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Hospital Strategies for Reducing Risk-Standardized Mortality Rates in Acute Myocardial Infarction

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Abstract

Background—Despite recent improvements in survival after acute myocardial infarction (AMI), U.S. hospitals vary 2-fold in their 30-day risk-standardized mortality rates (RSMRs). Nevertheless, information is limited on hospital-level factors that may be associated with RSMRs.

Objective—To identify hospital strategies that were associated with lower RSMRs.

Design—Cross-sectional survey of 537 hospitals (91% response rate) and weighted multivariate regression by using data from the Centers for Medicare & Medicaid Services to determine the associations between hospital strategies and hospital RSMRs.

Setting—Acute care hospitals with an annualized AMI volume of at least 25 patients.

Participants—Patients hospitalized with AMI between 1 January 2008 and 31 December 2009.

Measurements—Hospital performance improvement strategies, characteristics, and 30-day RSMRs.

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Results—In multivariate analysis, several hospital strategies were significantly associated with lower RSMRs and in aggregate were associated with clinically important differences in RSMRs. These strategies included holding monthly meetings to review AMI cases between hospital clinicians and staff who transported patients to the hospital (RSMR lower by 0.70 percentage points), having cardiologists always on site (lower by 0.54 percentage points), fostering an organizational environment in which clinicians are encouraged to solve problems creatively (lower by 0.84 percentage points), not cross-training nurses from intensive care units for the cardiac catheterization laboratory (lower by 0.44 percentage points), and having physician and nurse champions rather than nurse champions alone (lower by 0.88 percentage points). Fewer than 10% of hospitals reported using at least 4 of these 5 strategies.

Limitation—The cross-sectional design demonstrates statistical associations but cannot establish causal relationships.

Conclusion—Several strategies, which are currently implemented by relatively few hospitals, are associated with significantly lower 30-day RSMRs for patients with AMI.

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Although mortality from acute myocardial infarction (AMI) has significantly decreased during the past decade (1), substantial variation in 30-day risk-standardized mortality rates (RSMRs) persists across U.S. hospitals. National data from 2005 to 2008 indicate a 2-fold difference in RSMRs for AMI, with the top-performing hospital at 10.9% and the lowest-performing hospital at 24.9% (2). With public reporting of RSMRs and national focus on quality of care, hospitals are increasingly interested in how best to excel on this metric.

Nevertheless, we know little about modifiable factors that are associated with hospital RSMRs. Use of aspirin, β -blockers, and rapid reperfusion therapy can reduce mortality in appropriate patients (3, 4); however, with the current high adherence to medication and time to reperfusion, these strategies explain only 6% of the variation in RSMRs after AMI among hospitals (5). Studies have also identified hospital characteristics that are associated with risk-adjusted mortality, such as teaching status (6), AMI volume (7, 8), safety net status (9, 10), and geographic and urban or rural location (11–15). Together, however, these factors leave much of the hospital-level variation in RSMRs unexplained (16). They are also not easily modified and therefore do not provide guidance for hospitals seeking improvement.

We thus sought to identify key hospital strategies that were associated with RSMRs for patients with AMI. We used a qualitative design to develop hypotheses and then tested them in a national survey of hospitals, assessing how particular strategies were associated with RSMR performance by using a positive deviance approach (17) with mixed methods (18). Our qualitative study, which has been previously reported (19), identified strategies pertaining to organizational values and goals, senior management involvement, staff expertise, communication and coordination among staff, and problem solving and learning that were prominent in top-performing hospitals and not apparent in poor-performing hospitals.

In the present study, we examined the statistical associations between hospital strategies and hospital RSMRs. Evidence from this study may help to guide clinicians, researchers, and policymakers in efforts to decrease the hospital-specific risk for patients dying after hospitalization for AMI.

Methods

Study Design

We conducted a cross-sectional study of acute care hospitals in the United States that publicly reported Centers for Medicare & Medicaid Services (CMS) data for RSMRs for AMI from 1 July 2005 through 30 June 2008 as previously described (20). We included hospitals with at least 75 AMI discharges during the 3-year period ($n = 2120$); we excluded hospitals that could not be linked to the 2006 American Hospital Association hospital survey ($n = 151$). From the remaining hospitals ($n = 1969$), we drew a random sample of 600 hospitals; attempted contact for survey participation during 2009 and 2010; and asked them to report strategies in use from January 2008 to December 2009, the period for which the most recent RSMR data were available.

The sample size of 600 hospitals was calculated conservatively, assuming at least 350 respondents, which provided 80% statistical power to detect a difference in RSMR of 1.0% between 2 subgroups of 10% of responding hospitals. Of the 600 hospitals that we attempted to contact, 10 had closed, resulting in a total of 590 hospitals surveyed. We sent a letter of invitation to participate in the study to the chief executive officer of all selected hospitals and asked him or her to identify the person most involved in AMI quality improvement efforts (typically the director of quality improvement or director of cardiology), whom we then contacted to complete the Web-based survey. Respondents were instructed to coordinate with other relevant staff to complete a single survey that reflected the hospital's strategies. All research procedures were approved by the institutional review board at the Yale School of Medicine.

