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Survival of Patients Undergoing Rescue Percutaneous Coronary Intervention

Development and Validation of a Predictive Tool

Sukesh C. Burjonroppa, MD,* Paul D. Varosy, MD,† Sunil V. Rao, MD,‡
Fang-Shu Ou, MS,§ Matthew Roe, MD, MHS,§ Eric Peterson, MD,‡§
Mandeep Singh, MBBS,‖ Kendrick A. Shunk, MD¶

Fort Worth, Texas; Denver, Colorado; Durham, North Carolina; Rochester, Minnesota; and San Francisco, California

Objectives This study sought to develop a tool for predicting an individual's risk of mortality following rescue percutaneous coronary intervention (PCI).

Background Although fibrinolytic therapy is appropriate and improves survival for certain ST-segment elevation myocardial infarction patients, a substantial proportion suffer ongoing myocardial ischemia, a class I indication for emergent percutaneous coronary intervention (rescue PCI).

Methods Using the National Cardiovascular Data Registry (NCDR), rescue PCI was defined as non-elective PCI following failed fibrinolysis in patients with continuing or recurrent myocardial ischemia. Multivariable logistic regression was used to determine mortality predictors and the C-statistic for model discrimination. The NCDR-RESCUE (Real-World Estimator of Survival in Catheterized STEMI Patients Following Unsuccessful Earlier Fibrinolysis) score was developed using a shortened list of 6 pre-angiographic variables and 70% of the cohort; performance was subsequently validated against the remaining 30%.

Results Among 166,516 PCI procedures on patients with an admission diagnosis of ST-segment elevation myocardial infarction, 8,007 (4.8%) represented rescue PCI. In-hospital mortality occurred in 464 (5.8%). Factors in the final model were age, glomerular filtration rate, history of congestive heart failure, insulin-treated diabetes, cardiogenic shock, and salvage status. The NCDR-RESCUE score effectively segregated individuals into 6 clinically meaningful risk categories, with 0.4% (0.0% to 1.3%), 1.6% (0.9% to 2.4%), 7.6% (5.3% to10.4%), 27.5% (20.7% to 35.1%), 64.2% (49.8% to 76.9%), or 100% (59.0% to 100.0%) risk, respectively, of in-hospital mortality (mean ± 95% confidence interval, C-index = 0.88, Hosmer-Lemeshow p = 0.898).

Conclusions In-hospital mortality risk among individuals undergoing rescue PCI varies from minimal to extreme and can be easily calculated using the NCDR-RESCUE score. This information can be of value in counseling patients, families, and referring caregivers. (J Am Coll Cardiol Intv 2011;4: 42–50) © 2011 by the American College of Cardiology Foundation

From the *Fort Worth Heart PA, Fort Worth, Texas; †Denver Veterans Affairs Medical Center, and University of Colorado, Denver School of Medicine, Denver, Colorado; ‡Duke University Medical Center, Durham, North Carolina; §Duke Clinical Research Institute, Durham, North Carolina; ‖Mayo Clinic, Rochester, Minnesota; and the ¶University of California–San Francisco and the San Francisco Veterans Affairs Medical Center, San Francisco, California. Dr. Rao is a consultant for sanofi-aventis, Bristol-Myers Squibb, AstraZeneca, Daiichi Sankyo-Lilly, The Medicines Company, and Terumo USA; and has received research funding from Portola, Cordis Corp., Novartis, and Ikaria. Dr. Shunk received research support from Abbott Vascular, and Siemens Medical Systems; he is on the Advisory Board for GE Healthcare; and he has intellectual property rights from SurgiVision Options (modest) and Revascular Therapeutics. All other authors have reported that they have no relationships to disclose.

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In patients with ST-segment elevation myocardial infarction (STEMI) survival is strongly dependent on the time to reperfusion, whether it be mechanical or pharmacological (1–5). Despite potential advantages of primary percutaneous coronary intervention (PCI), it is not always available and is used as the initial reperfusion strategy in only 38% of all patients presenting with STEMI (6). Fibrinolytic therapy remains the most common initial therapy for STEMI in the U.S. and worldwide (7–9). For example, 27.6% of all U.S. patients reported in the NRMI (National Registry of Myocardial Infarction) database in 2006 received fibrinolytic treatment (10). An initial fibrinolytic strategy restores normal flow (Thrombolysis In Myocardial Infarction [TIMI] flow grade 3) in only about 50% to 60% of STEMI patients at 90 min (11). Successful pharmacological reperfusion is less commonly achieved in elderly patients and patients with cardiogenic shock and is also associated with increased risk of intracranial bleed in elderly patients (12–14).

