Effectiveness of Thrombolytic Therapy for Acute Myocardial Infarction in the Elderly

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Accessibility
Effectiveness of Thrombolytic Therapy for Acute Myocardial Infarction in the Elderly

Cause for Concern in the Old-Old

Stephen B. Soumerai, ScD; Thomas J. McLaughlin, ScD; Dennis Ross-Degnan, ScD; Cindy L. Christiansen, PhD; Jerry H. Gurwitz, MD

Background: National guidelines have encouraged increased use of thrombolytic therapy for elderly patients with acute myocardial infarction (AMI). However, evidence supporting thrombolytic therapy in patients 75 years and older is lacking. In a retrospective cohort study of 2659 elderly AMI patients, we determined the association between thrombolytic use and in-hospital mortality by age and among patients with or without absolute or relative contraindications to thrombolytic treatment.

Methods: We abstracted the medical records of 2659 elderly patients admitted with AMI at 37 Minnesota community hospitals between 1992 and 1996. The main outcome measure was in-hospital mortality, controlling for demographic, clinical, comorbidity, and severity-of-illness variables.

Results: Sixty-three percent of 719 eligible patients received thrombolytic therapy. Twenty-seven percent of thrombolytic recipients had absolute contraindications to treatment. Patients receiving thrombolytic agents had fewer and less severe comorbidities than those not receiving thrombolytic therapy. There was a 4% increase in the odds of death for every 1-year increase in age for all thrombolytic recipients vs nonrecipients (odds ratio [OR], 1.04 per year; 95% confidence interval [CI], 1.01-1.08; P=.03). Among patients with 1 or more contraindication, the OR for death associated with thrombolytic use was 1.57 (95% CI, 1.03-2.40; P=.04). The adjusted odds of death among eligible thrombolytic recipients (vs nonrecipients) increased significantly with age (OR, 1.08 per year; 95% CI, 1.02-1.14; P=.008). Among eligible patients aged 80 to 90 years, the predicted odds of death among thrombolytic recipients vs nonrecipients was 1.4. Among eligible patients younger than 80 years, thrombolytic use was associated with reduced mortality.

Conclusions: Our findings suggest the need for more research on the effectiveness of thrombolytic therapy for AMI patients 75 years and older and for more careful selection of elderly patients for this treatment.

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Author affiliations are listed at the end of this article.
SUBJECTS AND METHODS

STUDY SAMPLE

The data for this study were drawn from medical records for a previous study of patients admitted with AMI to 37 Minnesota hospitals during the periods October 1, 1992, to July 31, 1993, and July 1, 1995, to April 30, 1996 (before and after an educational intervention that did not affect thrombolytic use).14,17,18,21 The study hospitals represented more than 80% of all community hospital beds and more than half of all AMI cases statewide. Only 2 of the hospitals were academic centers, 17 were in rural communities, 19 had fewer than 100 beds, and 2 had more than 300 beds.

The study population consisted of all elderly patients (≥65 years) who were admitted with a diagnosis of AMI or suspected AMI and met at least 2 of the following criteria: (1) clinical symptoms typical of AMI (chest pain, arm or shoulder pain, diaphoresis, dyspnea, nausea or vomiting, or neck and/or jaw pain); (2) explicit medical record documentation by a physician that electrocardiographic findings were considered compatible with AMI (ie, new Q wave or ST segment depression or elevation ≥1 mm); and (3) elevated serum creatine kinase and MB fractions.14,24 Patients were excluded if they died before admission, were transferred from a nonstudy hospital, or had an AMI in the previous 2 weeks. We also excluded 229 patients who received a revascularization procedure within 12 hours of admission, leaving a total study sample of 2659.

DATA COLLECTION

As previously described,14,17,18,24 trained nurses abstracted detailed medical record data on selected clinical variables, including AMI inclusion and exclusion criteria; medical history; admission data, including time to presentation; clinical and electrocardiographic findings at presentation and during the first 24 hours of hospitalization, and comorbidities at admission (based on the Greenfield Index of Coexistent Disease)25; indications and absolute or relative contraindications to thrombolytic therapy at presentation to the hospital, based on national evidence-based guidelines (Table 1);26, drugs administered in the first 48 hours, including during emergency transport and in the emergency department; time from hospital presentation to thrombolytic administration; complications during the first 72 hours, including significant bleeding (requiring a blood transfusion or other procedure) and hemorrhagic stroke; and whether discharged alive. Abstractors were required to demonstrate ongoing interrater agreement of 95% or higher with the criterion reviewer. The reviewers audited random samples of 10% of each abstractor’s completed cases to ensure that this standard was met. In addition, the interpretations of electrocardiographic findings in the medical record correlated highly with the interpretations of 2 cardiologists.24

As described in other studies,14,17,18,24 we determined eligibility for thrombolytic therapy based on the 1990 American College of Cardiology/American Heart Association guidelines20 in effect during the observation period. Eligible patients were defined as having all indications for treatment and no absolute or relative contraindications (Table 1). All other patients had 1 or more absolute or relative contraindications.