Measures and Data Collection

We designed a Web-based survey to assess the use of specific strategies based on our qualitative study (19) and clinical experience. We examined concepts, wording, and specific descriptions of strategies from the text of our open-ended interviews to develop closed-ended, multiple-choice questions for each strategy, as recommended by experts in mixed methods (18, 21). Appendix Table 1 (available at www.annals.org) shows how the qualitative data informed the quantitative survey items. We field-tested the closed-ended items by using cognitive interviews (22) with hospital quality improvement directors to assess clarity and comprehensiveness. We asked about strategies in place during the time that matched the most recent RSMR data available (January 2008 to December 2009). The final survey (Supplement, available at www.annals.org) measured use of strategies for patients with AMI by using items that were designed to quantitatively measure the domains and concepts that emerged from our previous qualitative work (19). Appendix Table 2 (available at www.annals.org) shows the relationships between the domains from the qualitative study and the survey items. We also assessed each hospital's ability to perform primary percutaneous coronary interventions (PCIs) for ST-segment elevation MI. For survey questions that had more than 5% missing responses, we created a dummy indicator for the missing data.

The outcome was 30-day hospital RSMR based on hospital discharges between 1 January 2008 and 31 December 2009. We calculated the RSMR on the basis of 2 years of data for each hospital by using the same CMS methodology for publicly reported RSMRs (23, 24). For each hospital, the RSMR was calculated by dividing the predicted number of deaths within 30 days of admission at that hospital by the expected number of deaths within 30 days of admission at the hospital, assuming average performance, and then multiplying this ratio by the overall 30-day mortality rate of the cohort.

The method of estimation (23–25) accounts for sampling variability due to differences in hospital AMI volume, the hierarchical structure of the data, and the lack of independence among patients treated in the same hospital. Specifications for the RSMR for patients with AMI, including patient-level variables (for example, medical history, clinical comorbid conditions, age, and sex) used for standardization, have been previously described (2, 26–28). We used bootstrapping with 2000 samples to obtain variance estimates for each hospital RSMR, as detailed in the published methods (27, 28) used for calculating CIs for publicly reported RSMRs.

We obtained data on hospital structural characteristics from the 2008 American Hospital Association survey of hospitals, including teaching status, number of staffed beds (fewer than 300, 300 to 600, and more than 600), geographic region, and volume of AMIs (25 to 75, 76 to 125, 126 to 250, and more than 250 discharges annually). Cardiac capability was measured by an indicator for whether the hospital performed primary PCI as reported on the Web-based survey.

Statistical Analysis

For each strategy, we determined the number and percentage of hospitals in each response category, as well as the mean and SD of 30-day RSMRs, weighted by the inverse variance of the RSMR, for hospitals in that category. We compared respondent and nonrespondent hospitals in terms of teaching status, AMI volume, geographic region, cardiac capability, and RSMR by using *t* tests and chi-square tests. We also assessed whether the RSMR of surveyed hospitals differed significantly from that of nonsurveyed hospitals in the United States by using a *t* test. To evaluate the unadjusted associations between the independent variables and 30-day RSMR, we used weighted linear regression models with RSMR as the dependent variable, weighted by the inverse variance of the RSMR.

To examine the independent associations of specific strategies with RSMR, we used multivariate least-squares regression, weighted by the inverse variance of the RSMR. Analyses were based on observations with complete data. We considered as candidate independent variables those that were significant in the bivariate analysis and applicable for both hospitals that performed primary PCI for ST-segment elevation MI and hospitals that did not. We excluded variables with less than 1% in a response category.

We assessed multicollinearity among independent variables by using the variance decomposition proportions (29); we compared the conditional number with the conventional level of 30 and higher for detecting collinearity. The greatest conditional value between 2 variables in our study was 12, suggesting limited collinearity. To facilitate interpretation in multivariate analysis, we dichotomized the measures of organizational environment as never or rarely versus sometimes, usually, or always. In the final model, we included all independent variables that added significantly to the fit of the overall model on the basis of the likelihood ratio test for nested models ($P < 0.10$). We repeated the analysis by using a *P* value less than 0.05 as the threshold, which produced the same model in this primary analysis.

In secondary analysis, by using the same approach, we estimated a model that excluded the indicator for having cardiologists always on site from the candidate independent variables, because this strategy may not be feasible for some hospitals. In further secondary analysis, we assessed the added effect of the hospital characteristics that were significant in bivariate analysis (that is, teaching status, geographic region, and AMI volume).

We calculated Wald and category-specific *P* values for each categorical independent variable and reported the adjusted R^2 for our final multivariate models. To assess the

relationship between the number of identified strategies and RSMR, we calculated the mean and 95% CI for the RSMR by the number of practices and performed a nonparametric test for trend of RSMR against number of practices. All analyses were performed by using SAS, version 9.1 (SAS Institute, Cary, North Carolina), and Stata, version 12.0 (StataCorp, College Station, Texas).

Role of the Funding Source

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Results

Hospital Survey

Of the 590 hospitals surveyed, 537 responded (91% response rate); 4 hospitals were eliminated because they did not have CMS mortality data for AMI, yielding a final sample of 533 hospitals. Survey respondents included clinical and management staff in quality improvement, nursing, and cardiology. A total of 35.3% of responding hospitals were teaching hospitals; 57.6% had fewer than 300 staffed beds, 33.4% had 300 to 600 staffed beds, and 7.9% had 600 or more staffed beds. Nearly 50% of hospitals had an annualized volume of more than 125 patients with AMI; 73.2% of hospitals performed PCI for patients with ST-segment elevation MI. Appendix Table 3 (available at www.annals.org) shows hospital characteristics. Responding and nonresponding hospitals did not differ significantly ($P > 0.10$) in terms of teaching status, AMI volume, geographic region, cardiac capability, or RSMR.

Hospital Strategies

The Figure shows the frequency distribution of RSMRs for the hospital sample. The overall weighted mean RSMR for the surveyed hospitals was 15.4% (SD, 1.5%; range, 11.5% to 21.7%), which did not differ significantly from that of acute care hospitals not surveyed. In models adjusted for whether the hospital performed PCI for ST-segment elevation MI, numerous hospital strategies had significant associations with RSMRs (Table 1). These strategies corresponded to 5 of the 6 domains from our previous qualitative work (19).

