Longitudinal Trends in the Severity of Acute Myocardial Infarction: A Population Study in Olmsted County, Minnesota

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The mechanisms of the decline in coronary heart disease mortality are not fully elucidated. In particular, little is known about the trends in severity of myocardial infarction, which may have contributed to the mortality decline. This study examines indicators of myocardial infarction severity including Killip class, electrocardiogram descriptors, and peak creatine kinase values in a population-based, myocardial infarction incidence cohort to test the hypothesis that the severity of myocardial infarction declined over time. Between 1983 and 1994, 1,295 incident cases of myocardial infarction (mean age, 67 (standard deviation, 6) years; 43% women) occurred in Olmsted County, Minnesota. The median time between the onset of symptoms and presentation was 1.9 (interquartile range, 3.9) hours and declined over time (p = 0.018), while the use of reperfusion therapy increased. Over time, the hemodynamic presentation of patients did not change appreciably, but the proportion of persons with ST-segment elevation declined as did the occurrence of Q waves and peak creatine kinase values. These secular trends, which were largely independent from the time to first electrocardiogram and reperfusion therapy, indicate a decline in the severity of myocardial infarction over time. 


The determinants of the decline in age-adjusted mortality due to coronary heart disease observed during the last three decades are not fully elucidated. Recent US data on myocardial infarction incidence indicate that the decline in the incidence of hospitalized myocardial infarction cases was modest in recent years (1, 2) and thus not fully commensurate with the mortality decline, suggesting a greater contribution of medical care to the mortality decline. Data from the Monitoring of Trends and Determinants in Cardiovascular Diseases (MONICA) Study conversely underscored that the changes in coronary heart disease attack rates were the major driver of declining coronary heart disease deaths (3).

These diverging findings underscore the complexity of the mechanisms of the decline in coronary heart disease mortality and call for further studies to elucidate its determinants. In particular, trends in the severity of acute myocardial infarction with perhaps admission of milder cases in more recent years may have also played a role in the decline (4), yet data on time trends in myocardial infarction severity are scarce. Several indicators are used to analyze myocardial infarction severity. They include clinical presentation, sometimes combined in composite scores such as the Killip classification, electrocardiogram indicators, and enzyme values. Recently published data from the Atherosclerosis Risk in Communities (ARIC) Study (5) did not convincingly indicate a decline in the severity of acute myocardial infarction, but the study period was relatively brief and by design it did not include persons aged more than 74 years. Further, it did not address the potential impact of secular trends in the timing of presentation after the onset of symptoms on myocardial infarction severity indicators. Yet, while the measured severity of myocardial infarction depends on the intrinsic characteristics of the event, it is also affected by the time between the onset of symptoms and presentation to
care. As the time from symptom onset to presentation for medical care has been shown to decrease over time, it is important to analyze such trends in conjunction with trends in myocardial infarction severity, as recently emphasized (6).

Thus, the present study was undertaken to examine the trends in clinical presentation and the severity of acute myocardial infarction in a population-based myocardial infarction incidence cohort including all age groups to test the hypothesis that the severity of incident acute myocardial infarction, as measured by several indicators, has changed over time and to examine how the time from onset of symptoms to presentation to medical care changed during the same time period.

MATERIALS AND METHODS

Study setting

Epidemiologic research in Olmsted County, Minnesota, is optimized by the facts that the county is relatively isolated from other urban centers and that nearly all medical care is delivered to local residents by a small number of providers. With the exception of a higher proportion of the working population employed in the health care industry, the characteristics of the population of Olmsted County are similar to those of US Whites (7).

The Mayo Clinic provides approximately half of the primary care and nearly all specialty care for the community. Olmsted Medical Center and its affiliated hospital, along with the Mayo Clinic and hospitals, provide comprehensive care for the region in every discipline. Each provider uses a comprehensive medical record system, whereby all the data collected on a person are assembled in one place. Thus, the details of every inpatient and outpatient encounter, including visits to the emergency department, laboratory results, pathology reports, and correspondence concerning each patient, can be accessed. The result is the linkage of medical records from all sources of medical care used by the Olmsted County population. Data are easily retrievable because the Mayo Clinic has maintained since the early 1900s extensive indexes based on clinical and histologic diagnoses and surgical procedures (8, 9). Since 1966, similar indexes have been developed for non-Mayo providers under the aegis of the Rochester Epidemiology Project. The record linkage system therefore constitutes a unique opportunity to ascertain severity indicators of myocardial infarction in a defined nonreferred population.