RESULTS

CHARACTERISTICS OF SAMPLE AND USE OF THROMBOLYTIC THERAPY

Of the 2659 elderly patients who met study criteria, 735 patients (27.6%) received thrombolytic therapy. In general, patients receiving thrombolytic therapy had fewer comorbidities and risk factors than patients who did not receive a thrombolytic (Table 2). Patients who did not receive thrombolytic therapy were significantly more likely to have medical histories of previous AMI, angina, revascularization procedures, previous stroke, diabetes, and hypertension. Patients who did not receive thrombolytic therapy were almost twice as likely to have heart failure or pulmonary edema (31.5%) and a severe comorbidity (36.1%) at admission compared with thrombolytic recipients. Thrombolytic recipients were more likely to exhibit ST elevation and to have experienced anterior myocardial infarction. As expected, more than twice as many patients who did not receive thrombolytic therapy presented to the hospital more than 6 hours after symptoms (42.0% vs 13.8% for thrombolytic recipients).

Thrombolytic therapy recipients were significantly more likely than nonrecipients to have received aspirin...
PATIENT OUTCOMES
AND INDEPENDENT VARIABLES

Our primary outcome of interest was short-term mortality, measured as death due to any cause during the AMI hospitalization. Demographic variables included age and female sex, which are associated with lower short-term survival after AMI\(^2\) and reduced rates of thrombolytic use,\(^3,\)\(^4\) and race. We included relevant medical history variables, time to presentation, and clinical characteristics at admission (Table 1), which might predict AMI outcomes.\(^2\) Also, we included variables identifying anterior location of myocardial infarction (presence of a mild, moderate, or severe comorbidity based on the Greenfield Index of Coexistent Disease),\(^2\) both of which are associated with poorer AMI outcomes.\(^1\)

In addition, we included variables identifying patients receiving selected treatments during the first day of hospitalization (aspirin, \(\beta\)-blockers, and angiotensin-converting enzyme inhibitors) and several provider characteristics that could influence thrombolytic use or survival, such as the number of AMIs treated at the hospital\(^2\) and availability of cardiac catheterization.

STATISTICAL ANALYSIS

First, we compared the baseline demographic and clinical characteristics, time to presentation, medical histories, drug management in the first 24 hours, and provider characteristics of thrombolytic recipients vs nonrecipients using \(\chi^2\) statistics. Next, we conducted simple univariate comparisons of mortality among thrombolytic recipients and nonrecipients stratified by age (65-74 years vs \(\geq 75\) years).

We first calculated propensity scores\(^2\) to estimate the likelihood that a patient received thrombolytic therapy. These propensity scores were then used as control variables in analyses of the effects on mortality of actual use of thrombolytic therapy. Propensity scores are used in observational studies to reduce selection-to-treatment bias and to reduce to 1 value the differences in observed patient characteristics that affect treatment selection. Propensity of exposure to a thrombolytic agent was developed using logistic regression on all variables in Table 1 and interactions of these variables. To adjust maximally for potential confounding, we included in the final propensity model all variables associated with the likelihood of thrombolytic use with \(P<.30\). A \(c\) statistic (area under a receiver operating characteristic curve) and Hosmer-Lemeshow goodness-of-fit test indicated that the propensity score model predicted thrombolytic use well.\(^3,\)\(^3\)

A logistic regression model, with patients’ individual propensity scores as a control variable, was used to test the effect of age and thrombolytic use on mortality in all patients, while controlling for selection factors leading to thrombolytic use. In a separate model, we added an interaction term examining effect modification by age (continuous variable). In addition, patients were stratified into those eligible for thrombolytic therapy and all other patients with absolute or relative contraindications, and stratum-specific estimates of the effect of thrombolytic use on mortality were obtained and adjusted for propensity scores.

or \(\beta\)-blockers (89.4% vs 72.5% and 60.3% vs 42.3%, respectively) but were somewhat less likely to receive angiotensin-converting enzyme inhibitors (Table 2). In addition, those receiving thrombolytic therapy were somewhat more likely to be cared for by a cardiologist or at a hospital with a low volume of AMIs.