The multivariate model identified several strategies that added significantly to the fit of the model and were associated with lower RSMRs ($P < 0.05$). Some of the associations indicated approximate RSMRs between 0.3 and 0.9 percentage points lower (Table 2). Some strategies were implemented in a minority of hospitals. Hospitals that implemented a greater number of effective strategies tended to have lower RSMRs (nonparametric test for trend, $P < 0.001$) (Table 3).

Hospitals with meetings to review AMI care between hospital clinicians and staff who transported patients to the hospital and occurred at least monthly had significantly lower RSMRs than those with less frequent or no regular meetings (Table 3). Hospitals with cardiologists (interventional cardiologists, noninterventional cardiologists, or cardiology fellows) always on site and those where clinicians were encouraged to creatively solve problems had significantly lower RSMRs.

Hospitals with only nurse champions had higher RSMRs than all other categories of hospital, including those with both physician and nurse champions ($P = 0.002$), only physician champions ($P = 0.033$), and no champions ($P = 0.015$). Hospitals that cross-

trained their critical care nurses for the catheterization laboratory also had higher RSMRs. The addition of hospital teaching status, geographic region, and AMI volume did not change the significance of any hospital strategies reported in the primary multivariate model.

The secondary analysis (in which having a cardiologist always on site was excluded from the candidate independent variables) showed the same strategies as significant; nevertheless, when the P value threshold less than 0.10 was used for inclusion of independent variables, the role of the pharmacist was also retained ($P = 0.073$). Specifically, hospitals that had pharmacists rounding on all patients with AMI had lower RSMRs ($P < 0.025$) than those where pharmacists had no specific role; however, the addition of hospital teaching status, geographic region, and AMI volume attenuated the effects ($P > 0.10$) of cross-training nurses and of clinicians being encouraged to creatively solve problems in this secondary analysis.

Discussion

We identified several hospital strategies that were strongly associated with RSMRs for patients hospitalized with AMI. The size of the effect for individual strategies may be viewed as modest; however, in aggregate, they exceed an absolute difference of 1% in RSMRs. If a change this large could be achieved nationally, thousands of lives could be saved yearly by using interventions that have negligible risk and could be implemented with relatively few new resources. In previous interventions in cardiology, a 1% absolute difference in 30-day mortality has been considered consequential (30).

Fewer than 10% of hospitals reported using at least 4 of the 5 strategies that were associated with significantly lower RSMRs. Some of these strategies are not resource-intensive but require new ways of working across disciplinary and organizational groups. For example, hospitals where clinicians met at least monthly with staff who transported patients to the hospital had substantially lower RSMRs, but this occurred in fewer than 25% of hospitals. Such efforts may improve communication and coordination among staff, a key aspect of organizational environment identified in our previous qualitative work (19).

Another strategy was implemented by a few hospitals (14%) and is more resource-intensive but strongly associated with lower RSMRs: having cardiologists (interventional cardiologists, noninterventional cardiologists, or cardiology fellows) on site at all times. This strategy reflects the concept of broad staff presence and expertise identified in our earlier work (19) but may be impractical for many institutions.

Our secondary analysis demonstrated that, regardless of the presence of cardiologists on site, hospitals in which pharmacists rounded on patients with AMI achieved significantly lower RSMRs. Previous research (31–33) has shown that inclusion of pharmacists in multidisciplinary rounds can increase adherence to core quality measures, reduce length of stay and drug–drug interactions, and improve quality of care. Despite these benefits, only approximately 35% of hospitals in our study reported that pharmacists rounded on patients with AMI.

Having champions in AMI care has been associated with hospital performance (34–36), and we also found that hospitals with both physician and nurse champions had the lowest RSMRs (15.1%), whereas the 7% of hospitals with only nurse champions had among the highest RSMRs (16.2%). Having only nurse champions may be a marker for organizational environments that are not conducive to quality improvement and interdisciplinary collaboration, although more research is needed to further understand this effect. We also found that cross-training critical care nurses to cover the catheterization laboratory was associated with significantly higher RSMRs, perhaps because of inadequate specialization in

critical care nursing, as well as unintended effects of what might be a hospital cost-saving strategy.

Hospitals that reported that clinicians were encouraged to creatively solve problems had significantly lower RSMRs. Our cognitive interviews indicated that respondents understood the statement, “Clinicians are encouraged to creatively solve problems” to mean that “out-of-the-box ideas will be considered and piloted” and “different ways to solve a problem” will be sought. Our results suggest that hospitals with such work climates had lower RSMRs.

Problem solving and effective communication and coordination have been identified as essential aspects of quality improvement (37, 38), and our qualitative work on top-performing hospitals in RSMR (19) suggested a link between organizational environment and mortality rates. To our knowledge, however, ours is the first large published study to statistically link these aspects of organizational environment with RSMRs.

Our findings overall were largely consistent with our qualitative work (19), which identified 5 conceptual areas that were prominent in higher-performing hospitals and less apparent in lower-performing hospitals. This earlier work also suggested that higher-performing hospitals were not distinguished by specific practices and protocols but instead by organizational environments that could foster higher-quality care. The present quantitative findings largely support this earlier qualitative work in that specific practices and protocols were not significantly related to RSMRs once variables pertaining to the organizational environment were accounted for in multivariate analysis.

