HEALTH CARE REFORM

The Dissociation Between Door-to-Balloon Time Improvement and Improvements in Other Acute Myocardial Infarction Care Processes and Patient Outcomes

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Background: Recent initiatives have focused on reducing door-to-balloon (DTB) times among patients with acute myocardial infarction undergoing primary percutaneous coronary intervention. However, DTB time is only one of several important AMI care processes. It is unclear whether quality efforts targeted to a single process will facilitate concomitant improvement in other quality measures and outcomes.

Methods: This study examined 101 hospitals (43 678 patients with AMI) in the Get With the Guidelines program. For each hospital, DTB time improvement from 2005 to 2007 was correlated with changes in composite Centers for Medicare and Medicaid Services/Joint Commission on Accreditation of Healthcare Organizations (CMS/JCAHO) core measure performance and in-hospital mortality.

Results: Between 2005 and 2007, hospital geometric mean DTB time decreased from 101 to 87 minutes ($P<.001$). Mean overall hospital composite CMS/JCAHO core measure performance increased from 93.4% to 96.4% ($P<.001$), and mortality rates were 5.1% and 4.7% ($P=.09$) in the early and late periods, respectively. Improvement in hospital DTB time, however, was not significantly correlated with changes in composite quality performance ($r=-0.06$; $P=.55$) or with in-hospital mortality ($r=0.06$; $P=.58$). After adjustment for patient mix, hospitals with the most improvement in DTB time did not have significantly greater improvements in either CMS/JCAHO measure performance or mortality.

Conclusions: Within the Get With the Guidelines program, DTB times decreased significantly over time. However, there was minimal correlation between DTB time improvement and changes in other quality measures or mortality. These results emphasize the important need for comprehensive acute myocardial infarction quality-improvement efforts, rather than focusing on single process measures.

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PRIMARY PERCUTANEOUS CORONARY intervention (PCI), if delivered in a timely manner, is the preferred reperfusion strategy for patients with ST-segment elevation myocardial infarction (STEMI).[1] Previous studies have demonstrated that delays in primary PCI are associated with worse short- and long-term outcomes.[2,3] As such, door-to-balloon (DTB) time is considered a hospital quality-of-care indicator by the Centers for Medicare and Medicaid Services (CMS) and the Joint Commission on Accreditation of Healthcare Organizations (JCAHO).[4,5] More recently, both regional and national campaigns have been launched to improve DTB times.[6,7] In June 2006, the American College of Cardiology (ACC) introduced the D2B Alliance, a nationwide campaign focused on reducing DTB times for patients with STEMI.[8]

Yet, DTB time is only one of several acute myocardial infarction (AMI) quality measures[9,10] and within-hospital performance on separate AMI metrics varies markedly.[3-5] The underlying assumption of campaigns such as the D2B Alliance is that targeted improvement of a single care process may facilitate improvements in other care measures and outcomes. On the one hand, hospitals that improve DTB times likely do so via multidisciplinary collaborations which may, in turn, stimulate broad-scale process improvement across a variety of acute and secondary prevention therapies. On the other hand, singular attention on a given measure may detract a hospital from monitoring or improving other important care processes and outcomes.[11,12] More broadly, it is also unclear whether and to what extent improvements in given care processes will be associated with measurable improvement in patient outcomes.[3]