Based on limited randomized data, rescue PCI appears superior to conservative therapy following incomplete or unsuccessful fibrinolysis and merits more frequent consideration (15,16). Considering these studies and expert opinion, the recent European Society of Cardiology as well as the American College of Cardiology/American Heart Association STEMI guidelines favor urgent/emergent rescue PCI for many patients who fail to (fully) achieve reperfusion by 90 min following administration of fibrinolytic therapy (17,18).

The outcomes of rescue PCI have not been well described in community practice. Randomized trials have been small and universally have struggled with difficult enrollment. The paucity of randomized data is reflected in a recent meta-analysis of all 6 randomized rescue PCI trials with a combined total of 908 patients (19). Contemporary efforts to define the incidence and predictors of mortality in this rescue PCI population are lacking in the literature. Furthermore, only limited information on the major predictors of this outcome is available. The sheer volume of reported cases in the NCDR (National Cardiovascular Data Registry) make it a valuable resource for further examination of predictors of mortality and for development and validation of a tool for prediction of an individual's probability of being alive at the time of hospital discharge following rescue PCI.

Using the NCDR database, we determined the incidence and predictors of mortality in STEMI patients undergoing rescue PCI after failed fibrinolytic therapy. We then created a simplified survival prediction tool for this important patient population using 70% of the dataset and subsequently validated it against the remaining 30% of the dataset.

Methods

Data registry and selection. The NCDR is a national catheterization/PCI registry that has data from 811 participating hospitals. The participating hospitals provide standard data following written definitions and abiding by uniform data entry and transmission requirements. Submitted data undergo quality checks at NCDR. Details on the data collection process have previously been published (20,21). The study population consisted of all STEMI patients undergoing rescue PCI in the hospitals contributing to the NCDR during the period from January 1, 2004 to March 31, 2008 (Table 1).

Definition of rescue PCI. A rescue PCI was identified by requiring all the following. 1) Admission diagnosis was STEMI. 2) Operator indicated that the procedure was a rescue PCI, i.e., PCI followed failed fibrinolysis for a patient with persistent or recurrent myocardial ischemia (i.e., not a facilitated PCI). 3) The PCI status was indicated as urgent, emergent, or salvage (not elective). In addition, patients were excluded if more than 2 components among baseline features were missing. This is depicted in Figure 1.

Outcomes. The primary outcome event was in-hospital mortality.

Statistics. Of the data elements in the NCDR data form, 21 of the most plausible, known risk factors including those as identified in previous research (22) or as identified in the committee's clinical experience constituted the list of initial candidate predictors (Table 2). The variables include: age, sex, Caucasian race, body mass index, glomerular filtration rate (GFR) (modification of diet in renal disease), renal failure, diabetes, cerebrovascular disease, peripheral vascular disease, chronic lung disease, hypertension, family history of coronary artery disease, prior myocardial infarction, prior congestive heart failure, prior PCI, prior coronary artery bypass graft, New York Heart Association functional class, cardiogenic shock, pre-procedural intra-aortic balloon pump, PCI status, and symptom onset time to presentation. Multivariate logistic regression with a backward selection method ($p < 0.05$ to remain in the model) was then performed to identify independent predictors of mortality. Differences in baseline characteristics between derivation cohort and validation cohort were compared using Wilcoxon 2-sample test for continuous variables and chi-square test for categorical variables. With the goal of calculating a mortality risk score, the cohort was randomly divided into 2 parts: a derivation set (70% of the data) and a validation set (30% of the data). Missing values were imputed to the lower risk group for discrete variables, and replaced with sex, renal failure/dialysis-specific medians for estimated GFR. In the derivation set, the associations of rescue PCI for individual candidate risk factors with mortality were calculated with