Furthermore, key aspects of the organizational environment, including effective communication and collaboration among groups, broad staff presence and expertise, and a culture of problem solving and learning, were apparent in the qualitative work and were statistically associated with higher RSMRs in the quantitative work. Such findings provide evidence about the importance of these features in higher-performing hospitals.

Several considerations are important in interpreting our findings. The survey data were reported by a single respondent and have some subjectivity that cannot be avoided in survey-based research. Nevertheless, the chief executive officer of each hospital was asked to identify the staff member who was the most knowledgeable about AMI improvement activities to respond to the survey, and we recommended that the respondents review their answers with other staff to integrate hospital views. In addition, we extensively field-tested the instrument by using standard techniques of cognitive interviewing (39) to ensure comprehensibility and consistency before interviewing respondents.

Given the observational design of the study, we could not establish whether strategies were markers for unmeasured processes rather than important contributors to RSMRs. The strategies that were tested were based on our previous qualitative work (19) and are plausible contributors to improved quality of care. Nevertheless, this design cannot prove a causal role in reducing RSMR. Last, nonrespondents also may have differed from respondents in unmeasured ways. The response rate was very high (91%), however, and there were no significant differences in hospital characteristics or RSMRs between respondent and nonrespondent hospitals. Our findings should not be interpreted as meaning that the strategies that were nonsignificant in this study are unimportant. In certain hospitals, such efforts may be useful; however, in this national study, on average we did not find that they were associated with lower mortality rates. This finding may be due to the range of implementation approaches or low use in this sample. For example, the implementation of rapid-response teams, handoff protocols, or electronic medical records may differ markedly across hospitals, limiting our ability to find significant average effects in this study.

In conclusion, this study used survey information from 537 acute care hospitals to determine which specific strategies were associated with lower RSMRs for patients with AMI. These strategies, as reported, were associated with hospital performance as measured by mortality rates. The strategies may be important for improving outcomes for patients with AMI, and if effective, in aggregate would be associated with clinically important reductions in RSMRs.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Appendix Table 1

Examples of How the Qualitative Data Informed Quantitative Survey Items

Domains and Quotations From Qualitative Article (19)	Corresponding Survey Item
Broad staff presence and expertise	

Domains and Quotations From Qualitative Article (19)	Corresponding Survey Item
“I started writing my consult notes in the physician progress notes ... over the years it’s just become the standard ... That was a way of my breaking into the culture saying, ‘This is my note; I want you to read it. It’s not in the nurse’s section. I have some ideas ... and I’m open to talking about it.’”—Nurse Manager, no. 5	Nurses are comfortable checking with physicians if they have concerns about patient care (survey item 65)
Communication and coordination among groups	
“Everyone in this hospital from the housekeeper to the CEO plays a role ... The housekeeping needs to know why it’s important for them to go out and do their job ... No one has an insignificant role in it ... So everybody needs to be educated. Everyone.”—Director, Catheterization Laboratory, no. 2	Clinicians involved in the care of patients with AMI value each others’ skills and talents (e.g., physicians value nurses’ skills and talents and vice versa) (survey item 58)
Problem solving and learning	
“... [T]he performance improvement team ... identifies action steps, the plan is put in place, and then we continue to measure to see if it’s working or not working ... you identify, you intervene, you improve, you monitor, you tweak, and that’s the model that they’ve been using for 10 years.”—Director, Quality Management, ID, no. 4	After we make changes to improve AMI care, we fail to evaluate their effectiveness (survey item 67)

AMI = acute myocardial infarction; CEO = chief executive officer.

Appendix Table 2

Survey Items Organized by Domain

Survey Item, by Domain	Survey Item Number
Hospital protocols and practices to improve AMI care	
Did your hospital have efforts to improve any of the following inpatient AMI quality measures?	1
a. Adherence to the core medication measures	
b. Time to fibrinolytic therapy or percutaneous coronary intervention	
Beyond these quality measures, did your hospital initiate efforts to improve any of the following in patients admitted with AMI?	2
a. Inpatient mortality in patients with AMI	
b. Postdischarge mortality (death occurring after discharge but within 30 d of admission) in patients with AMI	
c. Readmission within 30 d from previous admission in patients with AMI	
Did your hospital have a quality improvement team devoted to improving:	3a, 3b
a. Inpatient mortality in patients with AMI	
b. Postdischarge mortality (death occurring after discharge but within 30 d of admission) in patients with AMI	
Please indicate members of either the inpatient or postdischarge mortality team.	3aa–3ag
a. Senior management of hospital	
b. Hospital governing board	
c. Chief of cardiology	
d. Nursing directors	
e. Other physicians participating in the care of patients with AMI	
f. Quality improvement or quality management department staff	