Ascertainment of the myocardial infarction incidence cohort

Details of the case ascertainment algorithms are reported elsewhere (10). The lists of patients discharged from the hospitals in Olmsted County with diagnoses compatible with a myocardial infarction were obtained from two separate data sources: the Rochester Epidemiology Project index of diagnoses and the Hospital Utilization Review Database, a Mayo Clinic administrative database of hospitalizations. The target codes were 410 (acute myocardial infarction), 411 (other acute and subacute forms of ischemic heart disease), 412 (old myocardial infarction), 413 (angina pectoris), and 414 (other forms of ischemic heart disease). All events coded as 410 were reviewed, while samples of coronary heart disease codes other than code 410 (codes 411–414) were reviewed. The sampling fractions were 100 percent for code 410, 50 percent for code 411, and 10 percent for codes 412–414 and were comparable with those used in other studies (11). Trained nurse abstractors reviewed criteria for residency in Olmsted County and International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM), code eligibility. The entire medical record was used to search for prior history of cardiac disease to ascertain the incident status of myocardial infarction. Persons with a history of prior myocardial infarction were excluded. A computerized algorithm was applied that incorporated standardized epidemiologic criteria to assign the diagnosis of myocardial infarction based on the information on cardiac pain, creatine kinase enzyme values, and Minnesota coding of the electrocardiogram (11–13).

Cardiac pain was defined as pain occurring in the anterior chest, left arm or jaw, back, shoulder, right arm, or abdomen. The pain was categorized as present if it met these criteria and if no other cause for the pain could be identified from the medical record (11).

Cases of emergency department deaths, cases dead on arrival, and in-hospital events with a rapid fatal course within 24 hours for whom no or few data were available were treated as out-of-hospital deaths to ascertain validated myocardial infarction status and not included in the present report. As a measure of the delay in seeking medical treatment, the time to first electrocardiogram was defined as the interval from the self-reported onset of acute symptoms to the recorded first electrocardiogram in hours. Reperfusion therapy was defined as thrombolytic therapy or acute coronary angioplasty within 24 hours after admission.

Indicators of myocardial infarction severity

The Killip class was used as an indicator of hemodynamic severity on admission (14). Killip class 1 included patients with no signs of heart failure; Killip class 2 included patients with rales, S3 gallop, and venous hypertension; and Killip class 3 included patients with pulmonary edema. Cardiogenic shock (Killip class 4) was defined as a systolic blood pressure under 90 mmHg in the absence of hypovolemia, which is similar to definitions used in other studies (15–17).

Copies of up to three 12-lead electrocardiograms from the first day of the event or hospital admission, the third day, and the last day of hospitalization were printed and sent to the Electrocardiogram Reading Center at the University of Minnesota to assign a Minnesota code (18). ST-segment elevation was defined as elevation of the ST segment of at least 1 mm in limb leads and at least to 2 mm in the anterior chest leads (19). Q-wave myocardial infarction was defined according to Minnesota coding including definite Q-wave myocardial infarction (ED1–ED7), any diagnostic Q-wave pattern (D1), or any equivocal Q-wave pattern (E1) (18).

Creatine kinase values were transcribed for up to three determinations on each of the first 3 days following hospital
admission. Information on the presence or absence of a history of trauma or surgery, which might invalidate enzyme values, was recorded. The method of creatine kinase activity measurement did not change over time, but the upper limit of normal in creatine kinase values changed in 1989. Therefore, “peak creatine kinase” was defined as the ratio of the maximum creatine kinase value to the upper limit of normal.

**Statistical analyses**

Data are presented as the frequency or mean and standard deviation. The time to first electrocardiogram is recorded as the median and interquartile range. The associations between year groups of index myocardial infarction and baseline characteristics were examined using logistic regression, while modeling year as a three-level categorical variable. We used weighted linear and logistic regression to account for the sampling design. The “weight” was the inverse of the sampling fraction in the corresponding ICD-9-CM code stratum. When modeling the severity indicators, we included the year of incident myocardial infarction as a continuous variable in all models and examined the presence of a nonlinear component to the trends by including quadratic terms. We examined the difference in time trends in severity indicators by age and sex. As a second step, the time between the onset of symptoms and the first electrocardiogram was added to the multivariable models; in addition, reperfusion therapy was included in the models with Q wave and peak creatine kinase as the dependent variable. The creatine kinase value was modeled after log transformation while using bootstrapping to obtain the standard error for the percentage of change in the creatine kinase value over time.