THROMBOLYTIC USE BY ELIGIBILITY

Among 719 patients who were eligible for thrombolytic therapy, 455 (63.3%) received this treatment. However, among the remaining 1940 patients who had 1 or more absolute (n = 1709) or relative contraindications, 280 (14.4%) received a thrombolytic.

Among 280 thrombolytic recipients with contraindications, 71.0% had 1 or more absolute contraindication to thrombolysis. The most frequent reasons for ineligibility (Table 1) were presence of 1 or more medical contraindications (43.3%), absence of an ST segment elevation of 1 mm or more (25.3%), and delay greater than 12 hours (23.9%).

UNADJUSTED MORTALITY
AND HEMORRHAGIC STROKE

In the overall study population, 13.1% died during the AMI hospitalization. The unadjusted mortality rate for thrombolytic recipients aged 65 to 74 years was 7.2%, slightly below the rate of 7.6% observed for nonrecipients (nonsignificant). However, among those 75 years or older, thrombolytic recipients experienced a somewhat higher unadjusted mortality rate than nonrecipients (20.1% vs 16.6%, \(P = .15\)).

Overall, 0.6% of study patients experienced a fatal or nonfatal hemorrhagic stroke; among younger thrombolytic recipients (age, <75 years), this rate was 1.4% compared with 0.2% among nonrecipients (\(P = .02\)); among patients 75 years and older, hemorrhagic stroke occurred in 2.4% of thrombolytic recipients compared with 0.2% of nonrecipients (\(P < .001\)).

MULTIVARIATE ANALYSES

Table 3 provides the results of the multiple logistic regression analyses of the odds of death for thrombolytic recipients vs nonrecipients for the entire sample and for subsets of the sample stratified by thrombolytic eligibility. Propensity scores (probability of receiving thrombolytic therapy) range between 0 and 1. As expected based on the lower baseline risk status of thrombolytic recipients compared with nonrecipients, the propensity score was strongly associated with a reduced odds of death in the overall sample (odds ratio [OR], 0.42; 95% confidence interval [CI], 0.22-0.82; \(P = .01\)) and among those with absolute or relative contraindications to thrombolytic therapy (OR, 0.23; 95% CI, 0.09-0.54; \(P = .001\)).

The odds of death associated with thrombolytic use in all patients (Table 3) was 1.53 (95% CI, 1.13-2.08;
The findings of this observational study regarding the use of thrombolytic agents in a large community population of AMI patients suggest that (1) in general, thrombolytic recipients have fewer comorbidities and risk factors than nonrecipients; (2) thrombolytic use is associated with reduced mortality among eligible patients younger than 80 years but increased mortality among the old-old; the oldest patients, even those without absolute or relative contraindications to therapy, experienced an excess risk of mortality compared with untreated patients (OR, 1.4 for thrombolytic recipients 80-90 years); and (3) the manner in which thrombolytic therapy is used in the community setting differs markedly from that observed in randomized clinical trials, where patients are selected for treatment using explicit and consistent criteria and agents are administered according to protocol. A substantial proportion of thrombolytic recipients in the study (38.0%) had relative and absolute contraindications to treatment, and this was strongly associated with an increased risk of mortality compared with such patients who did not receive thrombolytic therapy.

The current American College of Cardiology/American Heart Association practice guidelines for AMI assign a class IIa designation to the recommendation for use of thrombolytic therapy in persons older than 75 years, indicating that while the weight of evidence and expert opinion is in favor of the usefulness of treatment, there remains conflicting evidence or a divergence of opinion about whether the treatment is beneficial, useful, and effective. While a large randomized trial focused exclusively on elderly AMI patients would produce the most valid information regarding the benefits vs risks of thrombolytic therapy, this approach has failed previously because of ethical difficulties inherent in randomization of AMI patients to placebo and in identifying and enrolling large enough numbers of patients without contraindications to therapy. Analyses of combined data from the largest trials of thrombolytic agents in AMI have not demonstrated a significant survival benefit in patients older than 75 years. A systematic overview of 9 trials that randomized 58,600 patients with suspected AMI between thrombolytic therapy and control included 5754 participants 75 years or older. Among this group, the mortality during the first 35 days was 24.3% for those treated with a thrombolytic agent compared with 25.3% for those

