>
<td>≥85 y</td>
<td>2.71</td>
<td>4.64</td>
<td>2.46</td>
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</tr>
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<td>Female, %</td>
<td>34.08</td>
<td>35.09</td>
<td>33.95</td>
<td>0.45</td>
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<tr>
<td>Race, %</td>
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<tr>
<td>White</td>
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<td>67.45</td>
<td>71.02</td>
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</tr>
<tr>
<td>Black</td>
<td>15.70</td>
<td>18.00</td>
<td>15.40</td>
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<tr>
<td>Other</td>
<td>13.69</td>
<td>14.55</td>
<td>13.58</td>
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</tr>
<tr>
<td>BMI, mean (SD), kg/m²</td>
<td>30.05 (6.10)</td>
<td>29.81 (6.27)</td>
<td>30.08 (6.08)</td>
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<td></td>
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<td>≥18 kg/m²</td>
<td>0.58</td>
<td>1.18</td>
<td>0.51</td>
<td></td>
</tr>
<tr>
<td>19–40 kg/m²</td>
<td>92.68</td>
<td>92.73</td>
<td>92.67</td>
<td></td>
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<tr>
<td>&gt;40 kg/m²</td>
<td>6.74</td>
<td>6.09</td>
<td>6.62</td>
<td></td>
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<tr>
<td>Socioeconomic status, %</td>
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<td></td>
<td></td>
<td>0.55</td>
</tr>
<tr>
<td>Low income (lower third ZIP code median income)</td>
<td>31.97</td>
<td>31.18</td>
<td>32.08</td>
<td></td>
</tr>
<tr>
<td>Medium or high income</td>
<td>68.03</td>
<td>68.82</td>
<td>67.92</td>
<td></td>
</tr>
<tr>
<td>Primary payer, %</td>
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<td></td>
<td></td>
<td>&lt;0.001</td>
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<td>Private</td>
<td>43.41</td>
<td>36.45</td>
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<tr>
<td>Medicare</td>
<td>44.47</td>
<td>47.36</td>
<td>44.10</td>
<td></td>
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<tr>
<td>Other</td>
<td>12.12</td>
<td>16.18</td>
<td>11.60</td>
<td></td>
</tr>
<tr>
<td>Stress test results, %</td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Stress test result unknown</td>
<td>34.77</td>
<td>39.36</td>
<td>34.19</td>
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<tr>
<td>Positive stress test</td>
<td>65.22</td>
<td>60.64</td>
<td>65.81</td>
<td></td>
</tr>
<tr>
<td>Area of viable myocardium, %</td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Small</td>
<td>11.08</td>
<td>31.00</td>
<td>8.50</td>
<td></td>
</tr>
<tr>
<td>Medium or Large</td>
<td>88.92</td>
<td>69.00</td>
<td>91.50</td>
<td></td>
</tr>
<tr>
<td>Extent of coronary artery disease, %</td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.001</td>
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<tr>
<td>1 Vessel without proximal LAD</td>
<td>59.27</td>
<td>62.55</td>
<td>58.85</td>
<td></td>
</tr>
<tr>
<td>1 Vessel with proximal LAD</td>
<td>10.74</td>
<td>6.64</td>
<td>11.28</td>
<td></td>
</tr>
<tr>
<td>2 Vessels without proximal LAD</td>
<td>25.53</td>
<td>25.55</td>
<td>25.52</td>
<td></td>
</tr>
<tr>
<td>2 Vessels with proximal LAD/3 vessels</td>
<td>4.46</td>
<td>5.27</td>
<td>4.35</td>
<td></td>
</tr>
<tr>
<td>Congestive heart failure, %</td>
<td>5.45</td>
<td>9.55</td>
<td>4.91</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Left ventricular ejection fraction, %</td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Missing</td>
<td>5.65</td>
<td>8.18</td>
<td>5.33</td>
<td></td>
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<tr>
<td>30%–39%</td>
<td>4.06</td>
<td>8.18</td>
<td>3.52</td>
<td></td>
</tr>
<tr>
<td>40%–49%</td>
<td>9.97</td>
<td>13.27</td>
<td>9.55</td>
<td></td>
</tr>
<tr>
<td>≥50%</td>
<td>80.32</td>
<td>70.36</td>
<td>81.60</td>
<td></td>
</tr>
</tbody>
</table>

(Continued)
a significant interaction between treatment type and the risk factor. For each risk factor, a Cox proportional hazards model was fit, including treatment type (PCI versus RMT), the risk factor itself, their interaction term, and other significant ($P<0.05$) risk factors for mortality identified with a backward selection.

Analyses were performed according to the intention to treat, with medical patients undergoing PCI >30 days after the index catheterization regarded as medical patients. All tests were 2-sided and conducted at the 0.05 level, and all analyses were conducted in SAS 9.1 (SAS Institute, Inc, Cary, NC).

### Results

#### Characteristics of Patients and Providers Before Propensity Score Matching

The median follow-up time was 2.87 years (2.94 years for PCI/RMT patients, 2.81 years for RMT patients). Of the 9586 total patients, 8486 (88.5%) underwent PCI and 196 (2.0%) underwent CAGB surgery. The PCI percentage did not change substantially before and after the COURAGE trial findings (88.4% before 2008, 88.7% after 2008). As indicated in Table 1, PCI/RMT patients were younger, were more likely to be white, and were more likely to have private health insurance, a positive stress test, a medium or large area of viable myocardium at risk, proximal left anterior descending artery disease and 3-vessel disease, class III angina, and a higher ejection fraction. PCI/RMT patients were less likely to have peripheral vascular disease or previous cardiac surgery. For patients undergoing PCI, 91% of the patients had 1 vessel attempted and 9% had 2 vessels attempted. In addition, 72% had 1 lesion attempted and 23% had 2 lesions attempted. A total of 71% had 1 stent placed and 20% had 2 stents placed. Most patients had drug-eluting stents (71%) or bare metal stents (24%); only 5% of patients did not receive a stent.

#### After Propensity Score Matching

The process of propensity score matching resulted in being able to match 933 (84.8%) of the medical therapy patients to a very similar PCI/RMT patient. There were no significant differences between the 2 groups in any of the characteristics examined. As Table 2 demonstrates, the characteristics of the matched pairs were extremely similar, with only one of the standardized differences exceeding 10%. After matching, a total of 18 of the 20 hospitals in the database were included. Matched patients underwent PCIs in a total of 27 hospitals by 120 cardiologists.

### Adverse Outcome Rates

Table 3 and the Figure present adverse outcome rates for mortality/MI, mortality, and MI for RMT and PCI/RMT for propensity-matched patients. At 4 years, PCI/RMT patients had lower mortality/MI rate (16.5% versus 21.2%; $P=0.003$), lower mortality rate (10.2% versus 14.5%; $P=0.02$), a lower MI rate (8.0% versus 11.3%; $P=0.007$), and lower subsequent revascularization rate (24.1% versus 29.1%; $P=0.005$). The previous data include planned staged PCI procedures in the PCI/RMT group. On the basis of staging data available only in the last 2 years of the study that were extrapolated to all years, the subsequent revascularization rate for unstaged PCI/RMT patients is estimated to be 19.7%.

Adjusted hazard ratios representing the relative outcomes across the entire follow-up period were also significant in favor of PCI with RMT versus RMT alone, with ratios ranging from 1.39 to 1.56. For the subset of 789 matched pairs in whom PCI patients were defined as patients undergoing PCI in the index admission and RMT patients were patients who did not undergo PCI in the index admission or within 30 days, the RMT versus PCI with RMT outcomes were as follows: 20.5% versus 15.4% ($P=0.01$; adjusted hazard ratio=1.47; 95% confidence interval, 1.10–1.95) for mortality/MI; 13.5% versus 10.1% ($P=0.01$; adjusted hazard ratio=1.37; 95% confidence interval, 1.01–1.85) for mortality; 10.9% versus 7.1% ($P=0.01$; adjusted hazard ratio=1.73; 95% confidence interval, 1.15–

### Table 1.

#### Table 1. Continued

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>All Patients (n=9586)</th>
<th>RMT (n=1100, 11%)</th>
<th>PCI (n=8486, 89%)</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCS angina class, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>13.03</td>
<td>23.91</td>
<td>11.62</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>I</td>
<td>16.25</td>
<td>20.09</td>
<td>15.76</td>
<td></td>
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<tr>
<td>II</td>
<td>33.77</td>
<td>33.45</td>
<td>33.81</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>36.95</td>
<td>22.55</td>
<td>38.82</td>
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<tr>
<td>Previous MI (≥21 d), %</td>
<td>13.38</td>
<td>14.91</td>
<td>13.19</td>
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<td>Cerebrovascular disease, %</td>
<td>6.12</td>
<td>7.36</td>
<td>5.96</td>
<td>0.07</td>
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<tr>
<td>Peripheral vascular disease, %</td>
<td>7.45</td>
<td>11.36</td>
<td>6.94</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Diabetes mellitus, %</td>
<td>32.71</td>
<td>34.73</td>
<td>32.45</td>
<td>0.13</td>
</tr>
<tr>
<td>Renal failure, %</td>
<td>1.38</td>
<td>2.27</td>
<td>1.26</td>
<td>0.01</td>
</tr>
<tr>
<td>Previous PCI, %</td>
<td>25.05</td>
<td>23.18</td>
<td>25.29</td>
<td>0.13</td>
</tr>
<tr>
<td>Previous open heart surgery, %</td>
<td>13.00</td>
<td>18.18</td>
<td>12.33</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

RMT indicates routine medical treatment; PCI, percutaneous coronary intervention; BMI, body mass index; LAD, left anterior descending artery; CCS, Canadian Cardiovascular Society; and MI, myocardial infarction.

*For categorical variables, the numbers presented in each subcategory are percentages of the entire category.
Table 2. Baseline Characteristics of Stable Coronary Artery Disease Patients Undergoing Diagnostic Coronary Catheterization After Propensity Matching, New York, September 2003 to December 2008*

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>All Patients (n=1866)</th>
<th>Routine RMT (n=933)</th>
<th>PCI (n=933)</th>
<th>P</th>
<th>Standardized Difference, %</th>
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</thead>
<tbody>
<tr>
<td>Year of the index catheterization, %</td>
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<td></td>
<td></td>
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<tr>
<td>2003–2004</td>
<td>24.76</td>
<td>24.76</td>
<td>24.76</td>
<td>1.00</td>
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<td>2005–2006</td>
<td>33.55</td>
<td>33.55</td>
<td>33.55</td>
<td>1.00</td>
<td>0.00</td>
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<tr>
<td>2007–2008</td>
<td>41.69</td>
<td>41.69</td>
<td>41.69</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Age, mean (SD), y</td>
<td>66.4 (11.2)</td>
<td>66.6 (11.1)</td>
<td>66.3 (11.2)</td>
<td>0.52</td>
<td>8.98</td>
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<tr>
<td>Age categories, %</td>
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<td></td>
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<tr>
<td>&lt;=65 y</td>
<td>42.98</td>
<td>42.98</td>
<td>42.98</td>
<td>1.00</td>
<td>0.00</td>
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<tr>
<td>65–74 y</td>
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<td>30.33</td>
<td>30.33</td>
<td>1.00</td>
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</tr>
<tr>
<td>75–84 y</td>
<td>22.51</td>
<td>22.72</td>
<td>22.29</td>
<td>0.82</td>
<td>1.03</td>
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<td>&gt;=85 y</td>
<td>4.18</td>
<td>3.97</td>
<td>4.39</td>
<td>0.64</td>
<td>2.14</td>
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<td>Female, %</td>
<td>34.41</td>
<td>34.41</td>
<td>34.41</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Race, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>68.49</td>
<td>67.20</td>
<td>69.77</td>
<td>0.23</td>
<td>5.54</td>
</tr>
<tr>
<td>Black</td>
<td>18.06</td>
<td>17.90</td>
<td>18.22</td>
<td>0.86</td>
<td>0.84</td>
</tr>
<tr>
<td>Other</td>
<td>13.45</td>
<td>14.90</td>
<td>12.00</td>
<td>0.07</td>
<td>8.49</td>
</tr>
<tr>
<td>BMI, mean (SD), kg/m²</td>
<td>29.83 (6.14)</td>
<td>29.92 (6.23)</td>
<td>29.72 (6.06)</td>
<td>0.43</td>
<td>8.06</td>
</tr>
<tr>
<td>BMI categories, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤18 kg/m²</td>
<td>0.91</td>
<td>1.07</td>
<td>0.75</td>
<td>0.46</td>
<td>3.38</td>
</tr>
<tr>
<td>19–40 kg/m²</td>
<td>92.93</td>
<td>92.82</td>
<td>93.03</td>
<td>0.86</td>
<td>0.83</td>
</tr>
<tr>
<td>&gt;40 kg/m²</td>
<td>6.16</td>
<td>6.11</td>
<td>6.22</td>
<td>0.92</td>
<td>0.45</td>
</tr>
<tr>
<td>Socioeconomic status, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low income (lower third)</td>
<td>32.26</td>
<td>31.08</td>
<td>33.44</td>
<td>0.28</td>
<td>5.05</td>
</tr>
<tr>
<td>Medium or high income</td>
<td>67.74</td>
<td>68.92</td>
<td>66.56</td>
<td>0.28</td>
<td>5.05</td>
</tr>
<tr>
<td>Primary payer, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private</td>
<td>37.62</td>
<td>37.62</td>
<td>37.62</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Medicare</td>
<td>47.27</td>
<td>47.27</td>
<td>47.27</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Other</td>
<td>15.11</td>
<td>15.11</td>
<td>15.11</td>
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<td>Stress test results, %</td>
<td></td>
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</tr>
<tr>
<td>Stress test result unknown</td>
<td>37.35</td>
<td>38.16</td>
<td>36.55</td>
<td>0.47</td>
<td>3.32</td>
</tr>
<tr>
<td>Positive stress test</td>
<td>62.65</td>
<td>61.84</td>
<td>63.45</td>
<td>0.47</td>
<td>3.32</td>
</tr>
<tr>
<td>Area of viable myocardium, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>23.47</td>
<td>23.47</td>
<td>23.47</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Medium or large</td>
<td>66.53</td>
<td>66.53</td>
<td>66.53</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Extent of coronary artery disease, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Vessel without proximal LAD</td>
<td>62.33</td>
<td>61.09</td>
<td>63.56</td>
<td>0.27</td>
<td>5.09</td>
</tr>
<tr>
<td>1 Vessel with proximal LAD</td>
<td>7.18</td>
<td>6.86</td>
<td>7.50</td>
<td>0.59</td>
<td>2.49</td>
</tr>
<tr>
<td>2 Vessels without proximal LAD</td>
<td>26.42</td>
<td>27.97</td>
<td>24.87</td>
<td>0.13</td>
<td>7.05</td>
</tr>
<tr>
<td>2 Vessels with proximal LAD/3 vessels</td>
<td>4.07</td>
<td>4.07</td>
<td>4.07</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Congestive heart failure, %</td>
<td>7.61</td>
<td>8.36</td>
<td>6.86</td>
<td>0.22</td>
<td>5.66</td>
</tr>
<tr>
<td>Left ventricular ejection fraction, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Missing</td>
<td>6.22</td>
<td>6.22</td>
<td>6.22</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>30%–39%</td>
<td>6.11</td>
<td>6.11</td>
<td>6.11</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>40%–49%</td>
<td>11.58</td>
<td>12.43</td>
<td>10.72</td>
<td>0.25</td>
<td>5.36</td>
</tr>
<tr>
<td>≥50%</td>
<td>76.10</td>
<td>75.24</td>
<td>76.97</td>
<td>0.39</td>
<td>4.02</td>
</tr>
</tbody>
</table>