An alpha value of 0.05 was set for the threshold of statistical significance for all analyses, except for interaction testing, where $p = 0.10$ was accepted. SUDAAN version 8.0.1 software (Research Triangle Institute, Research Triangle Park, North Carolina) was used for all analyses.

The frequencies of missing data were examined in the study population. Except for the variable Q-wave occurrence, for which 7 percent values were missing, missing values for each variable did not exceed 3 percent.

**RESULTS**

**Baseline characteristics**

Between 1983 and 1994, 1,295 incident cases of hospitalized myocardial infarction occurred in Olmsted County, Minnesota. The mean age was 67 (standard deviation, 6) years, and 43 percent were women (table 1). Overall, 11 percent of the patients had a prior history of congestive heart failure.
failure; 19 percent, diabetes mellitus; and 55 percent, hypertension. A total of 28 percent were smokers. The prevalence of hypertension, diabetes, and hyperlipidemia increased over time. Forty-three percent of the patients had no comorbidity, 26 percent presented with one comorbid disease process, and 31 percent had two or more. Over time, no change in the age distribution and degree of comorbidity was observed. The use of reperfusion therapy increased markedly during the study period.

**Severity indicators**

**Hemodynamic status.** The majority of the patients were in Killip class 1. Although the proportion of patients presenting with cardiogenic shock (Killip class 4) declined from 7 percent to 4 percent between 1983 and 1994, this change did not reach statistical significance (p for trend = 0.086).

**Electrocardiographic data.** The mean number of electrocardiograms used for ascertainment in each patient was 2.6 (standard deviation, 0.3). The proportion of patients with ST-segment elevation decreased over the 12-year period (p for trend = 0.003), but the magnitude of the decline in the proportion of patients presenting with ST-segment elevation differed by sex (table 2). For men, after adjustment for age and the time to first electrocardiogram, the odds ratio for ST-segment elevation in 1994 compared with 1983 was 0.43 (95 percent confidence interval (CI): 0.31, 0.58; p = 0.001), whereas in women the odds ratio was 0.81 (95 percent CI: 0.75, 0.89; p = 0.001). A Q-wave pattern on the electrocardiogram was observed in 45 percent of the cohort, and its frequency declined over the time period (tables 2 and 3). Indeed, a 22 percent decline in the relative odds of having a Q-wave pattern was noted over the study period, which did not change after adjustment for the time to first electrocardiogram and reperfusion therapy.

**Enzyme values.** The mean number of enzyme draws used for ascertainment in each patient was 4.2 (standard deviation, 0.3). Decreased values followed 85 percent of peak values. The peak creatine kinase ratio remained seemingly stable until the 1990s and then decreased in the more recent time period (p for trend < 0.001). Inclusion of a quadratic

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**TABLE 2. Distributions of ST-segment elevation and severity indicators, Olmsted County, Minnesota, 1983–1994**