### Table 1. Eligibility and Contraindications for Thrombolytic Therapy*

<table>
<thead>
<tr>
<th>Eligible population†</th>
<th>All patients with AMI or suspected AMI presenting within 12 h of onset of symptoms; ST-segment elevation ≥1 mm‡; no contraindications.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absolute contraindications</td>
<td>Active internal bleeding; suspected aortic dissection; prolonged or traumatic cardiopulmonary resuscitation; recent head trauma (&lt;2 wk); intracranial neoplasm; hemorrhagic ophthalmic conditions; previous allergic reaction to the thrombolytic agent; sustained systolic blood pressure &gt;180 mm Hg or diastolic blood pressure &gt;110 mm Hg; any recorded blood pressure &gt;200/120 mm Hg on admission; trauma or surgery &lt;2 wk; and AMI onset &gt;24 h.</td>
</tr>
<tr>
<td>Relative contraindications</td>
<td>Major bleeding; recent trauma or surgery &lt;2 wk and &lt;2 mo; history of chronic severe hypertension with or without drug therapy; history of CVA; current use of warfarin anticoagulants; prior use of streptokinase or APSAC (if they are the agents of choice); significant liver dysfunction; active peptic ulcer; and AMI onset &gt;12 h.</td>
</tr>
</tbody>
</table>

*AMI indicates acute myocardial infarction; CVA, cerebrovascular accident; and APSAC, anistreplase (anisoylated plasminogen streptokinase activator complex).  
†Eligibility for thrombolytic therapy was defined as being in the eligible population and having no absolute or relative contraindications. Absence of ST-segment elevation greater than 1 mm was considered an absolute contraindication in analyses of patients with and without contraindications.  
‡Based on physician documentation in the medical record.
who did not receive treatment. These findings have been interpreted by many authorities to indicate an absolute benefit of treatment of 10 lives saved per thousand patients treated among those 75 years or older. However, the 95% CI around this estimate is quite wide (−16.0 to 36.0), suggesting the potential for risk as well as benefit. The relative risk of death for patients in this older age group who received thrombolytic therapy compared with controls was 0.96 (95% CI, 0.88-1.05). Thus, the limited data derived from clinical trials of thrombolytic therapy in elderly AMI patients suggest that the relative benefits from use of thrombolytic therapy experienced by this group is marginal at best. Given the low likelihood of mounting any new trials in the old-old, and a general consensus that eligible elderly AMI patients should have access to all available treatment modalities, it has become essential to examine the outcomes of these therapies in observational studies of community popu-

### Table 2. Baseline Demographic and Clinical Characteristics and Early Treatments According to Receipt of Thrombolytic Therapy