(Continued)
Table 2. Continued

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>All Patients (n=1866)</th>
<th>Routine RMT (n=933)</th>
<th>PCI (n=933)</th>
<th>P</th>
<th>Standardized Difference, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCS angina class, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>19.56</td>
<td>21.65</td>
<td>17.47</td>
<td>0.02</td>
<td>10.55</td>
</tr>
<tr>
<td>I</td>
<td>21.91</td>
<td>19.93</td>
<td>23.90</td>
<td>0.04</td>
<td>9.59</td>
</tr>
<tr>
<td>II</td>
<td>34.83</td>
<td>34.73</td>
<td>34.94</td>
<td>0.93</td>
<td>0.45</td>
</tr>
<tr>
<td>III</td>
<td>23.69</td>
<td>23.69</td>
<td>23.69</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Previous MI (≥21 d) , %</td>
<td>13.08</td>
<td>12.75</td>
<td>13.40</td>
<td>0.68</td>
<td>1.91</td>
</tr>
<tr>
<td>Cerebrovascular disease</td>
<td>6.97</td>
<td>6.97</td>
<td>6.97</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Peripheral vascular disease, %</td>
<td>9.43</td>
<td>9.75</td>
<td>9.11</td>
<td>0.63</td>
<td>2.20</td>
</tr>
<tr>
<td>Diabetes mellitus, %</td>
<td>35.74</td>
<td>35.05</td>
<td>36.44</td>
<td>0.53</td>
<td>2.91</td>
</tr>
<tr>
<td>Renal failure, %</td>
<td>0.96</td>
<td>0.96</td>
<td>0.96</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Previous PCI, %</td>
<td>22.29</td>
<td>22.29</td>
<td>22.29</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Previous open heart surgery, %</td>
<td>16.88</td>
<td>16.08</td>
<td>17.68</td>
<td>0.35</td>
<td>4.29</td>
</tr>
</tbody>
</table>

RMT indicates routine medical treatment; PCI, percutaneous coronary intervention; BMI, body mass index; LAD, left anterior descending artery; CCS, Canadian Cardiovascular Society; and MI, myocardial infarction.

Discussion

Although the COURAGE trial compared outcomes for patients with stable CAD undergoing PCI and medical therapy, it is not well known how often these patients undergo PCI in routine medical practice or what the outcomes are with and without PCI. Our study found that in a population-based study in New York of patients with stable CAD undergoing cardiac catheterization, nearly 90% of these patients underwent PCI. This percentage did not change even in 2008, well after the COURAGE results had been published. In addition, the propensity-matched patients who underwent PCI experienced significantly lower mortality, mortality/MI, and revascularization rates than the patients who did not undergo PCI.

Our outcomes rates for mortality/MI at 4 years were 16.5% for PCI/RMT and 21.2% for RMT compared with 19.0% and 18.5% for the COURAGE trial at 4.6 years. Our mortality rates at 4 years were 10.2% for PCI/RMT and 14.5% for RMT compared with 7.6% for PCI/OMT and 8.3% for OMT in COURAGE at 4.6 years. Although our RMT and PCI/RMT rates both were higher than the COURAGE rates, we hypothesize that our PCI/RMT rates were more similar to the COURAGE rates because drug-eluting stents were used in 74% of the patients in our study compared with all bare metal stents in COURAGE, and drug-eluting stents have been shown to be associated with lower mortality rates than bare metal stents in observational studies, although not in randomized controlled trials.13 Two possible reasons why the RMT outcome rates in our study were higher than in COURAGE...
are that our RMT population was significantly less selected (and therefore at a higher risk) and that patients had RMT instead of OMT.

A few factors may contribute to our findings. First, the observational nature of this study means that it is subject to selection bias, whereby the results are driven by differences among the patient populations rather than relative effectiveness of the treatments. Indeed, RMT patients appeared to be at higher risk than their PCI/RMT counterparts in the full study sample. We propensity matched patients based on numerous risk factors related to demographics, socioeconomics, payer, extent of CAD, stress test results, area of viable myocardium at risk, ventricular function, angina class, and comorbidities in an attempt to minimize this bias. In addition, all patients in the study were candidates for PCI. As a result, the subset of propensity-matched patients used in the study looked extremely similar with respect to those risk factors. Furthermore, the design of the study was such that any patients who died or experienced an MI within 30 days of the index catheterization without undergoing PCI were removed from the study rather than being placed in the RMT group in case they might have been assigned to PCI within 30 days. This was done despite the fact that 95% of the patients undergoing PCI received it within 1 week and 98% received it within 2 weeks. Nevertheless, unmeasured factors such as lesion characteristics, bleeding risk, and some noncardiac comorbidities (eg, cancer) and the possible differential use of appropriate medications could have biased the outcomes of the study in favor of PCI/RMT. The risk of unmeasured confounders is also enhanced by virtue of the large proportion of patients in the study who underwent PCI. We had no information on why the decision was made to refer each patient for PCI, and once the coronary anatomy is known, there is a bias toward revascularization.

However, it is also true that patients in the COURAGE trial constituted a highly select population willing to be randomized after angiography. Certainly, many high-risk patients were excluded, which contributed to the lower mortality rate in COURAGE. Thus, the fact that our study represents a real-world experience at least partially offsets the limitation of the lack of natural randomization.

Another limitation is that, because we used SPARCS to track readmissions for MI and New York State registries to
track subsequent CABG and target vessel PCI, we restricted the study to New York State patients. However, if patients moved outside the state after discharge and were admitted for MI or underwent revascularization out of state, these events would have been missed by our study. Moreover, the study would miss New York State patients who underwent a repeat revascularization out of state. We do not believe there is a good reason why there would be a bias in favor of PCI/RMT with respect to missed patients, and an earlier study demonstrated that there was not a bias in this regard.14

The extent to which lesser use of OMT in our study compared with COURAGE explains some of the differences in the study results deserves further investigation. The nature of the medical therapy provided to the RMT patients in our study is completely unknown, and undoubtedly many RMT patients received nonoptimal treatment. Several studies have shown that medication adherence is generally poor,15–21 and several other studies have shown that adherence strongly affects outcomes.17,19,22–26 In addition, studies from the COURAGE group demonstrate that adherence to both suggested lifestyle changes and medications was excellent in their trial.2,3 The combination of these facts suggests that although OMT is as effective as PCI/OMT for patients with stable CAD in a tightly controlled trial with excellent adherence, different results might occur in real-world situations. As noted by Ho et al,20 there are multifactorial reasons for poor adherence, including challenges presented by the health system (eg, patient-provider relationship, access problems), patient condition (eg, depression, cognitive impairment, psychological problems), therapy (eg, side effects, complex regimen), and socioeconomic problems (eg, low literacy, no or inadequate insurance).

Thus, the key findings of the study are that, with standard medical care, the vast majority of catheterization patients in New York between 2003 and 2008 were treated with PCI rather than by medical therapy alone and that patients with stable CAD treated with PCI had improved outcomes compared with patients who did not undergo PCI. The reasons for these findings need to be better understood, including the role of the inability to achieve OMT in routine medical practice. A randomized controlled trial in which patients are randomized
Table 4. Mortality/Myocardial Infarction Rates for Medical Treatment and Percutaneous Coronary Intervention for Subgroups of Propensity-Matched Groups

<table>
<thead>
<tr>
<th>Baseline Characteristics</th>
<th>Matched Pairs, n</th>
<th>4-Year Event Rate,%</th>
<th>RMT/PCI Adjusted Hazard Ratio (95% CI)</th>
<th>P for Interaction*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age, y</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;65</td>
<td>401</td>
<td>10.95</td>
<td>14.55</td>
<td>1.00</td>
</tr>
<tr>
<td>≥65</td>
<td>532</td>
<td>29.24</td>
<td>23.9</td>
<td>1.78</td>
</tr>
<tr>
<td><strong>Extent of CAD</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single-vessel disease</td>
<td>496</td>
<td>19.09</td>
<td>15.43</td>
<td>1.36</td>
</tr>
<tr>
<td>Multivessel disease</td>
<td>132</td>
<td>27.14</td>
<td>18.81</td>
<td>2.25</td>
</tr>
<tr>
<td><strong>Angina class</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0, I, II, III</td>
<td>712</td>
<td>20.28</td>
<td>16.62</td>
<td>1.48</td>
</tr>
<tr>
<td></td>
<td>221</td>
<td>23.72</td>
<td>15.85</td>
<td>1.54</td>
</tr>
<tr>
<td><strong>Area of viable myocardium at risk</strong></td>
<td></td>
<td></td>
<td></td>
<td>0.49</td>
</tr>
<tr>
<td>Small</td>
<td>219</td>
<td>15.47</td>
<td>13.31</td>
<td>1.17</td>
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<tr>
<td>Medium or large</td>
<td>714</td>
<td>23.07</td>
<td>17.51</td>
<td>1.57</td>
</tr>
</tbody>
</table>

RMT indicates routine medical treatment; PCI, percutaneous coronary intervention; CI, confidence interval; and CAD, coronary artery disease.

*P for interaction values are derived from models with complete follow-up. P values are derived from the Klein and Moeschberger test.12

to PCI and MT without efforts to guarantee OMT would serve as a definitive test of how patients in routine medical practice fare with each of the interventions.

Acknowledgments

We would like to thank New York State’s Cardiac Advisory Committee for its encouragement and support of this study, as well as Cynthia Johnson, Erika Ihara, and the catheterization laboratories of the participating hospitals for their tireless efforts to ensure the timeliness, completeness, and accuracy of the data submitted.

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Disclosures

Dr Jacobs serves as a site principal investigator for the Abbott Vascular Stent Registry and as a site principal investigator for Harvard Clinical Research Institute’s Dual Antiplatelet Therapy Randomized Trial. Dr Sharma served on speakers’ bureaus for BSC, Abbott, DSI/Lilly, and the Medicine Co. Dr King serves on Merck’s Clinical Events Committee. The other authors report no conflicts.

References

Little is known about the relative frequencies of different treatments that patients receive after being diagnosed with stable coronary artery disease and what the comparative outcomes are for routine medical treatment (RMT) versus percutaneous coronary intervention (PCI) with RMT for patients not in randomized controlled trials. Consequently, patients with stable coronary artery disease undergoing cardiac catheterization in New York State between 2003 and 2008 were followed up to determine the treatment they received. Patients receiving RMT and patients receiving PCI with RMT were propensity matched through the use of 20 factors that could have a bearing on outcomes. The resulting cohort of 933 matched pairs was used to compare mortality/myocardial infarction (MI), mortality, MI, and subsequent revascularization rates. Most of the patients (89%) underwent PCI. PCI/RMT patients had significantly lower adverse outcome rates at 4 years for mortality/MI (16.5% versus 21.2%; \(P = 0.003\)), mortality (10.2% versus 14.5%; \(P = 0.02\)), MI (8.0% versus 11.3%; \(P = 0.007\)), and subsequent revascularization (24.1% versus 29.1%; \(P = 0.005\)). Adjusted RMT/PCI hazard ratios were 1.49 (95% confidence interval, 1.16–1.93) for mortality/MI and 1.46 (95% confidence interval, 1.08–1.97) for mortality. There were no differences in treatment outcomes for patients <65 years of age or for patients with single-vessel disease. Most patients with stable coronary artery disease in New York undergoing catheterization between 2003 and 2008 received PCI, and those patients who received PCI experienced lower mortality, mortality/MI, and revascularization rates. The reasons for this finding need to be better understood, including the possible role of low medication adherence rates that have been found in other studies.
Comparative Outcomes for Patients Who Do and Do Not Undergo Percutaneous Coronary Intervention for Stable Coronary Artery Disease in New York
Edward L. Hannan, Zaza Samadashvili, Kimberly Cozzens, Gary Walford, Alice K. Jacobs, David R. Holmes, Jr, Nicholas J. Stamato, Jeffrey P. Gold, Samin Sharma, Ferdinand J. Venditti, Tia Powell and Spencer B. King III

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Cardiología intervencionista

Resultados comparativos en pacientes tratados o no con intervención coronaria percutánea por una enfermedad coronaria estable en Nueva York

Edward L. Hannan, PhD; Zaza Samadashvili, MD; Kimberly Cozzens, MA; Gary Walford, MD; Alice K. Jacobs, MD; David R. Holmes, Jr, MD; Nicholas J. Stamato, MD; Jeffrey P. Gold, MD; Samin Sharma, MD; Ferdinand J. Venditti, MD; Tia Powell, MD; Spencer B. King, III, MD

Antecedentes—Es poco lo que se sabe acerca de los tratamientos que reciben los pacientes tras un diagnóstico de enfermedad arterial coronaria estable o acerca de los resultados clínicos comparativos que se obtienen con el tratamiento médico estándar (TME) en comparación con la intervención coronaria percutánea (ICP) junto con TME en los pacientes fuera del contexto de los ensayos controlados y aleatorizados.