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>ST-segment elevation (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>51</td>
<td>40</td>
<td>38</td>
<td>0.001</td>
</tr>
<tr>
<td>Women</td>
<td>46</td>
<td>36</td>
<td>46</td>
<td>0.03</td>
</tr>
<tr>
<td>Age, &lt;75 years</td>
<td>49</td>
<td>42</td>
<td>44</td>
<td>0.21</td>
</tr>
<tr>
<td>Age, ≥75 years</td>
<td>52</td>
<td>34</td>
<td>37</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Killip class (%)</td>
<td></td>
<td></td>
<td></td>
<td>0.086*</td>
</tr>
<tr>
<td>Killip class 1</td>
<td>59</td>
<td>64</td>
<td>65</td>
<td></td>
</tr>
<tr>
<td>Killip class 2</td>
<td>10</td>
<td>8</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Killip class 3</td>
<td>24</td>
<td>21</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>Killip class 4</td>
<td>7</td>
<td>6</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Peak creatine kinase ratio (median [IQR†])</td>
<td>3.7 [5.9]</td>
<td>4.2 [5.5]</td>
<td>3.0 [4.5]</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Men</td>
<td>3.5 [5.0]</td>
<td>3.9 [4.8]</td>
<td>2.6 [3.0]</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Women</td>
<td>4.4 [7.9]</td>
<td>4.7 [8.0]</td>
<td>3.7 [5.9]</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Age, &lt;75 years</td>
<td>3.6 [5.8]</td>
<td>4.4 [5.4]</td>
<td>3.0 [3.9]</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Age, ≥75 years</td>
<td>3.8 [6.1]</td>
<td>3.8 [5.7]</td>
<td>2.7 [5.5]</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>No reperfusion</td>
<td>3.5 [4.7]</td>
<td>3.6 [4.9]</td>
<td>2.5 [3.2]</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Reperfusion</td>
<td>7.9 [10.3]</td>
<td>5.7 [6.7]</td>
<td>3.5 [6.1]</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Q wave (%)</td>
<td>47</td>
<td>45</td>
<td>44</td>
<td>0.023</td>
</tr>
<tr>
<td>Men</td>
<td>47</td>
<td>48</td>
<td>46</td>
<td>0.636</td>
</tr>
<tr>
<td>Women</td>
<td>46</td>
<td>41</td>
<td>41</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Age, &lt;75 years</td>
<td>46</td>
<td>48</td>
<td>40</td>
<td>0.007</td>
</tr>
<tr>
<td>Age, ≥75 years</td>
<td>48</td>
<td>39</td>
<td>49</td>
<td>0.302</td>
</tr>
</tbody>
</table>

* p value for Killip class 4 versus class 1, class 2, or class 3.
† IQR, interquartile range.
term for year in the regression model indicated a nonlinear component to the effect of year. When this was taken into account in the final models, the percentage of decrease in the peak creatine kinase ratio between 1983 and 1994 was –24 percent (95 percent CI: –39, –4) in women and –45 percent (95 percent CI: –56, –29) in men.

After adjustment for the time to first electrocardiogram and reperfusion therapy, the decline over time in the peak creatine kinase remained highly significant, while still differing by sex. In women, the peak creatine kinase declined by 37 percent over time (95 percent CI: –49, –20), and in men it declined by 52 percent (95 percent CI: –62, –40).

**Time to first electrocardiogram**

The median time between the onset of symptoms and the first electrocardiogram could be ascertained from the medical record in 97 percent of the cases and was 1.9 (interquartile range, 3.9) hours. Over the 12-year period, it declined from a median of 2.3 hours in 1983–1986 to 1.7 hours in 1991–1994 (p for trend < 0.001). After adjustment for age and sex, a strong negative association between calendar year and the time to first electrocardiogram was noted (p = 0.005). Because the time to first electrocardiogram can affect all severity indicators, it was entered as a variable in the regression models with each severity indicator as the dependent variable. This did not change the associations between calendar year and Killip class or Q waves (table 3). For ST-segment elevation in women, adjustment of time to the first electrocardiogram unmasked a temporal decline in the relative odds of presenting with ST-segment elevation, which however was of a lesser magnitude than what was observed in men.

**DISCUSSION**

This study was undertaken to test the hypothesis that the severity of myocardial infarction decreased over time. In this geographically defined myocardial infarction incidence cohort, the hemodynamic presentation of patients did not change appreciably over time, but the proportion of persons with ST-segment elevation declined as did the occurrence of Q waves and peak creatine kinase. Even though persons presented more rapidly after the onset of symptoms in recent years, the changes over time in the severity indicators appeared largely independent from this parameter and from the administration of reperfusion therapy.

Myocardial infarction severity is challenging to assess for several reasons (6). First, the time between the onset of symptoms and the presentation to medical care can affect each indicator analyzed in the present study, such that time trends in the time to presentation can confound any association between calendar year and myocardial infarction severity. Second, some indicators can be affected by treatment. Although Killip class and ST-segment elevation reflect the characteristics of the myocardial infarction during the initial 24 hours and are unlikely to be influenced by treatment, peak creatine kinase and Q waves conversely may be influenced by treatment measures, particularly reperfusion. Third, the interpretation of the changes in Killip class requires knowledge of the trends in out-of-hospital coronary disease deaths, because a decline in such deaths may result in larger numbers of persons admitted to the hospital who would have died out of the hospital. This, in turn, may confound any association between the Killip class and calendar year by modifying the case mix of hospitalized persons with myocardial infarction. Finally, accurate determination of the severity of myocardial infarction through peak creatine kinase measurement is subject to measurement errors, and variations in the timing and frequency of the enzyme measurements are such that the recorded peak creatine kinase measurement may not accurately reflect the true peak. These considerations underscore the complexity of the changes in myocardial infarction severity, which is yet an important potential contributor to the coronary disease mortality decline.