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Received Thrombolytic Therapy, % (n = 735)</th>
<th>Did Not Receive Thrombolytic Therapy, % (n = 1924)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demographic characteristics</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age ≥75 y</td>
<td>39.3</td>
<td>64.4</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Female</td>
<td>42.9</td>
<td>51.5</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Nonwhite race</td>
<td>9.5</td>
<td>9.6</td>
<td>.98</td>
</tr>
<tr>
<td><strong>Medical history</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Previous myocardial infarction</td>
<td>21.6</td>
<td>35.3</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Previous angina</td>
<td>31.8</td>
<td>40.2</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Previous coronary bypass or angioplasty</td>
<td>11.0</td>
<td>15.0</td>
<td>.009</td>
</tr>
<tr>
<td>Previous stroke</td>
<td>7.2</td>
<td>15.6</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Diabetes</td>
<td>22.2</td>
<td>27.9</td>
<td>.003</td>
</tr>
<tr>
<td>Hypertension</td>
<td>52.2</td>
<td>58.7</td>
<td>.003</td>
</tr>
<tr>
<td>Current smoker</td>
<td>16.6</td>
<td>10.6</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Hypercholesterolemia</td>
<td>30.3</td>
<td>24.9</td>
<td>.004</td>
</tr>
<tr>
<td><strong>Clinical characteristics at admission</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Severity index</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No heart failure</td>
<td>68.7</td>
<td>58.0</td>
<td></td>
</tr>
<tr>
<td>Heart failure/pulmonary edema</td>
<td>18.4</td>
<td>31.6</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Cardiogenic shock</td>
<td>12.9</td>
<td>10.4</td>
<td></td>
</tr>
<tr>
<td>No chest pain</td>
<td>3.4</td>
<td>10.1</td>
<td>&lt;.001</td>
</tr>
<tr>
<td><strong>Index of Coexistent Disease category</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No comorbidity present†</td>
<td>11.8</td>
<td>4.7</td>
<td></td>
</tr>
<tr>
<td>Mild-to-moderate comorbidity present†</td>
<td>69.3</td>
<td>59.2</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Severe comorbidity present†</td>
<td>18.9</td>
<td>36.1</td>
<td></td>
</tr>
<tr>
<td><strong>Body mass index‡</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;23</td>
<td>28.2</td>
<td>35.3</td>
<td></td>
</tr>
<tr>
<td>23-28</td>
<td>35.4</td>
<td>32.4</td>
<td>&lt;.002</td>
</tr>
<tr>
<td>&gt;28†</td>
<td>36.4</td>
<td>32.2</td>
<td></td>
</tr>
<tr>
<td><strong>Systolic blood pressure, mm Hg</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;120†</td>
<td>72.5</td>
<td>76.6</td>
<td>.08</td>
</tr>
<tr>
<td>90-120</td>
<td>21.9</td>
<td>18.3</td>
<td></td>
</tr>
<tr>
<td>&lt;90</td>
<td>5.6</td>
<td>5.1</td>
<td></td>
</tr>
<tr>
<td><strong>Pulse &gt;100 beats/min</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Findings on initial electrocardiogram</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ST elevation</td>
<td>84.9</td>
<td>30.4</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Anterior location of myocardial infarction</td>
<td>32.2</td>
<td>19.4</td>
<td>&lt;.001</td>
</tr>
<tr>
<td><strong>Time to presentation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;2 h</td>
<td>47.8</td>
<td>25.0</td>
<td></td>
</tr>
<tr>
<td>2-6 h</td>
<td>36.4</td>
<td>33.0</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>&gt;6 h</td>
<td>15.8</td>
<td>42.0</td>
<td></td>
</tr>
<tr>
<td><strong>Management in first 24 h</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aspirin</td>
<td>89.4</td>
<td>72.5</td>
<td></td>
</tr>
<tr>
<td>β-Blockers</td>
<td>60.3</td>
<td>42.3</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Angiotensin-converting enzyme inhibitors</td>
<td>14.3</td>
<td>24.3</td>
<td></td>
</tr>
<tr>
<td><strong>Characteristics of providers</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cardiologist attending or consultation</td>
<td>76.9</td>
<td>66.3</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Nonurban hospital</td>
<td>21.0</td>
<td>20.6</td>
<td>.83</td>
</tr>
<tr>
<td>Availability of cardiac catheterization</td>
<td>56.6</td>
<td>58.9</td>
<td>.90</td>
</tr>
<tr>
<td>Low volume of acute myocardial infarctions at hospital (&lt;1.4 per week)§</td>
<td>49.1</td>
<td>42.1</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

*Based on Greenfield’s Index of Coexistent Disease.*
†Reference category.
‡Calculated as weight in kilograms divided by the square of height in meters.
§Data based on the study by Thiemann et al.*
adverse events of thrombolytic therapy, notably intra-
administration in our analyses. The rates of important
the specific agent used, dosing, or the timing of drug
use, and we did not assess issues relating to
study, all thrombolytic agents were combined into a
relative and absolute contraindications to therapy who
between eligible thrombolytic recipients and patients with
survival be-
the validity of our findings is further supported by
mortality found among the oldest thrombolytic recipi-
it may also lead to an underestimation of the increased,
aggerated survival benefit in patients aged 65 to 74 years,
ment decisions that are determined in a nonrandomized
atical studies that attempt to assess therapeutic effec-
tiveness is to overcome confounding caused by treat-
ment purposes.33 Even after extensive statistical adjustments, it
is difficult to control for the bias that elderly thrombo-
lytic recipients have characteristics associated with bet-
ter prognosis before treatment relative to nonrecipients.
While underadjusting for this bias might lead to an
exaggerated survival benefit in patients aged 65 to 74 years,
this may also lead to an underestimation of the increased
mortality found among the oldest thrombolytic recipi-
ents. The validity of our findings is further supported by
the clear and predictable differences in survival be-
tween eligible thrombolytic recipients and patients with
relative and absolute contraindications to therapy who
received thrombolytic therapy.