Métodos y resultados—Entre 2003 y 2008 se llevó a cabo un seguimiento de pacientes con enfermedad arterial coronaria estable a los que se practicó un cateterismo cardíaco en el Estado de Nueva York, para determinar el tratamiento que habían recibido. Se realizó una igualación por propensión (propensity matched) de pacientes tratados con TME y pacientes tratados con ICP junto con TME, a través del empleo de 20 factores que podían tener influencia en los resultados clínicos. La cohorte resultante la formaron 933 parejas de pacientes equivalentes, y se utilizó para comparar las tasas de mortalidad/infarto de miocardio (IM), mortalidad, IM, y revascularización posterior. El 89% del total de pacientes fueron tratados con ICP junto con TME. Los pacientes tratados con ICP/TME presentaron unas tasas de eventos adversos significativamente inferiores a los 4 años para la mortalidad/IM (16,5% frente a 21,2%; \( p = 0,003 \)), la mortalidad (10,2% frente a 14,5%; \( p = 0,02 \)), el IM (8,0% frente a 11,3%; \( p = 0,007 \)) y la revascularización posterior (24,1% frente a 29,1%; \( p = 0,005 \)). Las razones de riesgos ajustadas para el TME frente a (ICP con TME) fueron de 1,49 (intervalo de confianza del 95%, 1,16 – 1,93) para la mortalidad/IM y de 1,46 (intervalo de confianza del 95%, 1,08 – 1,97) para la mortalidad. No hubo diferencias en los pacientes de edad ≤ 65 años ni en los pacientes de afectación de un solo vaso.

Conclusiones—La mayor parte de los pacientes con enfermedad arterial coronaria estable de Nueva York a los que se practicó un cateterismo entre 2003 y 2008 fueron tratados con una ICP. Los pacientes en los que se realizó una ICP presentaron menores tasas de mortalidad, mortalidad/IM y revascularización. Será necesario determinar mejor las razones de estas observaciones, incluido el posible papel de la baja adherencia a la medicación que se ha observado en otros estudios.


Palabras clave: comparative effectiveness research ■ coronary artery disease ■ medicine ■ coronary angioplasty

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El ensayo Clinical Outcomes Utilizing Revascularization and Aggressive Drug Evaluation (COURAGE), en el que se estudió a pacientes con enfermedad arterial coronaria estable (EC) a los que se asignó aleatoriamente o bien una terapia médica óptima (TMO) o bien una intervención coronaria percutánea (ICP) junto con TMO, indicó que el empleo de la ICP junto con TMO como estrategia terapéutica inicial no reducía las tasas de mortalidad, infarto de miocardio (IM) u otros eventos cardiovasculares mayores, en comparación con una estrategia inicial de TMO sola1. Se observaron efectos beneficiosos pequeños de la ICP en comparación con el tratamiento médico en el control de la angina, que desaparecieron en un plazo de 36 meses2. La TMO fue respaldada por la participación de enfermeras instructoras que asesoraban a los pacientes para ayudarles a alcanzar los objetivos de estilo de vida y de reducción de factores de riesgo, la entrega de las medicaciones a los pacientes sin coste, y un seguimiento de los pacientes a los 1, 2, 4 y 6 meses, y luego cada 6 meses. La adherencia
obtenida a la prescripción de medicación y de estilo de vida fue bastante alta (por ejemplo, 96% de adherencia a los antagonistas plaquetarios, 85% a los betabloqueantes, 93% al uso de estatinas)3–6.

**Métodos**

**Variables de valoración**

Las variables de valoración del estudio fueron la mortalidad, IM, reingresos por IM y revascularización posterior, a 4 años.

### Bases de datos

La base de datos principal utilizada en el estudio fue la *New York State’s Cardiac Diagnostic Catheterization Database* (CD2), un sistema de registro de datos voluntario de Nueva York que mantiene el Departamento de Salud del Estado de Nueva York. Para los pacientes a los que se practica un cateterismo cardíaco en Nueva York, la base de datos contiene información acerca de características demográficas, comorbilidades, pagador de la asistencia, tipo y clase de la angina, resultados de la prueba de estrés, IM previos, intervenciones de revascularización previas, fracción de eyecación, isquemia en curso, vasos afectados, fracción de eyecación, insuficiencia cardiaca congestiva, diabetes mellitus, shock, inestabilidad hemodinámica y área de miocardio viable en riesgo. Otras variables importantes incluidas son la anamnesis del paciente, si la anatomía del paciente es apta para la ICP o la cirugía de bypass, y si el paciente presenta alguna comorbilidad no cardiaca que contraindique la ICP.

La exhaustividad de los datos notificados se supervisa mediante el cotejo de la CD2 con la base de datos de altas de hospitales, y si el paciente presenta alguna comorbilidad no cardiaca que contra

### Análisis estadísticos

Dado que los pacientes no fueron asignados aleatoriamente al tratamiento de ICP/TME frente al de TME, identificamos las características de los pacientes que podían estar relacionadas con el tipo de tratamiento elegido, así como los posibles factores predictivos de una...
<table>
<thead>
<tr>
<th>Factor de riesgo</th>
<th>Todos los pacientes (n = 9,586)</th>
<th>TME (n = 1,100, 11%)</th>
<th>ICP (n = 8,486, 89%)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Año del cateterismo de cualificación, %</td>
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<td>2007–2008</td>
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<tr>
<td>65–74 años</td>
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<tr>
<td>75–84 años</td>
<td>19,09</td>
<td>23,64</td>
<td>18,50</td>
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<tr>
<td>≥ 85 años</td>
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<tr>
<td>Mujeres, %</td>
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<td>33,95</td>
<td>0,45</td>
</tr>
<tr>
<td>Raza, %</td>
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<td>29,81 (6,27)</td>
<td>30,08 (6,08)</td>
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<tr>
<td>Categorías de IMC, %</td>
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<td>19–40 kg/m²</td>
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<td>92,73</td>
<td>92,67</td>
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<tr>
<td>&gt; 40 kg/m²</td>
<td>6,74</td>
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<td>6,62</td>
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<tr>
<td>Posición socioeconómica, %</td>
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<td></td>
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<td>Ingresos bajos (tercio inferior de mediana de ingresos por código postal)</td>
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<tr>
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<tr>
<td>Pagador principal de la asistencia, %</td>
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<td>Medicare</td>
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<td>47,36</td>
<td>44,10</td>
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<tr>
<td>Otros</td>
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<td>16,18</td>
<td>11,60</td>
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<tr>
<td>Resultados de prueba de estrés, %</td>
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<td></td>
<td>&lt; 0,001</td>
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<tr>
<td>Resultado de prueba de estrés desconocido</td>
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<td>39,36</td>
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<tr>
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<td>60,64</td>
<td>65,81</td>
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<tr>
<td>Área de miocardio viable, %</td>
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<td></td>
<td></td>
<td>&lt; 0,001</td>
</tr>
<tr>
<td>Pequeña</td>
<td>11,08</td>
<td>31,00</td>
<td>8,50</td>
<td></td>
</tr>
<tr>
<td>Media o grande</td>
<td>88,92</td>
<td>69,00</td>
<td>91,50</td>
<td></td>
</tr>
<tr>
<td>Grado de enfermedad coronaria, %</td>
<td></td>
<td></td>
<td></td>
<td>&lt; 0,001</td>
</tr>
<tr>
<td>1 vaso sin afectación de la porción proximal de la DAI</td>
<td>59,27</td>
<td>62,55</td>
<td>58,85</td>
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</tr>
<tr>
<td>1 vaso con afectación de la porción proximal de la DAI</td>
<td>10,74</td>
<td>6,64</td>
<td>11,28</td>
<td></td>
</tr>
<tr>
<td>2 vasos sin afectación de la porción proximal de la DAI</td>
<td>25,53</td>
<td>25,55</td>
<td>25,52</td>
<td></td>
</tr>
<tr>
<td>2 vasos con afectación de la porción proximal de la DAI/3 vasos</td>
<td>4,46</td>
<td>5,27</td>
<td>4,35</td>
<td></td>
</tr>
<tr>
<td>Insuficiencia cardiaca congestiva</td>
<td>5,45</td>
<td>9,55</td>
<td>4,91</td>
<td>&lt; 0,001</td>
</tr>
<tr>
<td>Fracción de eyeción ventricular izquierda, %</td>
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<td></td>
<td></td>
<td>&lt; 0,001</td>
</tr>
<tr>
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<td>5,65</td>
<td>8,18</td>
<td>5,33</td>
<td></td>
</tr>
<tr>
<td>30%–39%</td>
<td>4,06</td>
<td>8,18</td>
<td>3,52</td>
<td></td>
</tr>
<tr>
<td>40%–49%</td>
<td>9,97</td>
<td>13,27</td>
<td>9,55</td>
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</tr>
<tr>
<td>≥ 50%</td>
<td>80,32</td>
<td>70,36</td>
<td>81,60</td>
<td></td>
</tr>
</tbody>
</table>

(Continúa)
Table 1. (Continuación)

<table>
<thead>
<tr>
<th>Factor de riesgo</th>
<th>Todos los pacientes (n = 9,586)</th>
<th>TME (n = 1,100, 11%)</th>
<th>ICP (n = 8,486, 89%)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clase CCS de la angina, %</td>
<td></td>
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<td></td>
<td>&lt; 0,001</td>
</tr>
<tr>
<td>0</td>
<td>13,03</td>
<td>23,91</td>
<td>11,62</td>
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<tr>
<td>I</td>
<td>16,25</td>
<td>20,09</td>
<td>15,76</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>33,77</td>
<td>33,45</td>
<td>33,81</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>36,95</td>
<td>22,55</td>
<td>38,82</td>
<td></td>
</tr>
<tr>
<td>IM previo (&gt; 21 d), %</td>
<td>13,38</td>
<td>14,91</td>
<td>13,19</td>
<td>0,11</td>
</tr>
<tr>
<td>Enfermedad cerebrovascular, %</td>
<td>6,12</td>
<td>7,36</td>
<td>5,96</td>
<td>0,07</td>
</tr>
<tr>
<td>Enfermedad vascular periférica, %</td>
<td>7,45</td>
<td>11,36</td>
<td>6,94</td>
<td>&lt; 0,001</td>
</tr>
<tr>
<td>Diabetes mellitus, %</td>
<td>32,71</td>
<td>34,73</td>
<td>32,45</td>
<td>0,13</td>
</tr>
<tr>
<td>Insuficiencia renal, %</td>
<td>1,38</td>
<td>2,27</td>
<td>1,26</td>
<td>0,01</td>
</tr>
<tr>
<td>ICP previa, %</td>
<td>25,05</td>
<td>23,18</td>
<td>25,29</td>
<td>0,13</td>
</tr>
<tr>
<td>Cirugía cardiaca abierta previa, %</td>
<td>13,00</td>
<td>18,18</td>
<td>12,33</td>
<td>&lt; 0,001</td>
</tr>
</tbody>
</table>

TME indica tratamiento médico estándar; ICP, intervención coronaria percutánea; IMC, índice de masa corporal; DAI, arteria descendente anterior izquierda; CCS, Canadian Cardiovascular Society; e IM, infarto de miocardio.

*Para las variables categóricas, las cifras indicadas en cada subcategoría son porcentajes del total de la categoría.

Hannan y cols.  Evolución de la enfermedad coronaria estable 95

evolución adversa. En primer lugar, comparamos las prevalencias de estos factores de riesgo en los pacientes de los grupos de ICP y de TME utilizando para ello pruebas de $\chi^2$.

Dado que muchos de los valores de prevalencia fueron significativamente diferentes, se utilizó un índice de propensión apareado (propensity score matching) para identificar un conjunto de pares de pacientes ICP/TME y TME equivalentes, de manera que pudiera reducirse la influencia de los factores de confusión. Se apareó a los pacientes en cuanto a los siguientes factores: intervalo de tiempo transcurrido hasta el cateterismo, edad, clase de la angina según la Canadian Cardiovascular Society, fracción de eyecación, área de miocardio viable en riesgo, insuficiencia renal (diálisis o creatinina > 2,5 mg/dl), grado de enfermedad cardiovascular, principal pagador de la asistencia, características demográficas, índice de masa corporal, mediana de ingresos per cápita del código postal del paciente, insuficiencia cardiaca congestiva, función ventricular izquierda, IM previo, ICP previa > 6 meses antes (las ICP más recientes se excluyeron del estudio), cirugía de bypass > 6 meses antes, y algunas comorbilidades (enfermedad cerebrovascular, enfermedad vascular periférica, diabetes mellitus). La puntuación de propensión se obtuvo con el empleo de un modelo de regresión logística para predecir la probabilidad de ser tratado con ICP junto con TME en vez del TME solo para cada paciente, como función de los factores que se han mencionado.

Se utilizó un algoritmo de equiparación con optimización global (que elige pares de pacientes de TME y de ICP/TME de manera que se reduzca al mínimo la suma de las distancias entre los índices de propensión de los pacientes del par), aceptando la equiparación tan solo si la diferencia en los logit de los índices de propensión apareados era $< 0,6$ veces la de las puntuaciones $7^{10}$. La igualación se realizó en una proporción 1:1; cada par igualado fue único; y los datos de los pacientes no igualados no se utilizaron en los análisis posteriores. El equilibrio de las características de los pacientes en los grupos emparejados se evaluó con el cálculo de las diferencias estandarizadas entre los 2 grupos (TME y ICP/TME) para cada una de las características utilizadas para la equiparación. Una diferencia $< 0,1$ (10%) se consideró acceptable.$^{11}$

Se utilizaron entonces los pares apareados por propensión para analizar las diferencias de resultados entre los dos grupos. Se emplearon métodos para comparar el TME con el ICP/TME durante un periodo de seguimiento de 4 años para cada uno de los parámetros de valoración, con el uso de curvas de supervivencia de Kaplan Meier con pruebas de Klein y Moeschberger, teniendo en cuenta el hecho de que las muestras habían sido equiparadas.$^{12}$ Tras haber confirmado que el supuesto de riesgos proporcionales era válido, se ajustaron a los pares igualados modelos de riesgos proporcionales de Cox para introducir un ajuste respecto a toda posible diferencia restante en las características de los pacientes, y se obtuvieron las razones de riesgos ajustadas de TME/ICP respecto a TME para cada uno de los parámetros de valoración examinados.