**Initial presentation of myocardial infarction**

The overall frequency of cardiogenic shock averaged 6 percent and, though it decreased over the study period, this trend was attenuated after adjustment for age and sex. Indeed, after adjustment, there was a 44 percent reduction in

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**TABLE 3. Change in severity indicators among 1,295 hospitalized myocardial infarction patients, Olmsted County, Minnesota, 1983–1994**

<table>
<thead>
<tr>
<th></th>
<th>OR*</th>
<th>95% CI*</th>
<th>OR†</th>
<th>95% CI†</th>
<th>OR‡</th>
<th>95% CI‡</th>
</tr>
</thead>
<tbody>
<tr>
<td>Killip class 4</td>
<td>0.57</td>
<td>0.28, 1.16</td>
<td>0.56</td>
<td>0.29, 1.09</td>
<td>0.56</td>
<td>0.29, 1.09</td>
</tr>
<tr>
<td>ST-segment elevation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>0.94</td>
<td>0.86, 1.02</td>
<td>0.92</td>
<td>0.85, 1.01</td>
<td>0.81</td>
<td>0.75, 0.89</td>
</tr>
<tr>
<td>Men</td>
<td>0.44</td>
<td>0.32, 0.59</td>
<td>0.44</td>
<td>0.33, 0.60</td>
<td>0.43</td>
<td>0.31, 0.58</td>
</tr>
<tr>
<td>Q waves</td>
<td>0.78</td>
<td>0.69, 0.88</td>
<td>0.79</td>
<td>0.70, 0.89</td>
<td>0.79</td>
<td>0.68, 0.92</td>
</tr>
</tbody>
</table>

* OR, odds ratio; CI, confidence interval.
† Adjusted for age and sex.
‡ Adjusted for age, sex, and time to first electrocardiogram. For Q waves, results are also adjusted for reperfusion therapy.
the relative odds of cardiogenic shock over time, which did not reach statistical significance.

These results are at odds with data from the ARIC Study (5) in which the proportion of persons with cardiogenic shock declined by 11 percent per year after adjustment for age, sex, and race/community. Although the reasons for this discrepancy can only be speculative, the mean age of persons in the ARIC Study was 59 years, which is younger than in the present cohort. The fact that the data presented here are consistent with the data from the Worcester study, which has no upper age limit, supports this assumption (16). Trends in the frequency of cardiogenic shock should be interpreted with knowledge of the trends in out-of-hospital deaths, as a decline in out-of-hospital deaths due to coronary disease may result in an increase over time in the admission of persons who would have died out of the hospital in previous years. Because these persons may be more ill and at greater risk for cardiogenic shock, this change in case mix may result in the absence of change in the frequency of cardiogenic shock. Indeed, in Olmsted County during the time period, out-of-hospital deaths declined (20), supporting this assumption.

The frequency of ST-segment elevation at presentation decreased over time in men and in women, but the magnitude of the decline was greater in men. The ARIC Study, which included only persons up to the age of 74 years, reported a 10 percent annual increase in the proportion of persons with ST-segment elevation on the initial electrocardiogram but did not identify any sex difference (5). Although the reasons for this discrepancy between the two studies can only be speculative, it is conceivable that the differences in age distributions discussed above are a contributing factor.

Indicators reflecting in-hospital course of myocardial infarction

The occurrence of Q wave declined over the study period, contrary to data from the Minnesota Heart Survey and the ARIC Study, which did not detect a change in the occurrence of Q waves (5, 21). It is important to emphasize that the approach used for ascertainment in the present study is similar to that used in the Minnesota Heart Survey and the ARIC Study and that the methodological differences cannot be offered as an explanation. The reasons for these discrepancies could include differences in the time period (1970–1980 for the Minnesota Heart Survey) and the age of the study populations, with the Minnesota Heart Survey and the ARIC Study both limited to persons less than 75 years of age (5, 21). Notwithstanding these possible explanations, the findings presented here underscore the importance of continuous monitoring of coronary heart disease and myocardial infarction trends across time and age groups.