Survey Item, by Domain	Survey Item Number
g. Other (please specify)	
For patients transported by ambulance with suspected AMI, approximately what percentage arrived with a 12-lead ECG performed by a provider in the field?	22
If the prehospital ECG indicated STEMI, was the catheterization team activated while the patient was still en route to the hospital?	22a
Did your hospital have a single-call system (i.e., 1 call either to an operator or to a single number) that led to activation of the entire catheterization team?	23
Who was usually responsible for making the decision to activate the catheterization team for patients with STEMI?	24
Are patients who are stable after percutaneous coronary intervention admitted to an ICU?	25
Did your emergency department use a uniform protocol to care for patients who arrived to the emergency department with STEMI?	26
Did your emergency department use a uniform protocol to care for patients who arrived to the emergency department with unstable angina or non-STEMI?	27
Did your hospital use simulations (i.e., trial exercises or dry runs) to practice any of the following AMI care processes?	28
a. Door-to-balloon or door-to-drug protocols	
b. Chest pain in hospitalized patients	
c. Inpatient codes (e.g., cardiac arrest or respiratory failure)	
To which patient care unit were patients who were stable with unstable angina or non-STEMI most likely admitted?	29
Did all or nearly all patients with AMI have a cardiologist as their primary attending physician?	30
Were cardiology consults required for all patients with AMI?	30a
In the ICU, who was primarily responsible for the care of patients with AMI?	31
What proportion of patients with AMI admitted to a nonintensive care unit (either telemetry unit or nonmonitored setting) were cared for by a hospitalist?	32
What proportion of patients with AMI admitted to an ICU were cared for by a hospitalist?	33
Did your hospital use an EMR in the following areas?	34
a. Emergency department	
b. Inpatient floors	
c. CCUs	
d. Affiliated ambulatory offices/clinics	
On the inpatient floors, did your hospital have the following electronic capabilities?	35
a. Computerized assisted physician order entry	
b. Computer prompts to alert user to potential drug–drug interactions or allergies	
c. Computer prompts to alert user to medication order expiration	
d. Computer prompts to improve adherence to core measures for AMI care (e.g., β -blocker use)	
In the emergency department, were previous ECGs electronically available at the time of care?	36
Did physicians regularly use explicit protocols or clinical pathways for patients with AMI?	37
Did clinicians on the inpatient care units regularly use order sets (either paper-based or electronic) for patients with STEMI?	38
Did clinicians on the inpatient care units regularly use order sets (either paper-based or electronic) for patients with unstable angina or non-STEMI?	39

Survey Item, by Domain	Survey Item Number
Did your hospital have a rapid-response system (also referred to as medical emergency teams, rapid-response teams, and ICU outreach)?	41
Who was permitted to activate the rapid-response system?	41a
Did nurses or nurse aides receive instructions on specific criteria to use (e.g., vital sign parameters) for activating the rapid-response system?	41b
Please indicate the capabilities of the rapid-response team.	41c
a. Prescribe medication therapy	
b. Perform advanced airway management skills	
c. Establish central vascular lines	
d. Begin an ICU level of care at the bedside	
e. Triage the patient to a more acute care setting	
f. Other (please specify)	
Are there any protocols used to guide nurses on when to call the attending cardiologist for patients with AMI?	43
Handoffs occur when care of a patient is transferred from one clinician to another. For patients with AMI, did your hospital:	44
a. Have a formal team charged with improving handoffs between physicians?	
b. Have a formal team charged with improving handoffs between nurses?	
d. Have a standardized written or electronic template for handoffs between physicians?	
e. Have a standardized written or electronic template for handoffs between nurses?	
At or shortly after admission, were patients with AMI typically assigned a case manager to arrange for postdischarge services?	47
Was it required that before discharge, all patients with AMI have a follow-up appointment with a cardiologist scheduled?	48
Were discharge summaries made available to the PCP or follow-up providers for patients with AMI?	49
How quickly was the discharge summary typically made available to the follow-up care provider?	49a
Other than the follow-up appointment, postdischarge contact with patients with AMI regularly included:	50
a. Nurse phone call follow-up	
b. Pharmacist phone call follow-up	
c. Other (please specify)	
Did your hospital offer the following end-of-life care support?	40
a. Palliative care consult service	
b. Hospice unit within your hospital	
Organizational values and goals	
Does the hospital have an organizational goal to reduce 30-d mortality rates (deaths occurring within 30 d of admission, including both inpatient and postdischarge deaths) in patients with AMI?	9
Did your hospital regularly compare its performance with other hospitals on either inpatient or 30-d mortality in patients with AMI?	14
Innovative ideas about AMI care are shared widely in the hospital.	61
Senior management involvement	
The hospital has the resources and information that it needs to reduce 30-d mortality rates in patients with AMI.	51

Survey Item, by Domain	Survey Item Number
Senior-level administration is supportive of efforts to improve AMI care.	52
Clinicians caring for patients with AMI have difficulty addressing problems and tough issues with their department heads or chiefs.	56
Department heads or chiefs are easily able to address problems and tough issues with senior-level administration.	57
Communication and coordination among groups	
Did cardiology and emergency department staff meet together to review care for patients with AMI?	15
What was typically discussed at these meetings?	15a
Did clinicians from your hospital meet monthly with EMS providers to review the care of patients with AMI?	16
Did your hospital provide training to EMS providers about AMI care?	17
Which best describes the quality of your interaction with hospitals that referred patients to you with AMI?	18
Very collaborative (we shared data along with strategies for improving AMI care)	
Somewhat collaborative (we communicated regularly, but we did not share data and strategies)	
Not collaborative (we had no or minimal contact with hospitals in our region)	
Not applicable (skip to question 19)	
Which best describes the quality of your interaction with hospitals that you referred patients to with AMI?	19
Very collaborative (we shared data along with strategies for improving AMI care)	
Somewhat collaborative (we communicated regularly, but we did not share data and strategies)	
Not collaborative (we had no or minimal contact with hospitals in our region)	
Not applicable	
Was your hospital part of a regional effort or consortium of hospitals to improve AMI care?	20
Clinicians involved in the care of patients with AMI value each others' skills and talents (e.g., physicians value nurses' skills and talents and vice versa).	58
There is good coordination among the different departments involved with the care of patients with AMI.	62
Departments caring for patients with AMI (e.g., cardiology or emergency medicine) communicate easily with each other.	64
Nurses are comfortable checking with physicians if they have concerns about patient care.	65
Broad staff presence and expertise in AMI care	
Who usually reviewed 30-d mortality rates in patients with AMI?	11a
a. Senior management of hospital	
b. Hospital governing board	
c. Chief of cardiology	
d. Nursing directors	
e. Other physicians participating in the care of patients with AMI	
f. Quality improvement or quality management department staff	
g. Other (please specify)	
Did your hospital have 1 or more physician champions focused on improving either inpatient or 30-d mortality in patients with AMI?	12