Se evaluó también el impacto del tipo de tratamiento sobre la tasa de mortalidad/IM respecto a algunos subgrupos de factores de riesgo previamente seleccionados de especial interés (edad, grado de EC, clase de la angina y área de miocardio viable en riesgo), con objeto de determinar si la diferencia de los resultados con ICP y con TME era distinta en función de estos factores de riesgo preseleccionados y si había alguna interacción significativa entre tipo de tratamiento y factor de riesgo. Para cada factor de riesgo, se ajustó un modelo de riesgos proporcionales de Cox, que incluía el tipo de tratamiento (ICP frente a TME), el propio factor de riesgo, su término de interacción y otros factores de riesgo significativos ($p < 0,05$) para la mortalidad, identificados mediante una selección retrógrada.

Los análisis se realizaron por intención de tratar, y los pacientes médicos que fueron tratados con una ICP 30 días después del cateterismo de cualificación se consideraron pacientes con tratamiento médico. Todas las pruebas fueron bilaterales y se realizaron con un nivel de significación de 0,05, y todos los análisis se llevaron a cabo con el programa SAS 9.1 (SAS Institute, Inc, Cary, NC).

**Resultados**

Características de los pacientes y los prestadores de asistencia antes del apareamiento por índice de propensión

La mediana de tiempo de seguimiento fue de 2,87 años (2,94 años en los pacientes ICP/TME, 2,81 años en los pacientes TME). Del total de 9,586 pacientes, 8,486 (88,5%) fueron tratados con una ICP y 196 (2,0%) con cirugía de bypass. El porcentaje de ICP no se modificó sustancialmente antes y des-
<table>
<thead>
<tr>
<th>Factor de riesgo</th>
<th>Todos los pacientes TME ordinario</th>
<th>TME ordinario</th>
<th>ICP</th>
<th>p</th>
<th>Diferencia estandarizada, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ano del cateterismo de cualificación, %</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2003–2004</td>
<td>24,76</td>
<td>24,76</td>
<td>24,76</td>
<td>1,00</td>
<td>0,00</td>
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<tr>
<td>2005–2006</td>
<td>33,55</td>
<td>33,55</td>
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<td>1,00</td>
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<tr>
<td>2007–2008</td>
<td>41,69</td>
<td>41,69</td>
<td>41,69</td>
<td>1,00</td>
<td>0,00</td>
</tr>
<tr>
<td>Edad, media (DE), años</td>
<td>66,4 (11,2)</td>
<td>66,6 (11,1)</td>
<td>66,3 (11,2)</td>
<td>0,52</td>
<td>8,98</td>
</tr>
<tr>
<td>Categorías de edad, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>≤ 65 años</td>
<td>42,98</td>
<td>42,98</td>
<td>42,98</td>
<td>1,00</td>
<td>0,00</td>
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<tr>
<td>65–74 años</td>
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<tr>
<td>75–84 años</td>
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<td>22,29</td>
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<td>3,97</td>
<td>4,39</td>
<td>0,64</td>
<td>2,14</td>
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<tr>
<td>Mujeres, %</td>
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<td>34,41</td>
<td>34,41</td>
<td>1,00</td>
<td>0,00</td>
</tr>
<tr>
<td>Raza, %</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Blancos</td>
<td>68,49</td>
<td>67,20</td>
<td>69,77</td>
<td>0,23</td>
<td>5,54</td>
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<tr>
<td>Negros</td>
<td>18,06</td>
<td>17,90</td>
<td>18,22</td>
<td>0,86</td>
<td>0,84</td>
</tr>
<tr>
<td>Otros</td>
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<td>14,90</td>
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<td>8,49</td>
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<tr>
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<td>29,72 (6,06)</td>
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<td>8,06</td>
</tr>
<tr>
<td>Categorías de IMC, %</td>
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<td></td>
<td></td>
<td></td>
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<td>1,07</td>
<td>0,75</td>
<td>0,46</td>
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<tr>
<td>19–40 kg/m²</td>
<td>92,93</td>
<td>92,82</td>
<td>93,03</td>
<td>0,86</td>
<td>0,83</td>
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<tr>
<td>&gt; 40 kg/m²</td>
<td>6,16</td>
<td>6,11</td>
<td>6,22</td>
<td>0,92</td>
<td>0,45</td>
</tr>
<tr>
<td>Posición socioeconómica, %</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ingresos bajos (tercio inferior)</td>
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<td>31,08</td>
<td>33,44</td>
<td>0,28</td>
<td>5,05</td>
</tr>
<tr>
<td>Ingresos medios o altos</td>
<td>67,74</td>
<td>68,92</td>
<td>66,56</td>
<td>0,28</td>
<td>5,05</td>
</tr>
<tr>
<td>Pagador principal de la asistencia, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Privado</td>
<td>37,62</td>
<td>37,62</td>
<td>37,62</td>
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<td>0,00</td>
</tr>
<tr>
<td>Medicare</td>
<td>47,27</td>
<td>47,27</td>
<td>47,27</td>
<td>1,00</td>
<td>0,00</td>
</tr>
<tr>
<td>Otros</td>
<td>15,11</td>
<td>15,11</td>
<td>15,11</td>
<td>1,00</td>
<td>0,00</td>
</tr>
<tr>
<td>Resultados de prueba de estrés, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resultado de prueba de estrés desconocido</td>
<td>37,35</td>
<td>38,16</td>
<td>36,55</td>
<td>0,47</td>
<td>3,32</td>
</tr>
<tr>
<td>Prueba de estrés positiva</td>
<td>62,65</td>
<td>61,84</td>
<td>63,45</td>
<td>0,47</td>
<td>3,32</td>
</tr>
<tr>
<td>Área de miocardio viable, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pequeña</td>
<td>23,47</td>
<td>23,47</td>
<td>23,47</td>
<td>1,00</td>
<td>0,00</td>
</tr>
<tr>
<td>Media o grande</td>
<td>66,53</td>
<td>66,53</td>
<td>66,53</td>
<td>1,00</td>
<td>0,00</td>
</tr>
<tr>
<td>Grado de enfermedad coronaria, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 vaso sin afectar a la porción proximal</td>
<td>62,33</td>
<td>61,09</td>
<td>63,56</td>
<td>0,27</td>
<td>5,09</td>
</tr>
<tr>
<td>de la DAI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 vaso con afectación de la porción proximal</td>
<td>7,18</td>
<td>6,86</td>
<td>7,50</td>
<td>0,59</td>
<td>2,49</td>
</tr>
<tr>
<td>de la DAI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 vasos sin afectación de la porción proximal</td>
<td>26,42</td>
<td>27,97</td>
<td>24,87</td>
<td>0,13</td>
<td>7,05</td>
</tr>
<tr>
<td>de la DAI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 vasos con afectación de la porción proximal</td>
<td>4,07</td>
<td>4,07</td>
<td>4,07</td>
<td>1,00</td>
<td>0,00</td>
</tr>
<tr>
<td>de la DAI/3 vasos</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insuficiencia cardíaca congestiva, %</td>
<td>7,61</td>
<td>8,36</td>
<td>6,86</td>
<td>0,22</td>
<td>5,66</td>
</tr>
<tr>
<td>Fracción de eyeción ventricular izquierda, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No disponible</td>
<td>6,22</td>
<td>6,22</td>
<td>6,22</td>
<td>1,00</td>
<td>0,00</td>
</tr>
<tr>
<td>30%–39%</td>
<td>6,11</td>
<td>6,11</td>
<td>6,11</td>
<td>1,00</td>
<td>0,00</td>
</tr>
<tr>
<td>40%–49%</td>
<td>11,58</td>
<td>12,43</td>
<td>10,72</td>
<td>0,25</td>
<td>5,36</td>
</tr>
<tr>
<td>≥ 50%</td>
<td>76,10</td>
<td>75,24</td>
<td>76,97</td>
<td>0,39</td>
<td>4,02</td>
</tr>
</tbody>
</table>

(Continúa)
Hannan y cols.  
Evolución de la enfermedad coronaria estable

Después del apareamiento por índice de propensión

El proceso de equiparación mediante índice de propensión permitió emparejar a 933 (84,8%) pacientes del grupo de tratamiento médico con un paciente ICP/TME muy similar. No hubo diferencias significativas entre los 2 grupos en ninguna de las características examinadas. Tal como se indica en la Tabla 2, las características de los pares de pacientes eran extremadamente similares, con tan solo una diferencia estandarizada que superara el 10%. Tras este emparejamiento, se incluyó en la base de datos a un total de 18 de los 20 hospitales. Los pacientes emparejados habían sido tratados con ICP en un total de 27 hospitales por 120 cardiólogos.

**Tasas de eventos adversos**

En la Tabla 3 y en la Figura se presentan las tasas de eventos adversos correspondientes a mortalidad/IM, mortalidad, e IM para los pacientes TME y los pacientes ICP/TME equiparados según la propensión. A los 4 años, los pacientes ICP/TME presentaron una tasa de mortalidad/IM inferior (16,5% frente a 21,2%; p = 0,003), una tasa de mortalidad inferior (10,2% frente a 14,5%; p = 0,02), y tasas de reingreso post-agudo de IM y revascularización posterior inferiores (11,3% frente a 19,1% y 29,1% frente a 34,6%, respectivamente; p = 0,01 y p = 0,003, respectivamente).

**Tabla 2. (Continuación)**

<table>
<thead>
<tr>
<th>Factor de riesgo</th>
<th>Todos los pacientes TME ordinario (n = 1.866)</th>
<th>ICP (n = 933)</th>
<th>Diferencia estandarizada, %</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Clase CCS de la angina, %</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>19,56</td>
<td>21,65</td>
<td>17,47</td>
<td>0,02</td>
</tr>
<tr>
<td>I</td>
<td>21,91</td>
<td>19,93</td>
<td>23,90</td>
<td>0,04</td>
</tr>
<tr>
<td>II</td>
<td>34,83</td>
<td>34,73</td>
<td>34,94</td>
<td>0,93</td>
</tr>
<tr>
<td>III</td>
<td>23,69</td>
<td>23,69</td>
<td>23,69</td>
<td>1,00</td>
</tr>
<tr>
<td>IM previo (&gt; 21 d), %</td>
<td>13,08</td>
<td>12,75</td>
<td>13,40</td>
<td>0,68</td>
</tr>
<tr>
<td>Enfermedad cerebrovascular</td>
<td>6,97</td>
<td>6,97</td>
<td>6,97</td>
<td>1,00</td>
</tr>
<tr>
<td>Enfermedad vascular periférica, %</td>
<td>9,43</td>
<td>9,75</td>
<td>9,11</td>
<td>0,63</td>
</tr>
<tr>
<td>Diabetes mellitus, %</td>
<td>35,74</td>
<td>35,05</td>
<td>36,44</td>
<td>0,53</td>
</tr>
<tr>
<td>Insuficiencia renal, %</td>
<td>0,96</td>
<td>0,96</td>
<td>0,96</td>
<td>1,00</td>
</tr>
<tr>
<td>ICP previa, %</td>
<td>22,29</td>
<td>22,29</td>
<td>22,29</td>
<td>1,00</td>
</tr>
<tr>
<td>Cirugía cardíaca abierta previa, %</td>
<td>16,88</td>
<td>16,08</td>
<td>17,68</td>
<td>0,35</td>
</tr>
</tbody>
</table>

*TME indica tratamiento médico estándar; ICP, intervención coronaria percutánea; IMC, índice de masa corporal; DAI, arteria descendente anterior izquierda; CCS, Canadian Cardiovascular Society; e IM, Infarto de miocardio.

*Para las variables categóricas, las cifras indicadas en cada subcategoría son porcentajes del total de la categoría.

**Tabla 3. Eventos adversos a cuatro años en los pacientes tratados con intervención coronaria percutánea y con tratamiento médico igualados por propensión**

<table>
<thead>
<tr>
<th>Resultados</th>
<th>TME</th>
<th>ICP</th>
<th>Tasa de eventos, %†</th>
<th>Casos, n</th>
<th>Tasa de eventos, %†</th>
<th>Casos, n</th>
<th>Diferencia, %</th>
<th>p†</th>
<th>TME/ICP con TME</th>
<th>Razón de riesgos ajustada*</th>
<th>p</th>
<th>Razón de riesgos sin ajustar*</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortalidad/IM</td>
<td>21,15</td>
<td>269</td>
<td>16,46</td>
<td>293</td>
<td>4,69</td>
<td>0,003</td>
<td>1,49</td>
<td>0,002</td>
<td>1,50</td>
<td>0,002</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mortalidad</td>
<td>14,53</td>
<td>292</td>
<td>10,15</td>
<td>310</td>
<td>4,38</td>
<td>0,02</td>
<td>1,46</td>
<td>0,02</td>
<td>1,47</td>
<td>0,01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reingreso por IM agudo</td>
<td>11,33</td>
<td>298</td>
<td>8,02</td>
<td>332</td>
<td>3,31</td>
<td>0,007</td>
<td>1,56</td>
<td>0,01</td>
<td>1,57</td>
<td>0,008</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Revascularización posterior</td>
<td>29,12</td>
<td>215</td>
<td>24,05</td>
<td>255</td>
<td>5,07</td>
<td>0,005</td>
<td>1,39</td>
<td>0,003</td>
<td>1,35</td>
<td>0,004</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*TME indica tratamiento médico estándar; ICP, intervención coronaria percutánea; e IM, infarto de miocardio.

*Razones de riesgos ajustadas y sin ajustar basada en modelos con seguimiento completo.

†Estimaciones de Kaplan-Meier.