With regard to peak values of creatine kinase, in the present study it declined in men and in women over the study period, irrespective of the code source (data not shown). The magnitude of the decline, however, was greater in men than in women. This decline is consistent with the data from the ARIC Study, in which the mean peak creatine kinase ratio decreased by 5 percent per year. Peak creatine kinase values are influenced by reperfusion therapy and, indeed, the use of reperfusion therapy increased in Olmsted County during the study period. However, the decline in peak creatine kinase values was observed among all patients regardless of reperfusion therapy, such that it can be viewed as a pertinent indicator of myocardial infarction severity, which in turn is strongly associated in outcome as shown in several studies (22–24).

The median time from the onset of symptoms to the first electrocardiogram was approximately 2 hours and declined over time. The time reported here from onset to electrocardiogram in the latest years (1.7 hours) is comparable with recent data from the Second National Registry of Myocardial Infarction (NRMI-2) (25) and from the Global Utilization of Strategies to Open Occluded Coronary Arteries (GUSTO) Trial (26). It is seemingly less than the time from symptom onset to hospital admission in the Rapid Early Action for Coronary Treatment (REACT) Trial of 2.3 hours (27), which is conceivably related to differences in study populations and community characteristics. Because changes in the time to seek care can affect all severity indicators, it is important to address the potential impact of secular trends in the time to seek care on myocardial infarction severity indicators, which had not been previously examined (5, 6). This study addresses this gap in knowledge by demonstrating that the secular trends in the indicators observed here remained largely similar after adjustment for time between the onset of symptoms and presentation to medical care.

Interpretation

Integrating the secular trends of the various severity indicators into one unifying explanation is challenging, underscoring the complexity of the interpretation of coronary disease trends. Presentation with ST-segment elevation is important to consider in analyses of myocardial infarction severity, because it may lead to prompter use of reperfusion therapy and in this sense can be related to the ultimate degree of myocardial damage, but it does not directly reflect the severity of the event. The frequency of Killip class 4 did not change, but the Killip class is likely to be influenced by case-mix changes due to the decline in out-of-hospital deaths, and the Q wave may not be sensitive enough to detect relatively small changes in myocardial infarction severity. The decline in peak enzyme value observed in men and women is consistent across age and across studies, and the consistency of the published data enhances the robustness of these findings (5, 28). The data presented here extend these findings by indicating that peak creatine kinase values declined over time irrespective of the time to first electrocardiogram and reperfusion therapy and that the occurrence of Q waves also declined. Altogether, these findings are indicative of a decline in the severity of myocardial infarction over time.

Limitations

Although these results provide insight into the changes in severity of myocardial infarction, some limitations should be kept in mind. The racial and ethnic composition of the population of Olmsted County limits the generalization of these data to ethnic groups not adequately represented in the popu-
lation studied. Although quasi-complete insurance coverage among all Olmsted County residents reduces the concern of confounding by access to care (29), this study will have to be replicated in other ethnic groups.

Creatine kinase MB isoenzyme measurements were not consistently available during the time period and thus could not be used in this analysis focusing on time trends. Although creatine kinase MB isoenzyme offers the advantage of myocardial specificity superior to that of creatine kinase, there is no plausible reason to assume that a systematic trend in the noncardiac elevation of creatine kinase could bias the results reported here. Further, the use of consistent criteria that did not change throughout the study period is a distinct benefit in any study such as this one focusing on time trends.

The history of hyperlipidemia, hypertension, and diabetes mellitus was ascertained from the medical record using clinical diagnoses. Although these diagnoses could be related in part to reporting bias, prospectively collected cross-sectional data from a population-based sample of Olmsted County indicated adverse trends in blood pressure awareness, treatment, and control (30) that are consistent with the data presented in this study.

Aspirin consumption prior to acute myocardial infarction has been reported to be associated with less severe myocardial infarction (31), and it is conceivable that such consumption could partly account for the decrease in peak enzyme values reported here. Data on aspirin consumption prior to the myocardial infarction were not consistently available during the study period, thus precluding analysis of its role.

Conclusion

In this geographically defined myocardial infarction incidence cohort, the hemodynamic presentation of patients did not change appreciably over time, but the proportion of persons with ST-segment elevation declined over time as did the occurrence of Q waves and peak creatine kinase values. These secular trends, which were largely independent of the time to first electrocardiogram and reperfusion therapy, indicate a decline in the severity of myocardial infarction over time.

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