Abbreviations and Acronyms

CI = confidence interval

GFR = glomerular filtration rate

GP = glycoprotein

PCI = percutaneous coronary intervention

STEMI = ST-segment elevation myocardial infarction

Table 1. Baseline Characteristics

Characteristic	Derivation Cohort (n = 5,569)	Validation Cohort (n = 2,438)	p Value
Demographics			
Age, yrs, median (25th–75th)	57 (50–66)	58 (50–67)	0.09
Male sex	4,191 (75.3)	1,827 (74.9)	0.8
Race			0.9
Caucasian	4,878 (87.6)	2,128 (87.3)	
Black	224 (4.0)	93 (3.8)	
Hispanic	141 (2.5)	57 (2.3)	
Asian	57 (1.0)	31 (1.3)	
Native American	31 (0.6)	14 (0.6)	
Other	235 (4.2)	111 (4.6)	
Risk factors			
BMI, kg/m^2			
<18.5	62 (1.1)	24 (1.0)	0.5
≥18.5 and <30	62 (1.1)	24 (1.0)	
≥30	2,101 (37.7)	904 (37.1)	
Previous MI, >7 days	887 (15.9)	375 (15.4)	0.5
Previous CHF	192 (3.5)	83 (3.4)	0.9
Cerebrovascular disease	261 (4.7)	116 (4.8)	0.9
Peripheral vascular disease	258 (4.6)	120 (4.9)	0.6
Chronic lung disease	673 (12.1)	273 (11.2)	0.3
Hypertension	3,197 (57.4)	1,337 (54.8)	0.03
History of tobacco use			
Former	1,132 (20.3)	507 (20.8)	0.5
Current	2,810 (50.5)	1,197 (49.1)	0.3
Family history of CAD	1,304 (23.4)	547 (22.4)	0.96
Dyslipidemia	3,238 (58.1)	1,419 (58.2)	0.4
Glomerular filtration rate, ml/min			
<30	96 (1.7)	45 (1.9)	
>30 and <60	1,136 (20.4)	505 (20.7)	
>60 and <90	2,687 (48.3)	1,209 (49.6)	
>90	1,252 (22.5)	494 (20.3)	
Diabetes/control			0.4
Noninsulin diabetes	879 (15.8)	375 (15.4)	
Insulin diabetes	226 (4.1)	85 (3.5)	
Renal failure			0.8
Nondialysis	85 (1.5)	35 (1.4)	
Dialysis	26 (0.5)	9 (0.4)	
Cardiac status			
Previous PCI	849 (15.3)	365 (15.0)	0.8
Previous CABG	254 (4.6)	117 (4.8)	0.6
NYHA functional class			
IV	3,467 (62.3)	1,543 (63.3)	0.8
III	851 (15.3)	360 (14.8)	0.5
Cardiogenic shock	643 (11.6)	270 (11.1)	0.2
Period of symptom onset to admission			
≤6 h	4,045 (72.6)	1,806 (74.1)	
>6 h and ≤12 h	893 (16)	364 (14.9)	
>12 h and ≤24 h	356 (6.4)	138 (5.7)	
>24 h and ≤48 h	145 (2.6)	73 (3.0)	
>48 h and ≤7 days	116 (2.1)	45 (1.9)	

Demographic characteristics and risk factors of patients undergoing rescue PCI in the derivation and validation cohorts, respectively, with p values. Cohort data presented as n (%) unless otherwise indicated.

BMI = body mass index; CABG = coronary artery bypass graft; CAD = coronary artery disease; CHF = congestive heart failure; MI = myocardial infarction; NYHA = New York Heart Association; PCI = percutaneous coronary intervention.

hierarchical logistic regression models using generalized estimating equation (23) that accounted for clustering of data by clinical center, and these associations were presented as odds ratios with 95% confidence intervals (CI). Using a backward variable selection strategy and clinical judgment (criterion for retention in the model, $p \leq 0.05$), a multivariable hierarchical logistic regression model was constructed to determine the independent predictors of mortality.

Risk score. To simplify the scoring tool and to optimize its utility, only pre-angiographic variables were considered. Of the remaining variables, the 6 most plausible and powerful were left in the model. Using the beta coefficients of these 6 variables, a point scoring system was created to predict survival to discharge from the hospital (24). Once the risk score was derived, the performance of this risk prediction tool as a discriminator of actual mortality was assessed in the remaining 30% of the data (validation set). Mortality discrimination in the validation set for this model was determined by the use of the C-statistic. All comparisons were 2-tailed, and a p value <0.05 was considered statistically significant. All statistical analyses were performed by the Duke Clinical Research Institute using SAS software (version 9.0, SAS Institute, Cary, North Carolina).