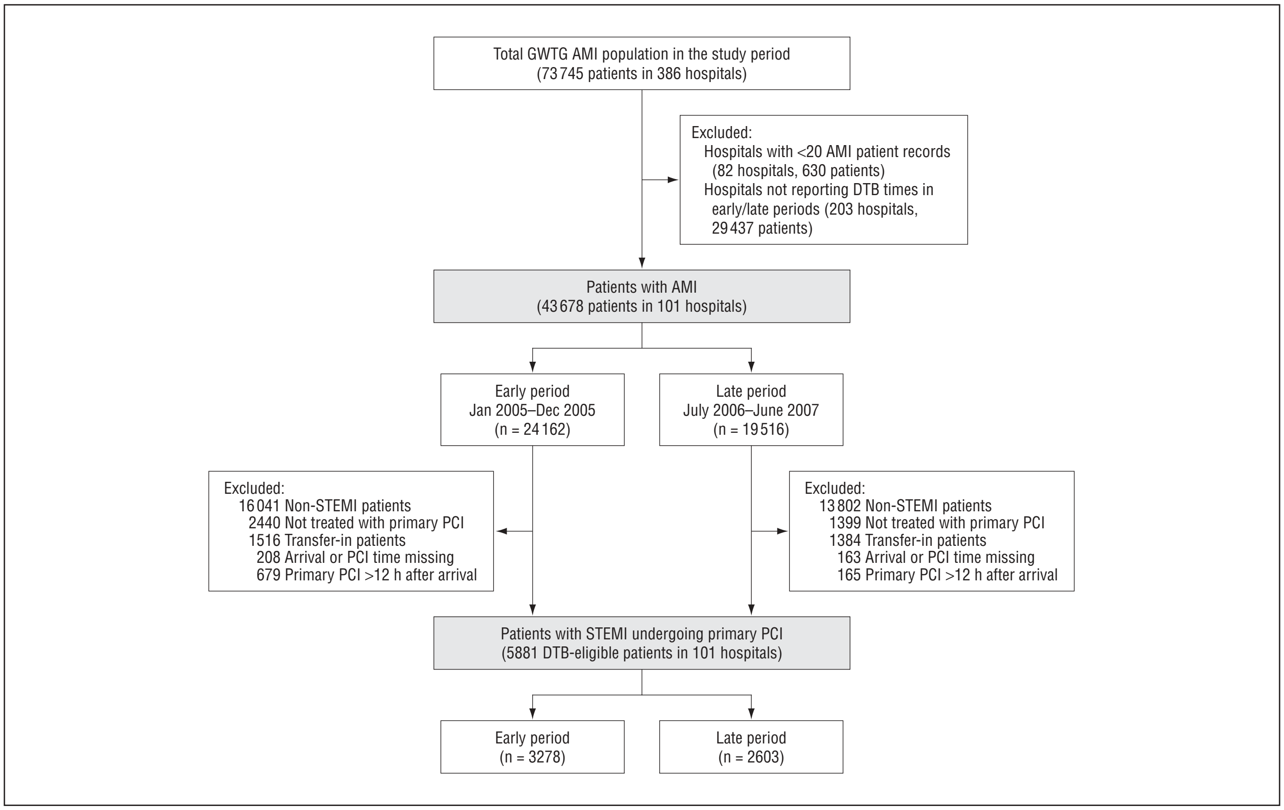

Figure 1. Flowchart of study population. AMI indicates acute myocardial infarction; DTB, door-to-balloon; GWTG, Get With the Guidelines; PCI, percutaneous coronary intervention; and STEMI, ST-segment elevation myocardial infarction.

Thus, we analyzed hospitals participating in the American Heart Association Get With the Guidelines (AHA GWTG) program to correlate temporal trends in DTB times to performance of other quality measures, including both CMS/JCAHO core measures as well as other ACC/AHA guideline-recommended measures.[10] We further assessed the relationship between improvements in DTB time, changes in other AMI performance measures, and overall in-hospital mortality.

METHODS

DATA SOURCE

The AHA GWTG program is a large, national observational registry started in 2000 to support and facilitate quality improvement in the care of patients with cardiovascular disease. Details of GWTG have been described previously.[10] In brief, the GWTG coronary artery disease program enrolls patients hospitalized with a confirmed diagnosis of coronary artery disease (*International Classification of Diseases, Ninth Revision* codes 410-414). Trained data abstractors at participating GWTG hospitals collect detailed information on baseline demographic and clinical characteristics, in-hospital care processes and outcomes, and discharge treatment using a standardized set of data elements and definitions.[13] Data are collected via a Web-based patient management tool (PMT; Outcome Sciences Inc, Cambridge, Massachusetts) that provides decision support with real-time online reporting features. With this Internet-based data entry system, data quality is monitored to assure completeness and accuracy of the submitted data. Because collected data are primarily used for institutional quality improvement and deidentified patient information is collected anonymously through retrospective medical record review, individual informed consent is not required under the common rule. However, participation in GWTG requires approval of the institutional review board of each hospital.

STUDY POPULATION

To best capture the impact of the ACC D2B campaign on hospital performance, we examined two 1-year periods before and after national introduction of the D2B Alliance, which resulted in an early period from January to December 2005 and a later period from July 2006 to June 2007 (**Figure 1**). We restricted this analysis to GWTG hospitals that submitted at least 20 AMI patient records in each period to define a threshold for stable hospital-level performance assessment, as well as to GWTG hospitals that reported DTB times in both the early and later periods (285 hospitals excluded). This yielded a total of 101 hospitals of varying size, teaching status, and surgical capability from all census regions of the United States. All 43 678 patients treated for AMI at these hospitals were included in the assessment of process measure performance.

To examine hospital-level changes in DTB time across periods, we excluded patients with non-STEMI (n=29 843), patients not treated with primary PCI (n=3839), patients transferred in from other hospitals for primary PCI (n=2900), patients with missing arrival or PCI times (n=371), and patients who received primary PCI more than 12 hours after hospital arrival (n=844). The final population for DTB time assessments included 5881 patients with STEMI undergoing primary PCI, among which 3278 and 2603 patients were treated in the early and later periods, respectively.