There are additional limitations regarding the present
study because of its observational nature. In our
study, all thrombolytic agents were combined into a
single category, and we did not assess issues relating to the
specific agent used, dosing, or the timing of drug
administration in our analyses. The rates of important
adverse events of thrombolytic therapy, notably intracra-
nal hemorrhage, have been shown to vary across agents33,35,
however, agent-specific effects on mortality
could not be examined in the context of the present
study owing to sample size limitations. Furthermore,
the dose at which the thrombolytic agent is adminis-
tered can have an impact on the occurrence of intracra-
nal hemorrhage. Recent data from the National Regis-
try of Myocardial Infarction 2 have demonstrated that
AMI patients who received excessive tissue-type plas-
mogen activator doses, relative to the recommended
weight-adjusted doses, had a significantly increased
risk of having an intracranial hemorrhage.36,37

Another limitation of this study is the relatively small
sample size of AMI patients from a single state. How-
ever, the sample size was sufficient to detect significant
increases in the odds of dying among elderly thrombo-
lytic recipients. Furthermore, patterns of use of throm-
bolitic agents for elderly AMI patients in Minnesota are
similar to patterns observed in other studies.12,16
Moreover, our findings of increased mortality among eli-
gable, elderly thrombolytic recipients are similar to those
of a recent study.22

In summary, the findings of this observational
study confirm the benefits of thrombolytic treatment in
the community setting among younger patients meet-
ing eligibility criteria for treatment. However, our find-
ings raise concerns about the benefits of this treatment
in the old-old, even those who might be considered eli-
gible for treatment according to current criteria. These results require confirmation using data derived from

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### Table 3. Multivariate Analysis of the Odds of In-Hospital Mortality*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odds of In-Hospital Death (95% Confidence Interval)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>All patients (n = 2631)†</td>
<td>0.42 (0.22-0.82)</td>
<td>.01</td>
</tr>
<tr>
<td>Propensity score (to receive thrombolytics)‡</td>
<td>1.53 (1.13-2.08)</td>
<td>.006</td>
</tr>
<tr>
<td>Interaction of thrombolytic use with age, y§</td>
<td>1.04 (1.01-1.08)</td>
<td>.03</td>
</tr>
<tr>
<td>Eligible for thrombolytics (n = 719)‡</td>
<td>0.66 (0.21-2.07)</td>
<td>.48</td>
</tr>
<tr>
<td>Propensity score (to receive thrombolytics)‡</td>
<td>0.96 (0.58-1.58)</td>
<td>.86</td>
</tr>
<tr>
<td>Interaction of thrombolytic use with age, y§</td>
<td>1.08 (1.02-1.14)</td>
<td>.008</td>
</tr>
<tr>
<td>All other patients with contraindications (n = 1912)‡</td>
<td>0.23 (0.09-0.54)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Propensity score (to receive thrombolytics)‡</td>
<td>1.57 (1.03-2.40)</td>
<td>.04</td>
</tr>
<tr>
<td>Interaction of thrombolytic use with age, y§</td>
<td>1.02 (0.98-1.06)</td>
<td>.49</td>
</tr>
</tbody>
</table>

*Adjusting for age and propensity score (probability of receiving thrombolytic therapy based on all other demographic and clinical predictors given in Table 2) in all models.
†There were 28 of 2639 patients with missing values in multivariate models.
‡Variables associated with thrombolytic use in the propensity score model were cardiogenic shock, delay time, ST depression, presence of cardiology consultation, female sex, high comorbidity, and absence of chest pain with significant interactions.
§Independent effect, not including interactions.
**Estimates the change in odds of death for thrombolytic recipient vs nonrecipient with each 1-year increase in age.

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Predicted odds of in-hospital mortality for thrombolytic recipients vs nonrecipients for different ages based on age interactions in multivariate models and stratified by thrombolytic eligibility. The logistic regression models controlled for age, propensity scores (to receive thrombolytic therapy), and interactions between age and thrombolytic use (see Table 3). P values denote significance of interaction of age and thrombolytic use as predictors of mortality.
other large observational studies of AMI patients that include meaningful numbers of the old-old. For the present, the findings of this study suggest a need to reassess our approach to the use of thrombolytic therapy in the treatment of AMI patients older than 75 years. Careful assessment for absolute and relative contraindications to thrombolytic therapy is critical in this group of patients. When such patients are considered eligible for treatment, the timing of treatment should be optimized, and the agent must be administered at the correct dosage. The relative benefits of alternatives to thrombolytic therapy, such as primary coronary angioplasty, in the old-old require further assessment. Despite reservations about the true benefits of thrombolytic therapy in the oldest AMI patients, this vulnerable group will clearly benefit from increased adherence to guidelines regarding use of all available beneficial therapeutic modalities.38-42

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