Results

A total of 166,516 patients undergoing PCI following a presentation of STEMI were reported from the 811 participating hospitals between January 1, 2004, and March 31, 2008 (Fig. 1). The final study cohort consisted of 8,007 STEMI patients being treated with PCI in a rescue mode after a failed initial fibrinolytic strategy. "Facilitated" PCI patients without rescue criteria were not included. Within this strictly defined rescue PCI cohort, 464 (5.8%) expired during the index hospital admission.

Demographic and clinical characteristics. Demographic and clinical characteristics are shown in Table 1. Most patients were Caucasian men with median age of 58

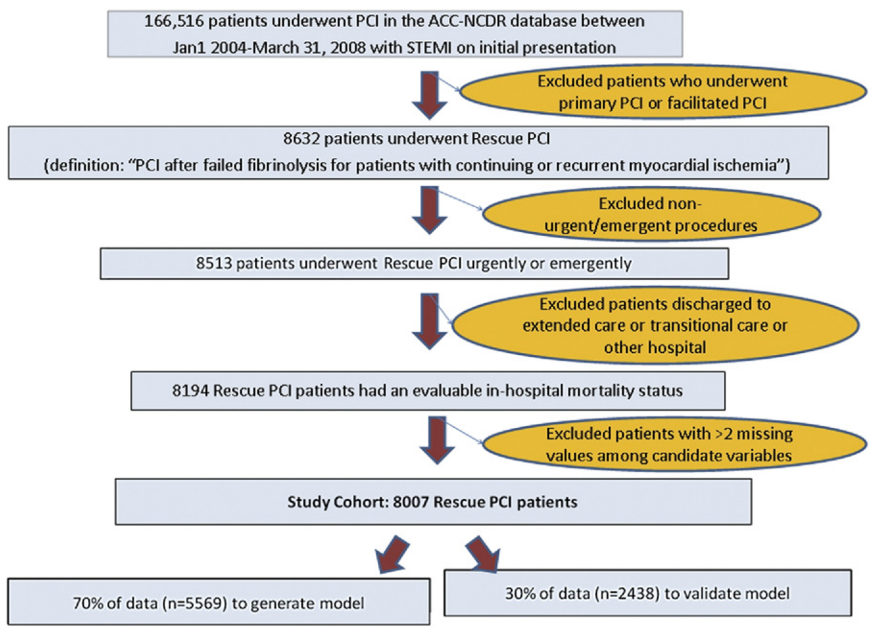


Figure 1. Flow Chart of Rescue PCI Patients

Of 166,516 patients who underwent percutaneous coronary intervention (PCI) for ST-segment elevation myocardial infarction, 8,632 patients underwent rescue PCI. Out of these, 625 patients were excluded for various reasons (nonurgent/emergent procedures, discharged to other hospital/transitional care, or missing >2 values among candidate variables). Study cohort consisting of 8,007 patients was divided into a derivation (70% of patients) group to generate a model and a validation (30% of patients) group to predict in-hospital mortality. ACC-NCDR = American College of Cardiology National Cardiovascular Data Registry.

years. Diabetic patients constituted 19.6% with 15.8% and 3.4% of patients having had past history of myocardial infarction and congestive heart failure, respectively. In 22.3% of patients, GFR ≤60 ml/min was noted. Additional clinical characteristics are shown in Table 1.

Predictors of mortality. Twenty-one candidate variables were considered. Multivariate logistic regression with a backward selection method ($p < 0.05$ to remain in the model) was then performed to identify 6 independent predictors of mortality. Table 2 depicts the multivariable logistic regression showing independent predictors of mortality using a generalized estimating equation. Independent predictors of mortality included: age, GFR, cardiogenic shock, salvage PCI status, prior congestive heart failure, and diabetes mellitus requiring insulin. The area under the receiver-operator characteristic curve (C-statistic) was 0.88, indicating excellent mortality discrimination.