‡Valores de p basados en la prueba de Klein y Moescherger12.
frente a 14,5%; \( p = 0,02 \), una tasa de IM inferior (8,0% frente a 11,3%; \( p = 0,007 \), y una tasa de revascularización posterior inferior (24,1% frente a 29,1%; \( p = 0,005 \)). En estos datos se incluyen las intervenciones de ICP en etapas planificadas que se realizaron en el grupo de ICP/TME. Partiendo de los datos existentes a este respecto, de los que se dispuso tan solo en los 2 años del estudio y que fueron extrapolados a todos los años, la tasa de revascularización posterior en pacientes ICP/TME que no habían sido intervenidos en etapas se estimó en un 19,7%.

Las razones de riesgos ajustadas que corresponden a los resultados relativos en todo el periodo de seguimiento fueron también significativas y favorables al grupo de ICP/TME frente al de TME solo, con valores de entre 1,39 y 1,56. En el subgrupo de 789 pares de pacientes en los que los pacientes ICP se definieron como los tratados con una ICP en el ingreso inicial, y los pacientes TME fueron los que no fueron tratados con ICP en el ingreso inicial o en un plazo de 30 días, los resultados del grupo de TME frente a los del grupo de ICP junto con TME fueron los siguientes: 20,5% frente a 15,4% (\( p = 0,01 \); razón de riesgos ajustada = 1,47; intervalo de confianza del 95%, 1,10–1,95) para la mortalidad; 10,9% frente a 7,1% (\( p = 0,01 \); razón de riesgos ajustada = 1,73; intervalo de confianza del 95%, 1,15–2,59) para el IM; y 28,7% frente a 23,8% (\( p = 0,005 \); razón de riesgos ajustada = 1,39; intervalo de confianza del 95%, 1,10–1,75) para la revascularización posterior.

**Tasas de eventos adversos en subgrupos de pacientes**

En la Tabla 4 se muestra que en todos los subgrupos de pacientes excepto los de edad < 65 años, las razones de riesgos ajustadas fueron > 1, lo cual indica una mortalidad superior con el TME. Tan solo 1 término de interacción (el de la interacción entre edad y tipo de tratamiento) fue significativo, e indicó que el efecto del tipo de tratamiento sobre la mortalidad podría depender de la edad, de tal manera que el efecto beneficioso de la ICP respecto al TME era significativamente superior en los pacientes de edad ≥ 65 años en comparación con los pacientes de edad < 65 años.

**Discusión**

Aunque el ensayo COURAGE comparó los resultados obtenidos en pacientes con EC estable tratados con ICP y tratamiento médico, no está claro con qué frecuencia estos pacientes...
son tratados con ICP en la práctica médica habitual ni cuáles son los resultados clínicos obtenidos con y sin ICP. En nuestro estudio observamos que, en los datos de base poblacional de Nueva York, en relación a pacientes con EC estable a los que se practicaba un cateterismo cardíaco, casi un 90% de ellos eran tratados con ICP. Éste porcentaje no se modificó ni siquiera en 2008, bastante después de que se hubieran publicado los resultados del ensayo COURAGE. Además, los pacientes apareados por propensión que fueron tratados con ICP presentaron unas tasas significativamente inferiores de mortalidad, mortalidad/IM, y revascularización, en comparación con los pacientes no tratados con ICP.

Nuestras tasas de eventos en cuanto a mortalidad/IM a los 4 años fueron del 16,5% con ICP/TME y del 21,2% con TME, en comparación con las del 19,0% y 18,5% del ensayo COURAGE a los 4,6 años. Nuestras tasas de mortalidad a los 4 años fueron del 10,2% con ICP/TME y del 14,5% con TME, en comparación con las del 7,6% con ICP/TMO y 8,3% con TMO del ensayo COURAGE a los 4,6 años. Aunque nuestras tasas con TME y con ICP/TME fueron superiores a las del COURAGE, planteamos la hipótesis de que nuestras tasas con ICP/TME fueron más similares a las del COURAGE porque se utilizaron stents liberadores de fármacos en el 74% de los pacientes de nuestro estudio, mientras que en todos los pacientes del COURAGE se usaron stents metálicos sin recubrimiento, y se ha demostrado que los stents liberadores de fármacos se asocian a unas tasas de mortalidad inferiores a las de los stents metálicos sin recubrimiento en estudios observacionales, aunque no en ensayos controlados y aleatorizados13. Dos posibles razones por las que las tasas de eventos clínicos con TME de nuestro estudio fueron superiores a las del COURAGE son que nuestra población de TME estaba significativamente menos seleccionada (y por tanto tenía un riesgo superior) y que los pacientes recibieron un TME en vez de TMO.

Hay algunos factores que pueden contribuir a explicar nuestros resultados. En primer lugar, el carácter observacional de este estudio hace que esté sujeto a un sesgo de selección, que puede hacer que los resultados sean consecuencia principalmente de las diferencias entre las poblaciones de pacientes y no de la efectividad relativa de estos. De hecho, los pacientes del grupo de TME tuvieron un riesgo superior al de los pacientes ICP/TME en el conjunto total de la muestra. Aparecemos a los pacientes por propensión basándonos en numerosos factores de riesgo relacionados con características demográficas, datos socioeconómicos, pagador de la asistencia, grado de EC, resultados de la prueba de estrés, área de
miocardio viable en riesgo, función ventricular, clase de la angina y comorbilidades, en un intento de reducir al mínimo este riesgo. Además, todos los pacientes del estudio eran candidatos adecuados para la ICP. En consecuencia, el subgrupo de pacientes con equiparación por propensión utilizado en este estudio estaba extraordinariamente equilibrado respecto a esos factores de riesgo. Por otro lado, el diseño del estudio hacía que todo paciente que falleciera o sufriera un IM en un plazo de 30 días tras el cateterismo de cualificación sin que se le hubiera practicado una ICP fuera apartado del estudio en vez de incluido en el grupo de TME, ya que se le podría haber asignado una ICP en un plazo de 30 días. Esto se hizo a pesar de que los 95% de los pacientes tratados con ICP lo fueron en el plazo de 1 semana, y el 98% en el plazo de 2 semanas. No obstante, otros factores no evaluados, como las características de la lesión, el riesgo de hemorragia y algunas comorbilidades no cardiacas (por ejemplo el cáncer) y la posible diferencia de los resultados debido a la medicación, muestran que la adherencia tanto a los cambios de estilo de vida sugeridos como a la medicación fue excelente en su ensayo2,3. Varios estudios han demostrado que la adherencia a la medicación suele ser baja15–21, y en otros varios se ha observado que la adherencia afecta de manera importante a los resultados clínicos17,19,22–26. Además, los estudios del grupo COURAGE demuestran que la adherencia tanto a los cambios de estilo de vida como a la medicación fue excelente en su ensayo2,3. La combinación de estos hechos sugiere que, aunque la TME es igual de efectiva que el empleo de ICP/TME en los pacientes con una EC estable en un ensayo clínico estrictamente controlado y con una adherencia excelente, los resultados podrían ser diferentes en situaciones de práctica clínica real. Tal como han señalado Ho y cols.18,20, hay razones multifactoriales que explican la mala adherencia, como las dificultades que plantea el sistema de asistencia sanitaria (por ejemplo, relación paciente-prestador de asistencia, problemas de acceso), el estado del paciente (por ejemplo, depresión, deterioro cognitivo, problemas psicosociales), el tratamiento (por ejemplo, efectos secundarios, pauta de administración compleja), y los problemas socioeconómicos (por ejemplo, baja capacidad de lectura o cobertura de seguro insuficiente o inexistente).

Así pues, los resultados clave de este estudio son que, con una asistencia médica estándar, la inmensa mayoría de los pacientes a los que se practicó un cateterismo en Nueva York entre 2003 y 2008 fueron tratados con ICP y no con el tratamiento médico solo, y que los pacientes con EC estable tratados con ICP presentaron mejores resultados que los pacientes a los que no se practicó la ICP. Las razones de estos resultados deberán esclarecerse, incluido el papel que desempeña la incapacidad de alcanzar el TMo en la práctica médica habitual. Un ensayo controlado y aleatorizado en el que los pacientes sean asignados aleatoriamente a ICP o TM sin intentar garantizar el TMo aportaría una prueba definitiva para determinar
el modo en el que evolucionan con cada intervención los pacientes de la práctica médica habitual.

**Agradecimientos**

Queremos agradecer al Cardiac Advisory Committee del Estado de Nueva York su estímulo y apoyo para este estudio, y también a Cynthia Johnson, Erika Ibarra y los laboratorios de cateterismo cardíaco de los hospitales participantes sus esfuerzos incansables por asegurar la rapidez, exhaustividad y exactitud de los datos presentados.

**Fuente de financiación**

Se dispuso de financiación por parte del Departamento de Salud del Estado de Nueva York. Sin embargo, las conclusiones no reflejan necesariamente las opiniones del Departamento de Salud.

**Declaraciones de intereses**

El Dr. Jacobs es investigador principal del centro en el Abbott Vascular Stent Registry e investigador principal del centro en el Dual Antiplalet Therapy Randomized Trial del Harvard Clinical Research Institute. El Dr. Sharma ha formado parte de los paneles de conferenciantes de BSC, Abbott, DSL/Lilly y Medicine Co. El Dr. King forma parte del Comité de Eventos Clínicos de Merck. Los demás autores no declaran ningún conflicto de intereses.

**Bibliografía**


PERSPECTIVA CLÍNICA

Es poco lo que se sabe acerca de las frecuencias relativas de uso de los diferentes tratamientos que reciben los pacientes tras un diagnóstico de enfermedad arterial coronaria estable y sobre los resultados comparativos del tratamiento médico estándar (TME) frente a la intervención coronaria percutánea (ICP) junto con TME en pacientes no incluidos en ensayos controlados y aleatorizados. Por ello, entre 2003 y 2008 se llevó a cabo un seguimiento de pacientes con enfermedad arterial coronaria estable a los que se practicó un cateterismo cardíaco en el Estado de Nueva York, para determinar el tratamiento que habían recibido. Se realizó un apareamiento por propensión de pacientes tratados con TME y pacientes tratados con ICP junto con TME, a través del empleo de 20 factores que podían tener influencia en los resultados clínicos. La cohorte resultante la formaron 933 pares de pacientes equiparables, y se utilizó para comparar las tasas de mortalidad/infarto de miocardio (IM), mortalidad, IM, y revascularización posterior. La mayor parte de los pacientes (89%) fueron tratados con una ICP. Los pacientes tratados con ICP/TME presentaron unas tasas de eventos adversos significativamente inferiores a los 4 años para la mortalidad/IM (16,5% frente a 21,2%; p = 0,003), la mortalidad (10,2% frente a 14,5%; p = 0,02), el IM (8,0% frente a 11,3%; p = 0,007) y la revascularización posterior (24,1% frente a 29,1%; p = 0,005). Las razones de riesgos ajustadas para el TME/ICP fueron de 1,49 (intervalo de confianza del 95%, 1,16–1,93) para la mortalidad/IM y de 1,46 (intervalo de confianza del 95%, 1,08–1,97) para la mortalidad. No hubo diferencias en los resultados del tratamiento en los pacientes de edad < 65 años ni en los pacientes con afectación de un solo vaso. La mayor parte de los pacientes con enfermedad arterial coronaria estable de Nueva York a los que se practicó un cateterismo entre 2003 y 2008 fueron tratados con una ICP, y los pacientes en los que se realizó una ICP presentaron menores tasas de mortalidad, mortalidad/IM y revascularización. Será necesario determinar mejor las razones de estas observaciones, incluido el posible papel de la baja adherencia a la medicación que se ha observado en otros estudios.
관상동맥중재술이 안정형 협심증 환자의 사망을 줄인다

조 상호 교수 한림대학교 성심병원 순환기내과

Summary

배경
무작위 배정 연구와는 별도로 실제 임상에서 안정형 협심증 진단을 받은 환자가 어떤 치료를 시행 받는지와 약물 치료군을 관상동맥중재술(percutaneous coronary intervention, PCI)과 약물치료(routine medical treatment, RMT)를 병행하는 군과 비교한 임상 결과는 잘 알려지지 않았다.

방법 및 결과
2003-2008년까지 뉴욕주에서 안정형 협심증으로 관상동맥조영술을 시행 받은 환자의 치료 행태를 추적 관찰하였다. RMT와 RMT+PCI 환자군으로 나누어 예후에 영향을 미치는 20개 요소를 propensity matching하였다. 993쌍의 환자 코호트로 사망/심근경색, 사망, 관상동맥 재개통술을 비교하였다. 전체 안정형 협심증 환자의 89%가 RMT+PCI를 시행 받았고 이 환자들은 4년간 추적 관찰하였을 때, 사망/심근경색(16.5% vs. 21.2%; P=0.003), 사망(10.2% vs. 14.5%; P=0.02), 심근경색(8.0% vs. 11.3%; P=0.007), 관상동맥 재개통술(24.1% vs. 29.1%; P=0.005)에서 모두 의미 있게 좋은 결과를 보였다. RMT+PCI에 대한 RMT군의 보정한 사망/심근경색의 HR은 1.49(95% CI, 1.16–1.93)이었고, 사망의 HR은 1.46(95% CI, 1.08–1.97)으로 RMT군의 위험도가 높았다. 65세 이하의 환자나 단일혈관 질환의 환자인 경우에 두 군 간에 차이가 없었다.

