# Predicting In-Hospital Mortality in Patients With Acute Myocardial Infarction

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## ABSTRACT

**BACKGROUND** As a foundation for quality improvement, assessing clinical outcomes across hospitals requires appropriate risk adjustment to account for differences in patient case mix, including presentation after cardiac arrest.

**OBJECTIVES** The aim of this study was to develop and validate a parsimonious patient-level clinical risk model of in-hospital mortality for contemporary patients with acute myocardial infarction.

**METHODS** Patient characteristics at the time of presentation in the ACTION (Acute Coronary Treatment and Intervention Outcomes Network) Registry–GWTG (Get With the Guidelines) database from January 2012 through December 2013 were used to develop a multivariate hierarchical logistic regression model predicting in-hospital mortality. The population (243,440 patients from 655 hospitals) was divided into a 60% sample for model derivation, with the remaining 40% used for model validation. A simplified risk score was created to enable prospective risk stratification in clinical care.

**RESULTS** The in-hospital mortality rate was 4.6%. Age, heart rate, systolic blood pressure, presentation after cardiac arrest, presentation in cardiogenic shock, presentation in heart failure, presentation with ST-segment elevation myocardial infarction, creatinine clearance, and troponin ratio were all independently associated with in-hospital mortality. The C statistic was 0.88, with good calibration. The model performed well in subgroups based on age; sex; race; transfer status; and the presence of diabetes mellitus, renal dysfunction, cardiac arrest, cardiogenic shock, and ST-segment elevation myocardial infarction. Observed mortality rates varied substantially across risk groups, ranging from 0.4% in the lowest risk group (score <30) to 49.5% in the highest risk group (score >59).

**CONCLUSIONS** This parsimonious risk model for in-hospital mortality is a valid instrument for risk adjustment and risk stratification in contemporary patients with acute myocardial infarction. (J Am Coll Cardiol 2016;68:626–35) © 2016 by the American College of Cardiology Foundation.

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Mortality from cardiovascular disease has decreased dramatically over the past few decades (1), in part because of improvements in acute myocardial infarction (AMI) management (2). In-hospital mortality has decreased from 29% in 1969 (3) to <7% today (4,5). However, more than 100,000 people continue to die after AMIs in the United States each year (1), and in-hospital mortality varies substantially across hospitals (5), suggesting an opportunity for improvement. Adjustment for the variation in patient risk across hospitals is essential to enable a more accurate assessment of each hospital's performance and opportunity to improve.

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Although many risk models of in-hospital mortality have been developed for patients with AMI (6–13), few have included a representative sample from routine clinical care. In 2011, a simple, validated risk model was developed using data from the ACTION (Acute Coronary Treatment and Intervention Outcomes Network) Registry-GWTG (Get With the Guidelines), which included patients from more than 300 hospitals (14). Since that time, ACTION Registry-GWTG collection has been expanded to identify patients presenting after cardiac arrest at the time of AMI presentation. Being able to adjust for cardiac arrest is

critical because it is a well-documented predictor of mortality (10,15). Moreover, continued improvement in AMI care mandates periodic updates to the risk models so that hospitals can assess their quality as contemporary care continues to evolve.

To update the existing ACTION-GWTG mortality risk model, we rebuilt the ACTION Registry-GWTG in-hospital mortality risk model using data from January 2012 through December 2013. We also sought to build a parsimonious risk score that could be used prospectively for risk stratification. These tools are designed to be used to further support quality improvement and to aid in clinical management during an AMI.

## METHODS

ACTION Registry-GWTG is a voluntary, hospital-based registry that receives data on consecutive patients admitted with AMI, either ST-segment elevation myocardial infarction (STEMI) or non–ST-segment elevation myocardial infarction (NSTEMI), from participating hospitals across the United States. The ACTION Registry-GWTG design and methods have been described previously (16). Briefly, participating hospitals collect data through retrospective chart review using standardized data
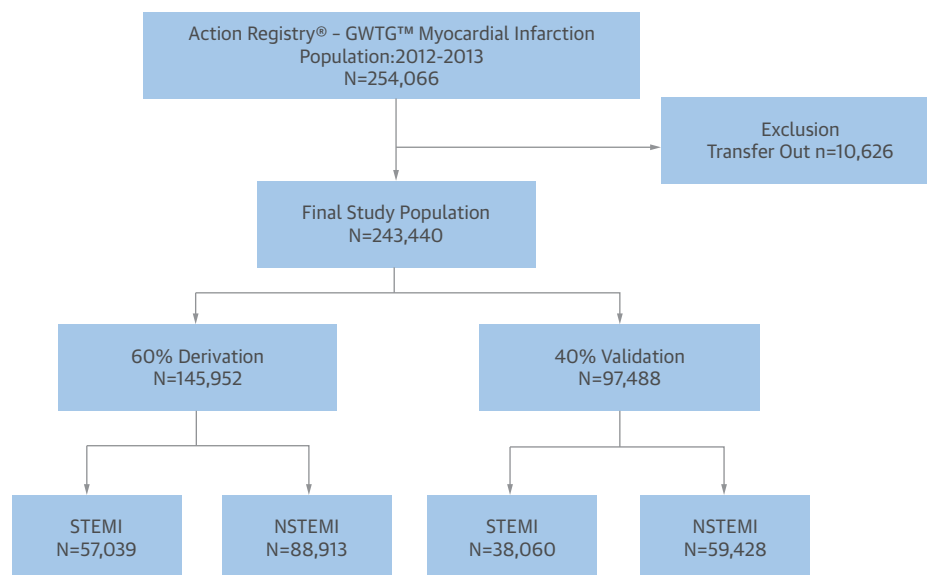


**FIGURE 1  Patient Flow Diagram**

The study population enrolled from ACTION (Acute Coronary Treatment and Intervention Outcomes Network) Registry-GWTG (Get With the Guidelines) was divided into derivation and validation cohorts. NSTEMI = non–ST-segment elevation myocardial infarction; STEMI = ST-segment elevation myocardial infarction.