Risk score for rescue angioplasty. Table 3 depicts the simplified survival prediction tool developed for this rescue PCI population, the NCDR-RESCUE (Real-World Estimator of Survival in Catheterized STEMI Patients Following Unsuccessful Earlier Fibrinolysis) score. This tool was derived from 70% of the dataset and validated against the remaining 30% of the dataset, with excellent performance (C-index =0.88). Figure 2A shows a good linear correlation between the observed and predicted mortality. Figure 2B shows the distribution of scores in both the derivation and the validation groups and the predicted mortality within various arbitrary score range. The remarkable feature of this risk estimator tool is that it enables the investigator to arbitrarily segregate patients into 6 clinically meaningful risk categories based on the risk score. The numbers of patients in Categories I to VI were as follows: 557 (22.8%) in Category I, 1,211 (49.7%) in Category II, 450 (18.5%) in Category III, 160 (6.6%) in Category IV, 53 (2.2%) were noted in Category V, and 7 (0.003%) patients were noted in Category VI. The risk of mortality in Category I with 0 to 9 points was 0.4% (95% CI: 0.0% to 1.3%). Category II with 10 to 19 points had a mortality risk of 1.6% (95% CI: 0.9% to 2.4%). Category III accrued 20 to 29 points and a 7.6% (95% CI: 5.3% to 10.4%) risk of mortality. Category IV with 30 to 39 points had a mortality risk of 27.5% (95% CI: 20.7% to 35.1%). The Category V patients accrued 40 to 49 points and had a mortality risk of 64.2% (95% CI: 49.8% to 76.9%) whereas the Category VI patients who scored ≥50 points suffered a risk of mortality of 100% (95% CI: 59% to 100%). The exact risks in both the derivation and the validation groups are shown in Figure 2B.

Table 2. Multivariate Predictors of Mortality

	Unadjusted					Adjusted +				
Variable	OR	Lower (95% CI)	Upper (95% CI)	p Value	Chi-Square	OR	Lower (95% CI)	Upper (95% CI)	p Value	Chi-Square
Cardiogenic shock	19.18	14.82	24.81	<0.001	504.5	12.66	9.55	16.78	<0.001	312.3
Age, per 10-yr increase	1.07	1.06	1.08	<0.001	172.8	1.64	1.45	1.86	<0.001	63.28
GFR, per 10-U increase	0.95	0.94	0.95	<0.001	270.6	0.74	0.68	0.81	<0.001	47.24
PCI status = salvage	6.95	4.37	11.05	<0.001	67.32	3.58	2.31	5.57	<0.001	32.27
Prior CHF	4.24	2.95	6.07	<0.001	61.67	2.07	1.23	3.47	0.006	7.54
Insulin-treated diabetes	2.45	1.66	3.63	<0.001	20.08	2.09	1.23	3.54	0.006	7.46

Multivariate predictors of mortality based on the initial univariate variables with significant p values (<0.05) in the derivation cohort (n = 5,569). Salvage indicates any cardiopulmonary resuscitation before catheterization laboratory or procedure. Variables in the initial models: − age, sex, Caucasian race, BMI, GFR (modification of diet in renal disease), renal failure, diabetes, cerebrovascular disease, peripheral vascular disease, chronic lung disease, hypertension, family history of CAD, prior MI, prior CHF, prior PCI, prior CABG, NYHA functional class, cardiogenic shock, pre-operation intra-aortic balloon pump, PCI status, symptom onset time to presentation.

CI = confidence interval; GFR = glomerular filtration rate; other abbreviations as in Table 1.

Discussion

There is a paucity of data on rescue PCI in community-based practice. This is an effort to develop a model for predicting mortality in this high-risk group to help better risk stratify patients to achieve optimal outcomes. Despite marked increase in primary PCI as the strategy of choice for STEMI patients, a significant number of these patients are treated with an initial thrombolytic strategy either due to lack of access to primary PCI or the time difference of door-to-balloon from door-to-needle time being >1 h. Despite the limitations of fibrinolytic therapy compared with primary PCI, data indicate that many physicians often do not assess the success of reperfusion in patients who receive fibrinolysis, and only a minority favored an interventional strategy in cases of failed fibrinolysis (25), possibly due to incorrect perceptions of the risk/benefit of PCI in this setting.