결론
2003-2008년까지 뉴욕주에서 관상동맥조영술을 시행받은 안정형 협심증 환자 중 대부분은 관상동맥중재술을 시행 받았다. 이들은 낮은 사망, 낮은 사망/심근경색, 낮은 관상동맥 재개통률을 보였다. 다른 연구보다 낮은 약물 순응도가 결과에 영향을 미쳤을 가능성을 포함하여 그 이유에 대한 향후 연구가 더 필요하다.
Commentary

COURAGE(Clinical Outcomes Utilizing Revascularization and Aggressive Drug Evaluation) 연구가 안정형 협심증 환자에서 약물치료와 PCI 사이에 임상 예후에서 차이가 없었다고 발표한 이후, 메타분석을 비롯한 후속 연구가 이를 지지하는 데이터를 제시하고 있어서 이러한 환자군에서 PCI의 입지는 매우 좁아지게 되었다.\(^1-3\) 그러나 이러한 연구에서 약물치료와 위험인자의 철저한 관리는 실제의 임상 현실과는 동떨어진 것으로, 임상 연구에서는 약제가 무상으로 제공되었고 연구 간호사에 의해 약물 복용 및 위험인자가 관리되어서 약물의 순응도가 무려 90% 이상이었다. 따라서 실제 진료 현장에 그대로 적용하는 것은 무리가 있고, 실제에서는 약물치료와 위험 관리가 느슨할 가능성이 높으므로 실제 현장에서도 같은 결과(즉, PCI+medical therapy와 medical therapy가 동일한 결과를 보인다는 것)가 나올지에 대한 의문이 생기게 된다.

본 연구는 이 질문에 대한 답을 주는 코호트 연구로서 PCI와 RMT를 행한 군이 RMT 단독군보다 관상동맥 재개통술은 물론 전체 사망을 비롯한 hard endpoint에서 우수하였다고 보고하고 있다. 즉, 4년간의 사망은 각각 10.2%, 14.5%로 PCI+medical therapy와 medical therapy가 동일한 결과를 보인다는 것에 나름에 대한 의문이 생겨나게 된다.

또한, 본 연구는 모든 관상동맥조영술을 시행한 안정형 협심증 환자 중에서 89%가 PCI를 받고 있어서 미국도 국내와 마찬가지로 PCI를 협심증 치료법으로 널리 사용하고 있음을 보여주고 있다.

그렇다면 왜 기존의 무작위 배정 임상연구나 메타분석과 대치되는 이러한 결과가 나왔는가? 이미 언급한 대로 비교 본 연구에서 데이터가 제시되지 않았지만, RMT가 실제 임상의 치료 현장에서는 잘 이루어지지 않아서 COURAGE연구의 optimal medical management만큼의 약물치료 효과를 상대적으로 보지 못하였을 가능성에 있고, 본 연구에서 사용한 스텐트가 거의 약물용출 스텐트로서 COURAGE 연구의 단순 금속 스텐트에 비해 예후가 좋을 가능성이 있겠다(물론, 이 두 스텩트의 예후 비교에 대해서도 논란이 있다).

최근スタチン을 투여한 aspirin, clopidogrel, ARB(angiotensin receptor blocker)/ACEI(angiotensin-converting enzyme inhibitor), beta blocker 약제들은 관상동맥의 죽상경화반의 안정화는 물론 퇴축까지도 도모하고, 종국에는 환자의 생명을 연장한다는 증거들이 있는 만큼 약물치료의 역할이 PCI보다 우수할 가능성이 있는 것이다.

COURAGE 연구가 2007년에 발표되었기 때문에, 본 연구에 등록된 환자 중 대다수가 2007년이전의 환자로서 관상동맥조영술을 시행 받은 후에 약물치료 단독보다는 대개 PCI를 시행 받는데, COURAGE 발표 이후에 어떻게 진료 형태가 변했는지도 관심사이다. Propensity matched 코호트를 사용하였으나, 그 수가 비교적 적기 때문에 추가적인 임상연구 및 optimal medical management보다는 좀 더 현실과 가까운 medical management와 PCI+약물치료를 비교하는 무작위 임상시험의 나온다면 과연 PCI가 안정형 협심증에서 임상 예후 개선 효과를 보이는가에 대한 해답을 줄 수도 있을 것이라 생각한다.

References
Comparative Outcomes for Patients Who Do and Do Not Undergo Percutaneous Coronary Intervention for Stable Coronary Artery Disease in New York

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Background—Little is known about what treatments patients receive after being diagnosed with stable coronary artery disease or what the comparative outcomes are for routine medical treatment (RMT) versus percutaneous coronary intervention (PCI) with RMT for patients in a setting apart from randomized controlled trials.

Methods and Results—Patients with stable coronary artery disease undergoing cardiac catheterization in New York State between 2003 and 2008 were followed up to determine the treatment they received. Patients receiving RMT and patients receiving PCI with RMT were propensity matched through the use of 20 factors that could have a bearing on outcomes. The resulting cohort of 933 matched pairs was used to compare mortality/myocardial infarction (MI), mortality, MI, and subsequent revascularization rates. A total of 89% of all patients underwent PCI with RMT. PCI/RMT patients had significantly lower adverse outcome rates at 4 years for mortality/MI (16.5% versus 21.2%; \( P = 0.003 \)), mortality (10.2% versus 14.5%; \( P = 0.02 \)), MI (8.0% versus 13.3%; \( P = 0.007 \)), and subsequent revascularization (24.1% versus 29.1%; \( P = 0.005 \)). Adjusted RMT versus (PCI with RMT) hazard ratios were 1.49 (95% confidence interval, 1.16–1.93) for mortality/MI and 1.46 (95% confidence interval, 1.08–1.97) for mortality. There were no differences for patients \(<65\) years of age or for patients with single-vessel disease.

Conclusions—Most patients with stable coronary artery disease in New York undergoing catheterization between 2003 and 2008 received PCI. Patients who received PCI experienced lower mortality, mortality/MI, and revascularization rates. The reasons for this finding need to be better understood, including the possible role of low medication adherence rates that have been found in other studies. (Circulation. 2012;125:1870-1879.)

Key Words: comparative effectiveness research ■ coronary artery disease ■ medicine ■ coronary angioplasty

The Clinical Outcomes Utilizing Revascularization and Aggressive Drug Evaluation (COURAGE) Trial, in which patients with stable coronary artery disease (CAD) were randomly treated with either optimal medical treatment (OMT) or percutaneous coronary intervention (PCI) with OMT, reported that PCI with OMT as an initial management strategy did not reduce rates of mortality, myocardial infarction (MI), or other major cardiovascular events compared with an initial strategy of OMT alone.¹ There were small benefits of PCI compared with medical therapy in angina control that disappeared by 36 months.² The OMT was supported by training nurse-managers to counsel patients to help them achieve lifestyle and risk factor reduction goals, providing medications at no cost to patients, and following up with patients at 1, 2, 4, and 6 months and every 6 months thereafter. The resulting adherence to lifestyle and medication prescription was quite high (eg, 96% adherence to antiplatelets, 85% to \( \beta \)-blockers, 93% to statin use).³–⁶

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However, little is known about how often patients with stable CAD undergo PCI in routine medical practice or how their outcomes compare with those of patients who do not undergo PCI. The purpose of this study is to compare outcomes for PCI with routine medical treatment (RMT) versus RMT in a setting with usual care, not as part of a clinical trial that focused on ensuring/improving adherence to medications or lifestyle changes.
Methods

End Points

End points in the study were 4-year mortality, MI, readmission for MI, and subsequent revascularization.

Databases

The primary database used in the study was the New York State’s Cardiac Diagnostic Catheterization Database (CD2), a voluntary data system in New York maintained by the New York State Department of Health. For patients undergoing cardiac catheterization in New York, the database contains information on demographics, comorbidities, payer, angina type and class, stress test results, previous MI, previous revascularization procedures, ejection fraction, ongoing ischemia, vessels diseased, ejection fraction, congestive heart failure, diabetes mellitus, shock, hemodynamic instability, and area of viable myocardium at risk. Important variables that are also included are whether the patient’s anatomy was suitable for PCI or for CABG surgery and whether the patient had a noncardiac comorbidity contraindicating PCI.

Completeness of data reporting is monitored by matching CD2 to the New York acute care hospital discharge database, the Statewide Planning and Research Cooperative System (SPARCS); the Department of Health’s Ambulatory Surgery Database; and the New York PCI registry (Percutaneous Coronary Interventions Reporting System); and identifying cases reported with a diagnostic catheterization in those databases that were not reported to CD2. Hospitals are required to provide data for those missing cases. In addition, missing or invalid data elements are returned to hospitals for review and correction on an ongoing basis.

Matching CD2 with the PCI registry and SPARCS enabled us to identify those catheterization patients who underwent PCI within 30 days of the catheterization without having experienced an MI in the interim. The match between CD2 data and SPARCS was also done for 2 purposes other than ensuring completeness. First, for patients who did not undergo PCI within 30 days of catheterization, SPARCS was used to confirm that the patient identification was correct for linking with other databases. Second, SPARCS data were used to identify readmissions for MI, using acute MI (International Classification of Disease, ninth edition, clinical modification code 410.x1 as a principal diagnosis, with the fifth digit of 1 to ensure that it was the first episode of care for a newly diagnosed MI). The fourth database used in the study was the Social Security Administration Death Master File. Patient identifiers in CD2 were used to link the index catheterization to the Death Master File data to identify deaths after discharge for the purpose of identifying longer-term mortality.

Patients, Hospitals, and Outcomes

Patients in the study were New York State residents who underwent cardiac catheterization and were judged to have stable CAD. Entry criteria included being asymptomatic or having stable angina with Canadian Cardiovascular Society class I through III and at least 70% stenosis in a proximal epicardial coronary artery or its major branch. Exclusion criteria included left main coronary disease with ≥50% stenosis, life-threatening ventricular arrhythmia within a week before the procedure, concomitant valvular heart disease likely to require surgery, class IV angina, a negative or a high-risk stress test, cardiogenic shock, a recent (<21 days) acute MI, severe left ventricular dysfunction (ejection fraction <30% or ejection fraction <35% and proximal left anterior descending artery disease), revascularization within the previous 6 months, CABG surgery as the choice for revascularization, coronary anatomy not suitable for PCI (including chronic total occlusion), and a noncardiac comorbidity contraindicating PCI. The study was limited to New York State residents because the subsequent revascularization information was obtained from the PCI registry and the MI outcome was obtained from the SPARCS data.

Remaining patients were included in the study as PCI/RMT patients if they underwent PCI within a month of the index catheterization without having experienced an MI in the interim. Patients were included as RMT patients in the study if they were alive 30 days after the index catheterization without having undergone PCI or CABG surgery or suffered an MI and if they could be identified in SPARCS to ensure that they could be tracked in SPARCS and the Social Security Administration Death Master File (30 patients could not be tracked). A subsequent sensitivity analysis was conducted by defining PCI patients as the group of patients undergoing PCI in the index admission and RMT patients as the group who did not undergo PCI in the index admission. A total of 20 hospitals were represented in the database, and 18 of these hospitals were represented after propensity matching (see below). All were hospitals with Certificate of Need approval to perform cardiac catheterization, and 8 were certified to perform PCI. Outcomes of the study include 4-year mortality, mortality/MI (mortality and/or MI), MI, and subsequent revascularization.

Statistical Analyses

Because patients were not randomized to PCI/RMT versus RMT, we identified patient characteristics that were potentially related to the type of treatment selected as well as being potential predictors of adverse outcomes. We first compared the prevalences of these risk factors among PCI and RMT patients using χ² tests.

Because many of the prevalences proved to be significantly different, propensity score matching was used to identify a set of matched PCI/RMT and RMT pairs so that confounding could be reduced. Patients were matched on the basis of time interval of catheterization, age, Canadian Cardiovascular Society angina class, ejection fraction, area of viable myocardium at risk, renal failure (on dialysis or creatinine >2.5 mg/dL), extent of cardiovascular disease, primary payer, demographics, body mass index, median per capita income of the patient’s ZIP code, congestive heart failure, left ventricular function, previous MI, previous PCI >6 months previously (more recent PICIs were excluded from the study), CABG surgery >6 months previously, and a few comorbidities (cerebrovascular disease, peripheral vascular disease, diabetes mellitus). The propensity score was derived by using a logistic regression model to predict the probability of undergoing PCI with RMT rather than RMT alone for each patient as a function of the risk factors just noted.

A global optimization matching algorithm (one that picks pairs of RMT and PCI/RMT patients so that the sum of distances between the propensity scores of the paired patients is minimized) was used, with matching allowed only if the difference in the logits of the matched propensity scores was <0.6 times the SDs of the scores. Matching was on a 1:1 basis; each matched pair was unique; and data for unmatched patients were not used in subsequent analyses. The balance between patient characteristics in the paired groups was tested by computing the standardized differences between the 2 groups (RMT and PCI/ RMT) for each of the matched characteristics. A difference <0.1 (10%) was regarded as acceptable.11

The propensity-matched pairs were then used to analyze differences in outcomes between the 2 groups. Methods were used to compare RMT and PCI/RMT for a 4-year follow-up period for each of the outcomes by use of Kaplan Meier survival curves with Klein and Moeschberger tests in view of the fact that the samples were censored.

After the proportional hazards assumption was confirmed to be valid, Cox proportional hazards models were fit to the matched pairs to adjust for any remaining differences in patient characteristics, and adjusted RMT/PCI with RMT hazard ratios were obtained for each of the adverse outcomes.

