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Risk Scores for 30-Day Mortality After Percutaneous Coronary Intervention: New Insights Into Causes and Risk of Death

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Abstract

Objective: To determine the causes and risk of death after percutaneous coronary interventions (PCIs) and to compare the discriminatory ability of the New York State Risk Score (NYSRS) with the Mayo Clinic Risk Score (MCRS).

Patients and Methods: We studied in-hospital and 30-day mortality after PCI in 4898 patients treated at Mayo Clinic in Rochester, Minnesota, from January 1, 2007, through December 31, 2010, to validate the NYSRS equation with recalibrated predicted probabilities of death.

Results: Of the 4898 patients studied, 93 (1.9%) died during the index hospitalization, and 36 (0.7%) died within 30 days after discharge. For the in-hospital and 30-day mortality, respectively, the area under the receiver operating characteristic curve was 0.92 and 0.88 for the NYSRS and 0.93 and 0.90 for the MCRS, indicating excellent discrimination. The NYSRS model underpredicted event rates when applied in Mayo Clinic data (2.6% observed [127 of 4898 patients] vs 2.3% predicted [114 of 4898 patients]), even after recalibration. The instantaneous hazard over time revealed the highest risk of death in the first 3 days after PCI (daily probability, >0.2%), declined to 0.1% until about day 12, and then decreased below 0.1%. Cardiac causes (mainly myocardial infarction) dominated in the first week (83 of 85 deaths [97.6%]) and then decreased to 59.5% (25 of 42 deaths) between 8 and 30 days after PCI.

Conclusion: The discriminatory ability of the NYSRS and the MCRS for in-hospital and 30-day mortality after PCI is roughly interchangeable. The risk of death is highest during the first 2 weeks and is dominated by cardiac causes of death.

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Percutaneous coronary intervention (PCI) is now used for many high-risk subgroups in which it was previously contraindicated.[1-3] Decision making for PCI is facilitated by predictive models that can assist patients and clinicians by providing an empirical estimate of procedural risks. Most risk scores, including the Mayo Clinic Risk Score (MCRS), have limited their outcome assessment after PCI to in-hospital events. To capture all the events related to PCI accurately and completely, 30-day event rates have recently been promulgated.[4-7]

To that end, the New York State Risk Score (NYSRS), based on clinical and invasive assessments, provides an estimate of 30-day mortality that can potentially serve as a risk assessment aid for PCI.[8] Unfortunately, the inclusion of angiographic variables in the model is a major limitation in clinical decision making at the time of first contact with the patient.[9] The need for detailed invasive results complicates the initial communication with the patient and family about treatment strategies.

For the past 3 decades, the Mayo Clinic database has captured in-hospital and long-term prognostic information on all PCIs performed at Mayo Clinic. Thus, it presents an ideal opportunity to compare the NYSRS with the MCRS developed from purely clinical and noninvasive data to determine whether an in-hospital mortality model can also predict 30-day mortality after PCI.

The typical causes of mortality and the daily mortality risk after PCI have not been well described. The mortality models have not differentiated between cardiac and noncardiac deaths, and it is unclear how the risk of mortality after PCI declines and whether and how the mortality risk differs on the basis of type of presentation.

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With that background, 2 objectives of this study were to compare the NYSRS with the MCRS to see whether a simpler in-hospital mortality model using only clinical and noninvasive information also predicts 30-day mortality and to define the causes and risk of 30-day death after PCI.

PATIENTS AND METHODS

This study focused on 4898 unique patients who underwent PCI at Mayo Clinic in Rochester, Minnesota, from January 1, 2007, through December 31, 2010. We excluded 46 patients without complete 30-day follow-up. Among patients with more than one PCI during the study period, only the earliest PCI was included. The outcome for this analysis was the incidence of 30-day mortality after PCI. The definitions used by the NYSRS are similar to those used in the Mayo Clinic database for variables included in the risk model and also for in-hospital death.[8]

Development and Validation of the NYSRS

The original NYSRS was obtained from New York's Percutaneous Coronary Interventions Reporting System in 2008 and 2009 and was internally validated using data from 54,223 patients who underwent PCI in nonfederal hospitals in New York state. Information in the registry includes lesion- and vessel-specific data, demographic characteristics, risk factors, complications, and discharge information. The model for in-hospital mortality had excellent ability to discriminate between high-risk and low-risk patients (C statistic, 0.89). The probabilities estimated from the model also matched the observed data well, as indicated by a nonsignificant Hosmer-Lemeshow goodness-of-fit test result.[8]

TABLE 1. Variables Used to Calculate the New York State and Mayo Clinic Risk Scores

New York State Risk Score	Mayo Clinic Risk Score
Age	Age
Hemodynamic state	Preprocedural cardiogenic shock
Ejection fraction	Ejection fraction
Preprocedural myocardial infarction, with or without ST-segment elevation	Preprocedural myocardial infarction (≤24 h)
Preprocedural myocardial infarction, onset to reperfusion time	Peripheral vascular disease
Peripheral vascular disease	Congestive heart failure on presentation
History of congestive heart failure	Creatinine level
Malignant ventricular arrhythmia	
Chronic obstructive pulmonary disease	
Creatinine level	
Multivessel disease	
Left main coronary artery disease	

Mayo Clinic Database and the MCRS

The Mayo Clinic database includes clinical, procedural, and angiographic data on all patients undergoing PCI. A research coordinator contacts all patients who have undergone PCI at 6 months, 1 year, and annually thereafter. Medical records, including electrocardiograms, death certificates, and laboratory parameters of all patients requiring hospitalization at Mayo Clinic or elsewhere, are reviewed to further characterize any clinical events during follow-up. Random monthly audits of data by the study coordinators are performed to identify and rectify inconsistencies in the data. The strengths of the registry include the use of standardized definitions, rigorous data quality and auditing procedures, and large sample size.

The MCRS has been previously described and is derived from clinical and noninvasive variables. It consists of 7 preprocedural variables: age, myocardial infarction within the preceding 24 hours, preprocedural cardiogenic shock, serum creatinine level, left ventricular ejection fraction, congestive heart failure, and peripheral arterial disease.[5] Table 1 shows the variables used by the 2 risk scores.

Ascertainment of Causes of Death

Deaths were primarily ascertained via scheduled surveillance telephone contact of all PCI patients. Communication with the Mayo Clinic registration office, which serves as a central repository of all patient death notifications, provided an additional source. On identification of a death, details were obtained through telephone contact with the family and outside physician and through review of local and external medical records. Death certificates were requested for all patients. Experienced data technicians recorded details of each death and performed initial classification.

Statistical Analyses

Data are summarized as mean ± SD for continuous data and frequency (percentage) for discrete data. The NYSRS estimated 30-day mortality risk was recalibrated for our data set as follows. The

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