The main strengths of this study include the large sample size, reflection of actual community practice of patients presenting with rescue PCI, and provision of a robust risk model for mortality based on pre-procedural variables. The size of the cohort-with 8,007 subjects—increases the published outcomes experience on rescue PCI by an order of magnitude and reflects actual community practice. Observational in nature, the main strength of the CathPCI registry is that its data reflect how clinicians as a group are actually negotiating a number of sequential decision nodes as an integrated function of all inputs, including availability of limited randomized trial data, extrapolation from related clinical scenarios for which data do exist, and nonclinical inputs. The study helps the cardiologist to stratify risk into different categories based on the easily defined pre-procedural covariates and will help health care providers, patients, and families to make informed decisions based on objective data. One can predict the probability of an individual being alive to hospital discharge with the NCDR-RESCUE score, which highlights the value of this novel and now validated prediction tool. A rescue PCI patient can be placed into 6 meaningful risk groups that correspond to clinically important categories of in-hospital mortality risk, ranging from Category I (0.4%, 95% CI: 0.0% to 1.3%) to Category VI (100%, 95% CI: 59% to 100%) with incremental increase in risk for in-between categories.

Our findings regarding magnitude and predictors of risk of mortality in this population are best understood in the context of prior studies. Difficulty in enrollment has limited previous studies. The MERLIN (Middlesbrough Early Revascularization to Limit Infarction) study (26) showed a significant reduction of the primary composite end point—driven by unplanned revascularization rather than mortality—in the rescue PCI arm compared with conservative therapy for STEMI patients failing to reperfuse following fibrinolytic therapy. Similarly, the REACT (Rescue Angioplasty Versus Conservative Treatment or Repeat Thrombolysis) trial demonstrated that rescue PCI, when compared with repeat fibrinolytic therapy or conservative management, was associated with no mortality benefit but an improvement in the composite of death, reinfarction, stroke, or severe heart failure (15). In both of these trials, rescue PCI was associated with increased bleeding, which has been demonstrated to be an adverse prognostic indicator (15,27,28). The previously reported in-hospital mortality rate from studies on patients undergoing rescue angioplasty including mostly observational nonrandomized studies and few randomized data falls within a wide range of 2% to 12% (29–33), although direct comparison to our 5.8% overall mortality is complicated by differing methodologies in the time of ascertainment of mortality. In REACT, mortality (6.2%) was measured at 6 months, and in MERLIN, at 30 days (9.8%) and at 1 year (14.4%) (15,26,28). The recently published 1-year results of the REACT trial showed a sustained benefit for RESCUE PCI with mortality rate of 11.2% in this high risk group

Table 3. The NCDR-RESCUE Score

Variable	Points
Presence of cardiogenic shock	
Yes	16
No	0
Age, yrs, per 10-yr increase	
<30	0
30–39	3
40–49	6
50–59	9
60–69	12
70–79	15
80–89	18
90–99	21
GFR, per 10-U decrease, ml/min	
≥90	0
80–89	1
70–79	3
60–69	5
50–59	6
40–49	8
30–39	10
20–29	12
10–20	14
<10	16
Salvage status, any CPR	
Yes	8
No	0
Prior CHF	
Yes	4
No	0
Diabetes mellitus treated with insulin	
Yes	5
No	0

Example: 68-year-old nondiabetic patient with GFR = 50 ml/min and no prior history of CHF, presenting with cardiogenic shock and no CPR has been administered: NCDR-RESCUE score = 12 + 6 + 16 + (0) + (0) + (0) = 34. Figure 2B facilitates conversion of score to absolute mortality risk.
CPR = cardiopulmonary resuscitation; NCDR-RESCUE = Real-World Estimator of Survival in Catheterized STEMI Patients Following Unsuccessful Earlier Fibrinolysis score for predicting survival to hospital discharge in patients presenting for rescue PCI; other abbreviations as in Tables 1 and 2.