The impact of treatment type on mortality/MI for a few preselected risk factor subgroups of interest (age, extent of CAD, angina class, and area of viable myocardium at risk) was also tested to determine whether the differential in outcomes for PCI and RMT differed according to these preselected risk factors and if there was...
Table 1. Baseline Characteristics of Stable Coronary Artery Disease Patients Undergoing Diagnostic Coronary Catheterization Before Propensity Matching, New York, September 2003 to December 2008*

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>All Patients  (n=9586)</th>
<th>RMT  (n=1100, 11%)</th>
<th>PCI  (n=8486, 89%)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year of the index catheterization, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2003–2004</td>
<td>20.54</td>
<td>25.82</td>
<td>19.86</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>2005–2006</td>
<td>37.13</td>
<td>31.91</td>
<td>37.80</td>
<td></td>
</tr>
<tr>
<td>2007–2008</td>
<td>42.33</td>
<td>42.27</td>
<td>42.34</td>
<td></td>
</tr>
<tr>
<td>Age, mean (SD), y</td>
<td>65.1 (11.0)</td>
<td>67.9 (10.9)</td>
<td>64.9 (10.9)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Age categories, %</td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>≤65 y</td>
<td>46.58</td>
<td>40.73</td>
<td>47.34</td>
<td></td>
</tr>
<tr>
<td>65–74 y</td>
<td>31.62</td>
<td>31.00</td>
<td>31.70</td>
<td></td>
</tr>
<tr>
<td>75–84 y</td>
<td>19.09</td>
<td>23.64</td>
<td>18.50</td>
<td></td>
</tr>
<tr>
<td>≥85 y</td>
<td>2.71</td>
<td>4.64</td>
<td>2.46</td>
<td></td>
</tr>
<tr>
<td>Female, %</td>
<td>34.08</td>
<td>35.09</td>
<td>33.95</td>
<td>0.45</td>
</tr>
<tr>
<td>Race, %</td>
<td></td>
<td></td>
<td></td>
<td>0.04</td>
</tr>
<tr>
<td>White</td>
<td>70.61</td>
<td>67.45</td>
<td>71.02</td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>15.70</td>
<td>18.00</td>
<td>15.40</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>13.69</td>
<td>14.55</td>
<td>13.58</td>
<td></td>
</tr>
<tr>
<td>BMI, mean (SD), kg/m²</td>
<td>30.05 (6.10)</td>
<td>29.81 (6.27)</td>
<td>30.08 (6.08)</td>
<td>0.17</td>
</tr>
<tr>
<td>BMI categories, %</td>
<td></td>
<td></td>
<td></td>
<td>0.02</td>
</tr>
<tr>
<td>≤18 kg/m²</td>
<td>0.58</td>
<td>1.18</td>
<td>0.51</td>
<td></td>
</tr>
<tr>
<td>19–40 kg/m²</td>
<td>92.68</td>
<td>92.73</td>
<td>92.67</td>
<td></td>
</tr>
<tr>
<td>&gt;40 kg/m²</td>
<td>6.74</td>
<td>6.09</td>
<td>6.62</td>
<td></td>
</tr>
<tr>
<td>Socioeconomic status, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low income (lower third ZIP code median income)</td>
<td>31.97</td>
<td>31.18</td>
<td>32.08</td>
<td>0.55</td>
</tr>
<tr>
<td>Medium or high income</td>
<td>68.03</td>
<td>68.82</td>
<td>67.92</td>
<td></td>
</tr>
<tr>
<td>Primary payer, %</td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Private</td>
<td>43.41</td>
<td>36.45</td>
<td>44.31</td>
<td></td>
</tr>
<tr>
<td>Medicare</td>
<td>44.47</td>
<td>47.36</td>
<td>44.10</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>12.12</td>
<td>16.18</td>
<td>11.60</td>
<td></td>
</tr>
<tr>
<td>Stress test results, %</td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Stress test result unknown</td>
<td>34.77</td>
<td>39.36</td>
<td>34.19</td>
<td></td>
</tr>
<tr>
<td>Positive stress test</td>
<td>65.22</td>
<td>60.64</td>
<td>65.81</td>
<td></td>
</tr>
<tr>
<td>Area of viable myocardium, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>11.08</td>
<td>31.00</td>
<td>8.50</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Medium or Large</td>
<td>88.92</td>
<td>69.00</td>
<td>91.50</td>
<td></td>
</tr>
<tr>
<td>Extent of coronary artery disease, %</td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>1 Vessel without proximal LAD</td>
<td>59.27</td>
<td>62.55</td>
<td>58.85</td>
<td></td>
</tr>
<tr>
<td>1 Vessel with proximal LAD</td>
<td>10.74</td>
<td>6.64</td>
<td>11.28</td>
<td></td>
</tr>
<tr>
<td>2 Vessels without proximal LAD</td>
<td>25.53</td>
<td>25.55</td>
<td>25.52</td>
<td></td>
</tr>
<tr>
<td>2 Vessels with proximal LAD/3 vessels</td>
<td>4.46</td>
<td>5.27</td>
<td>4.35</td>
<td></td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>5.45</td>
<td>9.55</td>
<td>4.91</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Left ventricular ejection fraction, %</td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Missing</td>
<td>5.65</td>
<td>8.18</td>
<td>5.33</td>
<td></td>
</tr>
<tr>
<td>30%–39%</td>
<td>4.06</td>
<td>8.18</td>
<td>3.52</td>
<td></td>
</tr>
<tr>
<td>40%–49%</td>
<td>9.97</td>
<td>13.27</td>
<td>9.55</td>
<td></td>
</tr>
<tr>
<td>≥50%</td>
<td>80.32</td>
<td>70.36</td>
<td>81.60</td>
<td></td>
</tr>
</tbody>
</table>

(Continued)
Results

Characteristics of Patients and Providers Before Propensity Score Matching
The median follow-up time was 2.87 years (2.94 years for PCI/RMT patients, 2.81 years for RMT patients). Of the 9586 total patients, 8486 (88.5%) underwent PCI and 196 (2.0%) underwent CABG surgery. The PCI percentage did not change substantially before and after the COURAGE trial findings (88.4% before 2008, 88.7% after 2008). As indicated in Table 1, PCI/RMT patients were younger, were more likely to be white, and were more likely to have private health insurance, a positive stress test, a medium or large area of viable myocardium at risk, proximal left anterior descending artery disease and 3-vessel disease, class III angina, and a higher ejection fraction. PCI/RMT patients were less likely to have peripheral vascular disease or previous cardiac surgery. For patients undergoing PCI, 91% of the patients had 1 vessel attempted and 9% had 2 vessels attempted. In addition, 72% had 1 lesion attempted and 23% had 2 lesions attempted. A total of 71% had 1 stent placed and 20% had 2 stents placed. Most patients had drug-eluting stents (71%) or bare metal stents (24%); only 5% of patients did not receive a stent.

After Propensity Score Matching
The process of propensity score matching resulted in being able to match 933 (84.8%) of the medical therapy patients to a very similar PCI/RMT patient. There were no significant differences between the 2 groups in any of the characteristics examined. As Table 2 demonstrates, the characteristics of the matched pairs were extremely similar, with only one of the standardized differences exceeding 10%. After matching, a total of 18 of the 20 hospitals in the database were included. Matched patients underwent PCIs in a total of 27 hospitals by 120 cardiologists.

Table 1. Continued

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>All Patients (n=9586)</th>
<th>RMT (n=1100, 11%)</th>
<th>PCI (n=8486, 89%)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCS angina class, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>13.03</td>
<td>23.91</td>
<td>11.62</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>16.25</td>
<td>20.09</td>
<td>15.76</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>33.77</td>
<td>33.45</td>
<td>33.81</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>36.95</td>
<td>22.55</td>
<td>38.82</td>
<td></td>
</tr>
<tr>
<td>Previous MI (≥21 d), %</td>
<td>13.38</td>
<td>14.91</td>
<td>13.19</td>
<td>0.11</td>
</tr>
<tr>
<td>Cerebrovascular disease, %</td>
<td>6.12</td>
<td>7.36</td>
<td>5.96</td>
<td>0.07</td>
</tr>
<tr>
<td>Peripheral vascular disease, %</td>
<td>7.45</td>
<td>11.36</td>
<td>6.94</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Diabetes mellitus, %</td>
<td>32.71</td>
<td>34.73</td>
<td>32.45</td>
<td>0.13</td>
</tr>
<tr>
<td>Renal failure, %</td>
<td>1.38</td>
<td>2.27</td>
<td>1.26</td>
<td>0.01</td>
</tr>
<tr>
<td>Previous PCI, %</td>
<td>25.05</td>
<td>23.18</td>
<td>25.29</td>
<td>0.13</td>
</tr>
<tr>
<td>Previous open heart surgery, %</td>
<td>13.00</td>
<td>18.18</td>
<td>12.33</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

RMT indicates routine medical treatment; PCI, percutaneous coronary intervention; BMI, body mass index; LAD, left anterior descending artery; CCS, Canadian Cardiovascular Society; and MI, myocardial infarction.

*For categorical variables, the numbers presented in each subcategory are percentages of the entire category.

Adverse Outcome Rates
Table 3 and the Figure present adverse outcome rates for mortality/MI, mortality, and MI for RMT and PCI/RMT for propensity-matched patients. At 4 years, PCI/RMT patients had lower mortality/MI rate (16.5% versus 21.2%; P=0.003), lower mortality rate (10.2% versus 14.5%; P=0.02), a lower MI rate (8.0% versus 11.3%; P=0.007), and lower subsequent revascularization rate (24.1% versus 29.1%; P=0.005). The previous data include planned staged PCI procedures in the PCI/RMT group. On the basis of staging data available only in the last 2 years of the study that were extrapolated to all years, the subsequent revascularization rate for unstaged PCI/RMT patients is estimated to be 19.7%.

Adjusted hazard ratios representing the relative outcomes across the entire follow-up period were also significant in favor of PCI with RMT versus RMT alone, with ratios ranging from 1.39 to 1.56. For the subset of 789 matched pairs in whom PCI patients were defined as patients undergoing PCI in the index admission and RMT patients were patients who did not undergo PCI in the index admission or within 30 days, the RMT versus PCI with propensity outcomes were as follows: 20.5% versus 15.4% (P=0.01; adjusted hazard ratio=1.47; 95% confidence interval, 1.10–1.95) for mortality/MI; 13.5% versus 10.1% (P=0.01; adjusted hazard ratio=1.37; 95% confidence interval, 1.01–1.85) for mortality; 10.9% versus 7.1% (P=0.01; adjusted hazard ratio=1.73; 95% confidence interval, 1.15–
Table 2. Baseline Characteristics of Stable Coronary Artery Disease Patients Undergoing Diagnostic Coronary Catheterization After Propensity Matching, New York, September 2003 to December 2008*

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>All Patients (n=1866)</th>
<th>Routine RMT (n=933)</th>
<th>PCI (n=933)</th>
<th>P</th>
<th>Standardized Difference, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year of the index catheterization, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2003–2004</td>
<td>24.76</td>
<td>24.76</td>
<td>24.76</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>2005–2006</td>
<td>33.55</td>
<td>33.55</td>
<td>33.55</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>2007–2008</td>
<td>41.69</td>
<td>41.69</td>
<td>41.69</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Age, mean (SD), y</td>
<td>66.4 (11.2)</td>
<td>66.6 (11.1)</td>
<td>66.3 (11.2)</td>
<td>0.52</td>
<td>8.98</td>
</tr>
<tr>
<td>Age categories, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤65 y</td>
<td>42.98</td>
<td>42.98</td>
<td>42.98</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>65–74 y</td>
<td>30.33</td>
<td>30.33</td>
<td>30.33</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>75–84 y</td>
<td>22.51</td>
<td>22.72</td>
<td>22.29</td>
<td>0.82</td>
<td>1.03</td>
</tr>
<tr>
<td>≥85 y</td>
<td>4.18</td>
<td>3.97</td>
<td>4.39</td>
<td>0.64</td>
<td>2.14</td>
</tr>
<tr>
<td>Female, %</td>
<td>34.41</td>
<td>34.41</td>
<td>34.41</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Race, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>68.49</td>
<td>67.20</td>
<td>69.77</td>
<td>0.23</td>
<td>5.54</td>
</tr>
<tr>
<td>Black</td>
<td>18.06</td>
<td>17.90</td>
<td>18.22</td>
<td>0.86</td>
<td>0.84</td>
</tr>
<tr>
<td>Other</td>
<td>13.45</td>
<td>14.90</td>
<td>12.00</td>
<td>0.07</td>
<td>8.49</td>
</tr>
<tr>
<td>BMI, mean (SD), kg/m²</td>
<td>29.83 (6.14)</td>
<td>29.92 (6.23)</td>
<td>29.72 (6.06)</td>
<td>0.43</td>
<td>8.06</td>
</tr>
<tr>
<td>BMI categories, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤18 kg/m²</td>
<td>0.91</td>
<td>1.07</td>
<td>0.75</td>
<td>0.46</td>
<td>3.38</td>
</tr>
<tr>
<td>19–40 kg/m²</td>
<td>92.93</td>
<td>92.82</td>
<td>93.03</td>
<td>0.86</td>
<td>0.83</td>
</tr>
<tr>
<td>&gt;40 kg/m²</td>
<td>6.16</td>
<td>6.11</td>
<td>6.22</td>
<td>0.92</td>
<td>0.45</td>
</tr>
<tr>
<td>Socioeconomic status, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low income (lower third)</td>
<td>32.26</td>
<td>31.08</td>
<td>33.44</td>
<td>0.28</td>
<td>5.05</td>
</tr>
<tr>
<td>Medium or high income</td>
<td>67.74</td>
<td>68.92</td>
<td>66.56</td>
<td>0.28</td>
<td>5.05</td>
</tr>
<tr>
<td>Primary payer, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private</td>
<td>37.62</td>
<td>37.62</td>
<td>37.62</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Medicare</td>
<td>47.27</td>
<td>47.27</td>
<td>47.27</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Other</td>
<td>15.11</td>
<td>15.11</td>
<td>15.11</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Stress test results, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stress test result unknown</td>
<td>37.35</td>
<td>38.16</td>
<td>36.55</td>
<td>0.47</td>
<td>3.32</td>
</tr>
<tr>
<td>Positive stress test</td>
<td>62.65</td>
<td>61.84</td>
<td>63.45</td>
<td>0.47</td>
<td>3.32</td>
</tr>
<tr>
<td>Area of viable myocardium, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>23.47</td>
<td>23.47</td>
<td>23.47</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Medium or large</td>
<td>66.53</td>
<td>66.53</td>
<td>66.53</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Extent of coronary artery disease, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Vessel without proximal LAD</td>
<td>62.33</td>
<td>61.09</td>
<td>63.56</td>
<td>0.27</td>
<td>5.09</td>
</tr>
<tr>
<td>1 Vessel with proximal LAD</td>
<td>7.18</td>
<td>6.86</td>
<td>7.50</td>
<td>0.59</td>
<td>2.49</td>
</tr>
<tr>
<td>2 Vessels without proximal LAD</td>
<td>26.42</td>
<td>27.97</td>
<td>24.87</td>
<td>0.13</td>
<td>7.05</td>
</tr>
<tr>
<td>2 Vessels with proximal LAD/3 vessels</td>
<td>4.07</td>
<td>4.07</td>
<td>4.07</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Congestive heart failure, %</td>
<td>7.61</td>
<td>8.36</td>
<td>6.86</td>
<td>0.22</td>
<td>5.66</td>
</tr>
<tr>
<td>Left ventricular ejection fraction, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Missing</td>
<td>6.22</td>
<td>6.22</td>
<td>6.22</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>30%–39%</td>
<td>6.11</td>
<td>6.11</td>
<td>6.11</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>40%–49%</td>
<td>11.58</td>
<td>12.43</td>
<td>10.72</td>
<td>0.25</td>
<td>5.36</td>
</tr>
<tr>
<td>≥50%</td>
<td>76.10</td>
<td>75.24</td>
<td>76.97</td>
<td>0.39</td>
<td>4.02</td>
</tr>
</tbody>
</table>