Survey Item, by Domain	Survey Item Number
Did your hospital have 1 or more nurse champions focused on improving either inpatient or 30-d mortality in patients with AMI?	13
Were nurses in any of your critical care areas cross-trained to cover in the catheterization laboratory?	45
Which of the following types of physicians were at the hospital 24 h per day and 7 d per week?	42
a. Critical care physicians (i.e., intensivists)	
b. Noninterventional cardiologists	
c. Interventional cardiologists	
d. Cardiology fellows (including noninterventional and interventional)	
e. Hospitalists	
Which of the following best describes the role of pharmacists in caring for patients with AMI during this time?	46
Pharmacists rounded on all patients in the CCU	
Pharmacists rounded on all patients with AMI (including patients not in a unit)	
Pharmacists did not round but reviewed the medications of all patients with AMI	
Pharmacists did not have a specific role in the care of patients with AMI	
Nurses are engaged in efforts to improve AMI care.	53
Cardiologists are engaged in efforts to improve AMI care.	54
Emergency medicine physicians are engaged in efforts to improve AMI care.	55
Problem solving and learning	
Did your hospital have a designated person or group to review the deaths of patients with AMI (i.e., on an individual case level) that occurred during the following points of care?	4
a. Deaths that occurred during hospitalization	
b. Deaths that occurred within 30 d of admission	
Did your hospital selectively review the deaths of patients with AMI?	4a
How long after the occurrence of the death were the cases typically reviewed?	4b
Who usually reviewed these cases?	4c
Clinicians are encouraged to creatively solve problems related to AMI care processes.	60
Did your hospital have regular “morbidity and mortality” conferences (or another educational session) for discussing individual cases involving patients with AMI?	5
Did your hospital have a designated person or group to review any of the following adverse events in patients with AMI (i.e., on an individual case level)?	6
a. Sentinel events (unexpected occurrence involving death or serious physical or psychological injury) that occurred during hospitalization	
b. Unexpected transfers from a floor (nonmonitored unit) to an ICU	
c. Catastrophic complications that occurred immediately after discharge from the hospital	
How long after the occurrence of these adverse events were the cases typically reviewed?	6a
Who usually reviewed these cases?	6b
Were physicians explicitly encouraged to disclose medical errors to patients or their family members?	7
Did your hospital use root-cause analysis or a similar method to understand problems in AMI care?	8
Did your hospital review data on 30-d mortality rates (deaths occurring within 30 d of admission, including both inpatient and postdischarge deaths) in patients admitted with AMI?	10

Survey Item, by Domain	Survey Item Number
How quickly were 30-d mortality rates in patients with AMI available to your hospital (i.e., what were the most current data available to your hospital)?	10a
Did your hospital have a designated person or group to review the hospital's 30-d mortality rates in patients with AMI?	11
Did your hospital routinely give feedback to the referring hospitals on any of the following?	18a
a. Time to transfer	
b. AMI-related procedures performed	
c. Patient outcome	
d. Other (please specify)	
Clinicians caring for patients with AMI share new evidence-based approaches with the AMI team.	63
Clinicians involved in the care of patients with AMI avoid sharing responsibility for medical errors.	59
Among clinicians taking care of patients with AMI, there is a tendency to blame individuals for errors in patient care.	66
After we make changes to improve AMI care, we fail to evaluate their effectiveness.	67
Mistakes have led to positive changes in AMI care processes at the hospital.	68

AMI = acute myocardial infarction; CCU = critical care unit; ECG = electrocardiography; EMR = electronic medical record; EMS = emergency medical services; ICU = intensive care unit; PCP = primary care provider; STEMI = ST-segment elevation myocardial infarction.

Appendix Table 3

Characteristics of Hospital Sample *

Characteristic	Hospitals, n (%)
Teaching status	
COTH	68 (12.8)
Non-COTH teaching	120 (22.5)
Nonteaching	339 (63.6)
Number of beds	
<300	307 (57.6)
300–600	178 (33.4)
>600	42 (7.9)
Region	
New England	35 (6.6)
Mid-Atlantic	77 (14.4)
South Atlantic	99 (18.6)
East North Central	96 (18.0)
East South Central	42 (7.9)

Characteristic	Hospitals, <i>n</i> (%)
West North Central	31 (5.8)
West South Central	54 (10.1)
Mountain	26 (4.9)
Pacific	62 (11.6)
Other	5 (0.9)
AMI volume[†]	
25–75	129 (24.2)
76–125	130 (24.4)
126–250	159 (29.8)
<250	115 (21.6)
Performs PCI for patients with STEMI	
Yes	390 (73.2)
No	143 (26.8)

AMI = acute myocardial infarction; COTH = Council of Teaching Hospitals and Health Systems; PCI = percutaneous coronary intervention; STEMI = ST-segment elevation myocardial infarction.

* Teaching status, number of beds, and region were available for 527 hospitals.

[†] Number of AMI discharges annually.

Context

Mortality after acute myocardial infarction (AMI) is twice as low in some U.S. hospitals as in other hospitals, and we do not understand why.

Contribution

This study found lower mortality when the culture encouraged physicians to solve problems creatively, physicians and nurses acted as champions to improve the quality of care, hospital clinicians met at least monthly to review care with staff who transported patients to the hospital, cardiologists were always present in the hospital, and intensive care nurses did not work in cardiac catheterization laboratories.