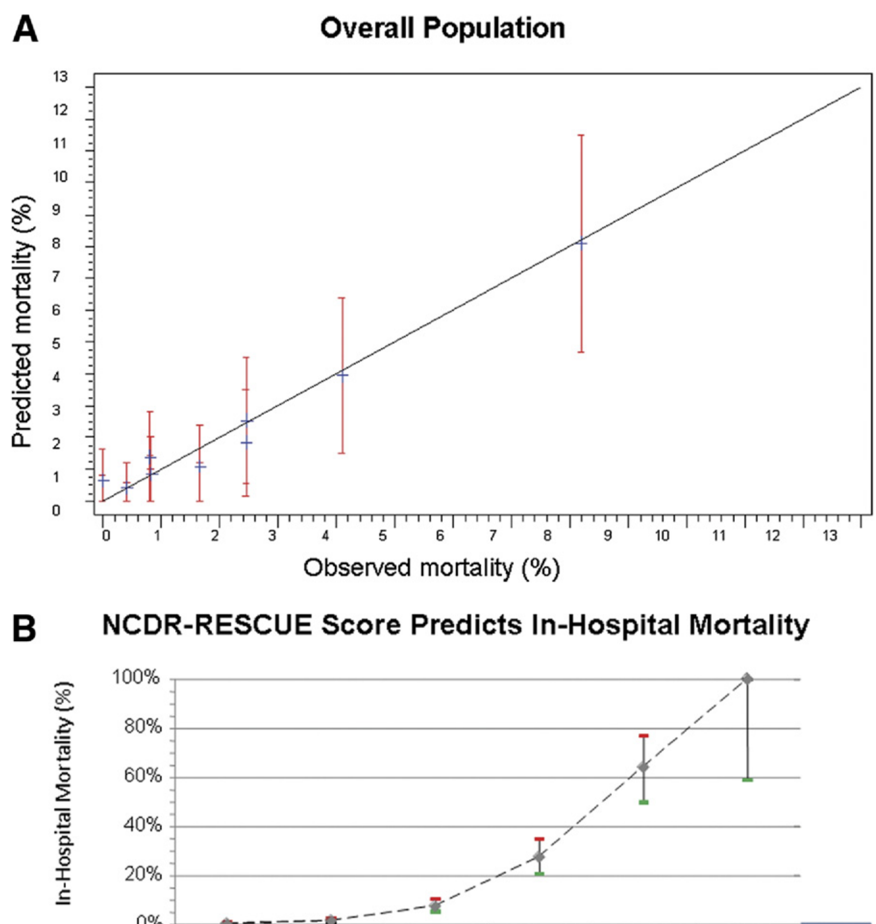
compared with 22.3% in the repeat thrombolysis and 22.4% in conservative treatment groups (34).

The factors that may have favorably influenced mortality in our study may reflect certain technical advances and other shifts in PCI practice patterns since the time of enrollment in MERLIN and REACT. In our patient population, 59% received glycoprotein (GP) IIb/IIIa inhibitor and 92.6% received stents; in the positive REACT trial (15), 43.4% of patients received GP IIb/IIIa inhibitors and 68.5% received stents. In contrast, in the negative MERLIN trial, 3.3% received GP IIb/IIIa inhibitors and only 50.3% received stents (28). The practice patterns have possibly shifted toward greater GP IIb/IIIa inhibitor usage in response to data showing lower mortality using abciximab (vs. no abciximab) in the setting of rescue PCI (35,36). The patient population we studied was much sicker and included 4.9% who had undergone any cardiopulmonary resuscitation and 11.4% with cardiogenic shock. Both of these conditions were exclusions from the REACT trial and presumably in MERLIN trial, although the investigators did not report this.

Comparing the current predictive model to a previous STEMI-population predictive model derived from the CADILLAC trial (37) in primary PCI, there are remarkable similarities. Although the presence of renal insufficiency, age, and history of congestive heart failure are common to both models, we excluded post-angiographic variables in the calculation of the NCDR-RESCUE score to improve its usefulness in the clinical setting. An individualized risk assessment can be invaluable in guiding patient and family discussion and setting realistic expectations of outcome.

Each of the final 6 inputs to our RESCUE survival prediction tool also has a sound basis in the published literature as a mortality predictor in similar or related clinical settings. Cardiogenic shock provides the strongest adjusted odds ratio (12.7) of the simplified model's 6 final input variables, which is consistent with the PCI arm in SHOCK (Should We Emergently Revascularize Occluded Coronaries for Cardiogenic Shock?) trial (38). Age was an important and powerful independent predictor of mortality in our study, which is consistent with previous studies (39,40). Impaired renal function, as reflected by a diminished estimated GFR calculated from a single creatinine measurement, was also a notably potent predictor of mortality similar to the GRACE (Global Registry of Acute Coronary Events) registry (41). Diabetic status and prior diagnosis of congestive heart failure each contributed independently as well, although to a modest extent when compared with the other 4 factors in agreement with published reports (40). In the subgroup of patients who have undergone any cardiopulmonary resuscitation before PCI (salvage status), PCI was another independent predictor of mortality in our final simplified model. The negative impact of the need for cardiopulmonary resuscitation on the patient's likelihood of survival to discharge from the hospital is not unanticipated and has been documented in numerous patient subsets (42).