(Continued)
Table 2. Continued

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>All Patients (n=1866)</th>
<th>Routine RMT (n=933)</th>
<th>PCI (n=933)</th>
<th>P</th>
<th>Standardized Difference, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCS angina class, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>19.56</td>
<td>21.65</td>
<td>17.47</td>
<td>0.02</td>
<td>10.55</td>
</tr>
<tr>
<td>I</td>
<td>21.91</td>
<td>19.93</td>
<td>23.90</td>
<td>0.04</td>
<td>9.59</td>
</tr>
<tr>
<td>II</td>
<td>34.83</td>
<td>34.73</td>
<td>34.94</td>
<td>0.93</td>
<td>0.45</td>
</tr>
<tr>
<td>III</td>
<td>23.69</td>
<td>23.69</td>
<td>23.69</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Previous MI (≥21 d), %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.08</td>
<td>12.75</td>
<td>13.40</td>
<td>0.68</td>
<td>1.91</td>
<td></td>
</tr>
<tr>
<td>Cerebrovascular disease</td>
<td>6.97</td>
<td>6.97</td>
<td>6.97</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Peripheral vascular disease, %</td>
<td>9.43</td>
<td>9.75</td>
<td>9.11</td>
<td>0.63</td>
<td>2.20</td>
</tr>
<tr>
<td>Diabetes mellitus, %</td>
<td>35.74</td>
<td>35.05</td>
<td>36.44</td>
<td>0.53</td>
<td>2.91</td>
</tr>
<tr>
<td>Renal failure, %</td>
<td>0.96</td>
<td>0.96</td>
<td>0.96</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Previous PCI, %</td>
<td>22.29</td>
<td>22.29</td>
<td>22.29</td>
<td>1.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Previous open heart surgery, %</td>
<td>16.88</td>
<td>16.08</td>
<td>17.68</td>
<td>0.35</td>
<td>4.29</td>
</tr>
</tbody>
</table>

RMT indicates routine medical treatment; PCI, percutaneous coronary intervention; BMI, body mass index; LAD, left anterior descending artery; CCS, Canadian Cardiovascular Society; and MI, myocardial infarction.

Adverse Outcome Rates for Patient Subgroups
Table 4 shows that across all subgroups of patients except age <65 years, the adjusted hazard ratios were >1, indicating higher mortality for RMT. Only 1 interaction term (the interaction between age and treatment type) was significant, indicating that the impact of treatment type on mortality might depend on age, with the benefit of PCI relative to RMT being significantly higher for patients ≥65 years of age than for patients <65 years of age.

Discussion
Although the COURAGE trial compared outcomes for patients with stable CAD undergoing PCI and medical therapy, it is not well known how often these patients undergo PCI in routine medical practice or what the outcomes are with and without PCI. Our study found that in a population-based study in New York of patients with stable CAD undergoing cardiac catheterization, nearly 90% of these patients underwent PCI. This percentage did not change even in 2008, well after the COURAGE results had been published. In addition, the propensity-matched patients who underwent PCI experienced significantly lower mortality, mortality/MI, and revascularization rates than the patients who did not undergo PCI.

Our outcomes rates for mortality/MI at 4 years were 16.5% for PCI/RMT and 21.2% for RMT compared with 19.0% and 18.5% for the COURAGE trial at 4.6 years. Our mortality rates at 4 years were 10.2% for PCI/RMT and 14.5% for RMT compared with 7.6% for PCI/OMT and 8.3% for OMT in COURAGE at 4.6 years. Although our RMT and PCI/RMT rates both were higher than the COURAGE rates, we hypothesize that our PCI/RMT rates were more similar to the COURAGE rates because drug-eluting stents were used in 74% of the patients in our study compared with all bare metal stents in COURAGE, and drug-eluting stents have been shown to be associated with lower mortality rates than bare metal stents in observational studies, although not in randomized controlled trials. Two possible reasons why the RMT outcome rates in our study were higher than in COURAGE

Table 3. Four-Year Adverse Outcomes for Propensity-Matched Percutaneous Coronary Intervention and Medical Treatment Patients

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>RMT</th>
<th>PCI</th>
<th>Event Rate, %†</th>
<th>Cases, n</th>
<th>Event Rate, %†</th>
<th>Cases, n</th>
<th>Difference, %</th>
<th>P‡</th>
<th>RMT/(PCI With RMT) Adjusted Hazard Ratio*</th>
<th>P</th>
<th>Unadjusted Hazard Ratio*</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality/MI</td>
<td>21.15</td>
<td>269</td>
<td>16.46</td>
<td>293</td>
<td>23.90</td>
<td>0.03</td>
<td>1.49</td>
<td>0.002</td>
<td>1.50</td>
<td>0.002</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mortality</td>
<td>14.53</td>
<td>292</td>
<td>10.15</td>
<td>310</td>
<td>14.66</td>
<td>0.2</td>
<td>1.46</td>
<td>0.02</td>
<td>1.47</td>
<td>0.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Readmission for acute MI</td>
<td>11.33</td>
<td>298</td>
<td>8.02</td>
<td>332</td>
<td>4.38</td>
<td>0.02</td>
<td>1.56</td>
<td>0.01</td>
<td>1.57</td>
<td>0.008</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subsequent revascularization</td>
<td>29.12</td>
<td>215</td>
<td>24.05</td>
<td>255</td>
<td>5.07</td>
<td>0.005</td>
<td>1.39</td>
<td>0.003</td>
<td>1.35</td>
<td>0.004</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RMT indicates routine medical treatment; PCI, percutaneous coronary intervention; and MI, myocardial infarction.

*Adjusted and unadjusted hazard ratios are derived from models with complete follow-up.

†Rates are Kaplan-Meier estimates.

‡P values are derived from the Klein and Moeschberger test.
are that our RMT population was significantly less selected (and therefore at a higher risk) and that patients had RMT instead of OMT.

A few factors may contribute to our findings. First, the observational nature of this study means that it is subject to selection bias, whereby the results are driven by differences among the patient populations rather than relative effectiveness of the treatments. Indeed, RMT patients appeared to be at higher risk than their PCI/RMT counterparts in the full study sample. We propensity matched patients based on numerous risk factors related to demographics, socioeconomics, payer, extent of CAD, stress test results, area of viable myocardium at risk, ventricular function, angina class, and comorbidities in an attempt to minimize this bias. In addition, all patients in the study were candidates for PCI. As a result, the subset of propensity-matched patients used in the study looked extremely similar with respect to those risk factors. Furthermore, the design of the study was such that any patients who died or experienced an MI within 30 days of the index catheterization without undergoing PCI were removed from the study rather than being placed in the RMT group in case they might have been assigned to PCI within 30 days. This was done despite the fact that 95% of the patients undergoing PCI received it within 1 week and 98% received it within 2 weeks. Nevertheless, unmeasured factors such as lesion characteristics, bleeding risk, and some noncardiac comorbidities (eg, cancer) and the possible differential use of appropriate medications could have biased the outcomes of the study in favor of PCI/RMT. The risk of unmeasured confounders is also enhanced by virtue of the large proportion of patients in the study who underwent PCI. We had no information on why the decision was made to refer each patient for PCI, and once the coronary anatomy is known, there is a bias toward revascularization.

However, it is also true that patients in the COURAGE trial constituted a highly select population willing to be randomized after angiography. Certainly, many high-risk patients were excluded, which contributed to the lower mortality rate in COURAGE. Thus, the fact that our study represents a real-world experience at least partially offsets the limitation of the lack of natural randomization.

Another limitation is that, because we used SPARCS to track readmissions for MI and New York State registries to
track subsequent CABG and target vessel PCI, we restricted the study to New York State patients. However, if patients moved outside the state after discharge and were admitted for MI or underwent revascularization out of state, these events would have been missed by our study. Moreover, the study would miss New York State patients who underwent a repeat revascularization out of state. We do not believe there is a good reason why there would be a bias in favor of PCI/RMT with respect to missed patients, and an earlier study demonstrated that there was not a bias in this regard.\textsuperscript{14}

The extent to which lesser use of OMT in our study compared with COURAGE explains some of the differences in the study results deserves further investigation. The nature of the medical therapy provided to the RMT patients in our study is completely unknown, and undoubtedly many RMT patients received nonoptimal treatment. Several studies have shown that medication adherence is generally poor,\textsuperscript{15–21} and several other studies have shown that adherence strongly affects outcomes.\textsuperscript{17,19,22–26} In addition, studies from the COURAGE group demonstrate that adherence to both suggested lifestyle changes and medications was excellent in their trial.\textsuperscript{2,3} The combination of these facts suggests that although OMT is as effective as PCI/OMT for patients with stable CAD in a tightly controlled trial with excellent adherence, different results might occur in real-world situations. As noted by Ho et al,\textsuperscript{20} there are multifactorial reasons for poor adherence, including challenges presented by the health system (eg, patient-provider relationship, access problems), patient condition (eg, depression, cognitive impairment, psychological problems), therapy (eg, side effects, complex regimen), and socioeconomic problems (eg, low literacy, no or inadequate insurance).

Thus, the key findings of the study are that, with standard medical care, the vast majority of catheterization patients in New York between 2003 and 2008 were treated with PCI rather than by medical therapy alone and that patients with stable CAD treated with PCI had improved outcomes compared with patients who did not undergo PCI. The reasons for these findings need to be better understood, including the role of the inability to achieve OMT in routine medical practice. A randomized controlled trial in which patients are randomized...
Table 4. Mortality/Myocardial Infarction Rates for Medical Treatment and Percutaneous Coronary Intervention for Subgroups of Propensity-Matched Groups

<table>
<thead>
<tr>
<th>Baseline Characteristics</th>
<th>Matched Pairs, n</th>
<th>4-Year Event Rate,%</th>
<th>RMT/PCI With RMT Interaction RMT/(PCI) Adjusted Hazard Ratio (95% CI)</th>
<th>P for Interaction*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;65</td>
<td>401</td>
<td>10.95</td>
<td>14.55</td>
<td>1.00</td>
</tr>
<tr>
<td>≥65</td>
<td>532</td>
<td>29.24</td>
<td>23.9</td>
<td>1.78</td>
</tr>
<tr>
<td>Extent of CAD</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single-vessel disease</td>
<td>496</td>
<td>19.09</td>
<td>15.43</td>
<td>1.36</td>
</tr>
<tr>
<td>Multivessel disease</td>
<td>132</td>
<td>27.14</td>
<td>18.81</td>
<td>2.25</td>
</tr>
<tr>
<td>Angina class</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0, I, II, III</td>
<td>712</td>
<td>20.28</td>
<td>16.62</td>
<td>1.48</td>
</tr>
<tr>
<td>65</td>
<td>221</td>
<td>23.72</td>
<td>15.85</td>
<td>1.54</td>
</tr>
<tr>
<td>Area of viable myocardium at risk</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>219</td>
<td>15.47</td>
<td>13.31</td>
<td>1.17</td>
</tr>
<tr>
<td>Medium or large</td>
<td>714</td>
<td>23.07</td>
<td>17.51</td>
<td>1.57</td>
</tr>
</tbody>
</table>

RMT indicates routine medical treatment; PCI, percutaneous coronary intervention; CI, confidence interval; and CAD, coronary artery disease. *P for interaction values are derived from models with complete follow-up. P values are derived from the Klein and Moeschberger test.12

to PCI and MT without efforts to guarantee OMT would serve as a definitive test of how patients in routine medical practice fare with each of the interventions.

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Disclosures

Dr Jacobs serves as a site principal investigator for the Abbott Vascular Stent Registry and as a site principal investigator for Harvard Clinical Research Institute’s Dual Antiplatelet Therapy Randomized Trial. Dr Sharma served on speakers’ bureaus for BSC, Abbott, DSI/Lilly, and the Medicine Co. Dr King serves on Merck’s Clinical Events Committee. The other authors report no conflicts.

References

Little is known about the relative frequencies of different treatments that patients receive after being diagnosed with stable coronary artery disease and what the comparative outcomes are for routine medical treatment (RMT) versus percutaneous coronary intervention (PCI) with RMT for patients not in randomized controlled trials. Consequently, patients with stable coronary artery disease undergoing cardiac catheterization in New York State between 2003 and 2008 were followed up to determine the treatment they received. Patients receiving RMT and patients receiving PCI with RMT were propensity matched through the use of 20 factors that could have a bearing on outcomes. The resulting cohort of 933 matched pairs was used to compare mortality/myocardial infarction (MI), mortality, MI, and subsequent revascularization rates. Most of the patients (89%) underwent PCI. PCI/RMT patients had significantly lower adverse outcome rates at 4 years for mortality/MI (16.5% versus 21.2%; \( P = 0.003 \)), mortality (10.2% versus 14.5%; \( P = 0.02 \)), MI (8.0% versus 11.3%; \( P = 0.007 \)), and subsequent revascularization (24.1% versus 29.1%; \( P = 0.005 \)). Adjusted RMT/PCI hazard ratios were 1.49 (95% confidence interval, 1.16–1.93) for mortality/MI and 1.46 (95% confidence interval, 1.08–1.97) for mortality. There were no differences in treatment outcomes for patients <65 years of age or for patients with single-vessel disease. Most patients with stable coronary artery disease in New York undergoing catheterization between 2003 and 2008 received PCI, and those patients who received PCI experienced lower mortality, mortality/MI, and revascularization rates. The reasons for this finding need to be better understood, including the possible role of low medication adherence rates that have been found in other studies.