Caution

This observational study cannot establish cause and effect.

Implication

Hospitals with lower AMI mortality have different management strategies than hospitals with higher mortality.

— *The Editors*

Figure.

Frequency distribution for 30-day RSMR for AMI among study hospitals.

AMI = acute myocardial infarction; RSMR = risk-standardized mortality rate.

Table 1

Relationship of Hospital Strategies With 30-Day RSMR *

Survey Item, by Domain	Hospitals, n (%)	30-Day RSMR	P Value [†]
Hospital practices and protocols			
Did your hospital have a quality improvement team devoted to improving inpatient mortality in patients with AMI (survey item 3a)?			
No	256 (48.0)	15.6	
Yes	277 (52.0)	15.2	0.015
On the inpatient floors, did your hospital have the following electronic capabilities (survey item 35):			
Computerized assisted physician order entry			
No	395 (74.1)	15.5	
Yes	138 (25.9)	15.2	0.073
Computer prompts to alert user to medication order expiration			
No	295 (55.3)	15.5	
Yes	237 (44.5)	15.2	0.025
Computer prompts to alert user to potential drug–drug interactions or allergies			
No	221 (41.5)	15.5	
Yes	311 (58.3)	15.3	0.073
Are there any protocols used to guide nurses on when to call the attending cardiologist for patients with AMI (survey item 43)?			
No	223 (41.8)	15.5	
Yes	307 (57.6)	15.3	0.048
At or shortly after admission, were patients with AMI typically assigned a case manager to arrange for postdischarge services (survey item 47)?			
No	95 (17.8)	15.7	
Yes	436 (81.8)	15.3	0.026
Senior management involvement			
The hospital has the resources and information it needs to reduce 30-d mortality rates in patients with AMI (survey item 51).			
Never	18 (3.4)	16.2	
Rarely	56 (10.5)	15.6	
Sometimes	127 (23.8)	15.5	
Usually	230 (43.2)	15.4	
Always	99 (18.6)	15.0	0.023
Communication and coordination among groups			

Survey Item, by Domain	Hospitals, n (%)	30-Day RSMR	P Value [†]
Did clinicians from your hospital meet monthly with EMS providers to review the care of patients with AMI (survey item 16)? [‡]			
Do not meet	138 (25.9)	15.8	
Other than monthly	272 (51.0)	15.4	
Monthly	122 (22.9)	14.9	<0.001
Was your hospital part of a regional effort or consortium of hospitals to improve AMI care (survey item 20)?			
No	225 (42.2)	15.6	
Yes	306 (57.4)	15.2	0.003
There is good coordination among the different departments involved with the care of patients with AMI (survey item 62).			
Never	0 (0.0)	–	
Rarely	11 (2.1)	16.3	
Sometimes	46 (8.6)	15.8	
Usually	330 (61.9)	15.4	
Always	144 (27.0)	15.2	0.046
Departments caring for patients with AMI (e.g., cardiology and emergency medicine) communicate easily with each other (survey item 64).			
Never	0 (0.0)	–	
Rarely	5 (0.9)	17.2	
Sometimes	46 (8.6)	15.2	
Usually	359 (67.4)	15.5	
Always	122 (22.9)	15.2	0.028
Broad staff presence and expertise			
Did your hospital have 1 or more physician or nurse champions focused on improving either inpatient or 30-d mortality in patients with AMI (survey items 14 and 15)? [§]			
Nurse champion only	39 (7.3)	16.2	
Neither physician nor nurse champion	221 (41.5)	15.5	
Physician champion only	44 (8.3)	15.4	
Both physician and nurse champions	227 (42.6)	15.1	0.001
Were nurses in any of your critical care areas cross-trained to cover in the catheterization laboratory (survey item 45)?			
No	436 (81.8)	15.3	
Yes	93 (17.4)	15.6	0.085

Survey Item, by Domain	Hospitals, n (%)	30-Day RSMR	P Value [†]
Cardiologist always on site (interventional cardiologist, noninterventional cardiologist, or cardiology fellow) (survey items 42 b, c, or d).			
No	442 (82.9)	15.5	
Yes	77 (14.4)	14.8	<0.001
Which of the following best describes the role of pharmacists in caring for patients with AMI during this time (survey item 46)? ^{//}			
No specific role in care of patients with AMI	124 (23.3)	15.8	
Rounded on patients in CCU or with AMI	187 (35.1)	15.2	
Did not round, but reviewed the medication of all patients with AMI	219 (41.1)	15.4	0.003
Emergency medicine physicians are engaged in efforts to improve AMI care (survey item 55).			
Never	0 (0.0)	–	
Rarely	4 (0.8)	18.3	
Sometimes	34 (6.4)	15.8	
Usually	167 (31.3)	15.5	
Always	326 (61.2)	15.3	0.008
Problem solving and learning			
Clinicians are encouraged to creatively solve problems related to AMI care processes (survey item 60).			
Never	2 (0.4)	15.7	
Rarely	22 (4.1)	16.2	
Sometimes	80 (15.0)	15.3	
Usually	216 (40.5)	15.5	
Always	211 (39.6)	15.2	0.029
Did your hospital have regular “morbidity and mortality” conferences (or another educational session) for discussing individual cases involving patients with AMI (survey 5)?			
No	285 (53.5)	15.5	
Yes	244 (45.8)	15.2	0.029
Did your hospital use root-cause analysis or a similar method to understand problems in AMI care (survey item 8)?			
No	51 (9.6)	15.9	
Yes	479 (89.9)	15.3	0.010
Clinicians caring for patients with AMI share new evidence-based approaches with the AMI team (survey 63).			
Never	4 (0.8)	15.7	
Rarely	23 (4.3)	16.0	

Survey Item, by Domain	Hospitals, <i>n</i> (%)	30-Day RSMR	<i>P</i> Value [†]
Sometimes	80 (15.0)	15.9	
Usually	240 (45.0)	15.3	
Always	183 (34.3)	15.2	0.004

AMI = acute myocardial infarction; CCU = critical care unit; EMS = emergency medical services; PCI = percutaneous coronary intervention; RSMR = risk-standardized mortality rate; STEMI = ST-segment elevation myocardial infarction.