This study from the NCDR registry is the largest series of patients undergoing rescue angioplasty. The dataset provides a real-world estimate of mortality in contemporary practice including use of stents, GP IIb/IIIa antagonist, and thienopyridine with beta-blockers, statins, and angiotensin-converting enzyme inhibitors. There has been recent published data of overall mortality prediction from the NCDR population for patients undergoing PCI (22). However, we believe that the rescue PCI population dataset is unique and warrants a separate model that would facilitate providers to



RESCUE Score→	0--9	10--19	20--29	30--39	40--49	≥50	0--59
Upper CI	1.3%	2.4%	10.4%	35.1%	76.9%	100.0%	6.7%
Lower CI	0.0%	0.9%	5.3%	20.7%	49.8%	59.0%	4.8%
Mortality	0.4%	1.6%	7.6%	27.5%	64.2%	100.0%	5.7%
N	557	1211	450	160	53	7	2438

Figure 2. Correlation of Predicted Versus Observed Mortality and NCDR Rescue Score Used To Predict In-Hospital Mortality

(A) Predicted mortality versus observed mortality in the derivation versus validation cohorts in rescue percutaneous coronary intervention patients shows a good correlation. **(B)** For individual patients, the points are calculated to predict in-hospital mortality as described in legend of Table 3. Data are shown with 95% confidence interval (CI). Abbreviations as in Figure 1.

make clinical decisions. This is reinforced by the overall in-hospital mortality of 5.8% with a wide range from 0.4% to 100% depending on patient characteristics predicating the requirement of a tool such as this to provide individualized risk estimation for patients who fail to reperfuse after fibrinolytic therapy. Personalized risk information of this sort can be invaluable in guiding triage decisions and discussions with patients, families, and colleagues. It is our hope that this tool may prevent the lack of an appropriate referral for a potentially life-saving rescue PCI procedure because of an incorrect perception of mortality risk.

Study limitations. Although this is the largest reported examination of mortality predictors in the rescue PCI population, it is fundamentally derived from a self-reported retrospective cohort registry, without independent core laboratory assessment of angiographic variables. Because only in-hospital mortality was captured and 3.7% of the cohort was transferred to another facility following rescue PCI, uncertainty is introduced around our reported overall mortality risk of 5.8%. In paired sensitivity analyses—assuming 0% or 100% mortality following transfer—overall mortality boundaries were 5.6% to

9.6%. However, assuming 100% mortality for transferred patients failed to appreciably change the multivariable model. The ability of the novel RESCUE survival prediction tool to predict outcomes beyond hospital discharge remains unexamined. Also unattainable was information regarding the outcomes of patients who were managed without a catheterization laboratory. In addition, the study was observational in nature and unmeasured confounders cannot be excluded. Finally, these findings have not been validated against other databases outside of the NCDR CathPCI population, as no other suitable comparator dataset on this important patient group exists.

Conclusions

Overall risk of in-hospital mortality among patients undergoing rescue PCI in the NCDR CathPCI registry is 5.8% (95% CI: 4.8% to 6.7%). Within this population of STEMI patients who have failed to clinically reperfuse, it is possible to quickly and easily place an individual patient into 1 of 6 risk categories with mortality range between 0.4% in Category I to 100% in Category VI using the NCDR-RESCUE tool, derived from only 6 clinical input variables, all readily discernable before angiography. This NCDR-RESCUE tool has the potential to quickly and accurately provide the clinician with critical prognostic information to inform, triage, and guide patient and family discussions for this important and vulnerable population.

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Reprint requests and correspondence: Dr. Sukesh C. Burjonroppa, Interventional Cardiology and Vascular Specialist, Fort Worth Heart PA, 1300 West Rosedale, Fort Worth Heart PA, Fort Worth, Texas 76104. E-mail: sukeshbc@yahoo.com.

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Key Words: acute myocardial infarction ■ predictive tool ■ rescue percutaneous coronary intervention.

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Sukesh C. Burjonroppa, Paul D. Varosy, Sunil V. Rao, Fang-Shu Ou, Matthew Roe, Eric Peterson, Mandeep Singh, and Kendrick A. Shunk

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