* All models were adjusted for whether the hospitals performed PCI for STEMI. Rows do not sum to 533 for some variables because of missing responses.

[†] Based on weighted linear regression, weighted by the inverse variance of the RSMR.

[‡] $P < 0.001$ for meeting monthly vs. not meeting; $P = 0.001$ for meeting monthly vs. meeting other than monthly.

[§] $P = 0.49$ for physician champions only vs. no champions; $P = 0.012$ for physician champions only vs. nurse champions only; $P = 0.36$ for physician champions vs. both types of champions; $P = 0.015$ for nurse champions only vs. no champions; $P < 0.001$ for nurse champions only vs. both physician and nurse champions; $P = 0.007$ for both types of champions vs. no champions.

^{//} $P = 0.22$ for pharmacists rounding vs. those not rounding but reviewing medications.

Table 2**Multivariate Analysis of Relationship of Hospital Strategies With 30-Day Risk-Standardized Mortality Rates**

Survey Item	Primary Model*		Secondary Model†	
	Regression Coefficient (95% CI)	P Value	Regression Coefficient (95% CI)	P Value
Did clinicians from your hospital meet monthly with EMS providers to review the care of patients with AMI?		0.002 [§]		0.007 [§]
No	Reference	Reference	Reference	Reference
Yes, meet other than monthly	−0.324 (−0.657 to 0.009)	0.056	−0.211 (−0.522 to 0.130)	0.224
Yes, meet monthly	−0.704 (−1.094 to −0.314)	<0.001	−0.609 (−1.007 to −0.211)	0.003
Cardiologist always on site (interventional cardiologist, noninterventional cardiologist, or cardiology fellow)				
No	Reference	Reference	NA ^{//}	NA ^{//}
Yes	−0.535 (−0.879 to −0.191)	0.002	—	—
Clinicians are encouraged to creatively solve problems related to AMI care processes				
No	Reference	Reference	Reference	Reference
Yes	−0.840 (−1.485 to −0.195)	0.011	−0.660 (−1.295 to −0.024)	0.042
Did your hospital have 1 or more physician or nurse champions focused on improving either inpatient or 30-d mortality in patients with AMI? [‡]		0.023 [§]		0.016 [§]
Nurse champion only	Reference	Reference	Reference	Reference
No physician or nurse champion	−0.695 (−1.253 to −0.137)	0.015	−0.738 (−1.297 to −0.178)	0.010
Physician champion only	−0.731 (−1.404 to −0.059)	0.033	−0.703 (−1.377 to −0.028)	0.041
Both physician and nurse champions	−0.880 (−1.442 to −0.318)	0.002	−0.915 (−1.477 to −0.353)	0.001
Were nurses in any of your critical care areas cross-trained to cover in the catheterization laboratory?				
No	Reference	Reference	Reference	Reference
Yes	0.440 (0.100 to 0.780)	0.011	0.412 (0.065 to 0.760)	0.020
Which of the following best describes the role of pharmacists in caring for patients with AMI during this time? [¶]				0.073 [§]
No specific role in the care of patients with AMI	NA ^{//}	NA ^{//}	Reference	Reference
Rounded on patients in CCU or with AMI			−0.410 (−0.769 to −0.052)	0.025
Did not round, but reviewed medication of all patients with AMI			−0.329 (−0.680 to 0.022)	0.066

AMI = acute myocardial infarction; CCU = critical care unit; EMS = emergency medical services; NA = not applicable; PCI = percutaneous coronary intervention; STEMI = ST-segment elevation myocardial infarction.

* Sample size is 516 hospitals with no missing data for these variables. Model adjusted for primary PCI capacity for STEMI; adjusted $R^2 = 9.5\%$.

† Sample size is 527 hospitals with no missing data for these variables. Model adjusted for primary PCI capacity for STEMI; adjusted $R^2 = 7.7\%$.

‡ $P = 0.88$ for physician champions only vs. no champions; $P = 0.53$ for physician champions only vs. both physician and nurse champions; $P = 0.21$ for both physician and nurse champions vs. no champions.

§ By using the Wald test.

// Variable omitted from model.

¶ $P = 0.58$ for comparison of pharmacists rounding vs. pharmacists not rounding but reviewing medication for patients with AMI.

Table 3Thirty-Day RSMR, by the Number of Key Strategies Used^{*}

Key Strategies Used, <i>n</i>	Hospitals (<i>n</i> = 537), <i>n</i> (%)	Mean 30-Day RSMR (95% CI)
0	15 (2.8)	15.9 (15.2 to 16.5)
1	191 (35.8)	16.0 (15.8 to 26.3)
2	189 (35.5)	15.7 (15.5 to 16.0)
3	101 (18.9)	15.2 (15.0 to 15.5)
4	31 (5.8)	15.2 (14.9 to 15.6)
5	6 (1.1)	14.3 (13.0 to 15.5)

RSMR = risk-standardized mortality rate.

^{*}Nonparametric test for trend $P < 0.001$; key strategies are from the primary model of Table 2.