STATISTICAL METHODS

We evaluated hospital performance of the following process measures: (1) geometric mean DTB time; (2) CMS/JCAHO core pro-

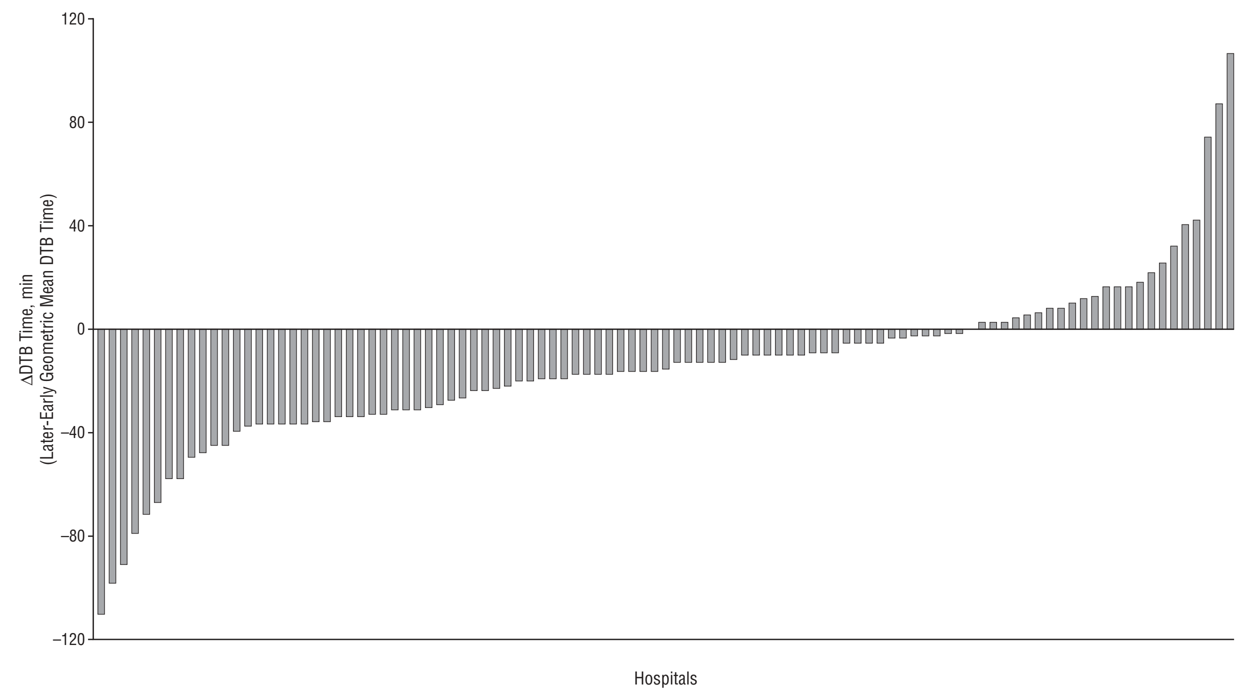

Figure 2. Distribution of changes in door-to-balloon (ΔDTB) time across hospitals in the United States.

Table 1. Hospital Characteristics Stratified by Quartiles of Change in DTB Time

Variable	Improvement in DTB Time Most→Least: First Quartile	Second Quartile	Third Quartile	Fourth Quartile	*P* Value for Trend
Hospitals, No.	25	25	26	25	
Patients with AMI, No.	8129	11 322	13 125	11 102	
Beds, median (IQR), No,	326 (236-590)	331 (270-482)	392 (243-491)	409 (251-648)	<.001
Teaching hospital, %	57.1	33.6	60.4	64.2	<.001
Surgical facility, %	81.7	84.1	95.3	83.8	<.001
Patients with STEMI, %	35.4	29.7	32.7	29.8	<.001
Patients transferred from another ED or hospital, %	29.1	23.3	28.8	28.5	.002
Duration in AHA GWTG, median (IQR), y	3.8	3.8	4.3	3.5	.69
DTB time in early period, mean, min[a]	128	102	92	82	<.001
DTB time in later period, mean, min[a]	77	80	84	105	.001

Abbreviations: AHA GWTG, American Heart Association Get With the Guidelines program; AMI, acute myocardial infarction; DTB, door-to-balloon; ED, emergency department; IQR, interquartile range; STEMI, ST-segment elevation myocardial infarction.

[a] Hospital DTB time is calculated using the geometric mean DTB time across all patients in a given hospital.

cess measures, which included aspirin and β-blocker use at admission and discharge, angiotensin-converting enzyme-inhibitor or angiotensin receptor blocker use at discharge among patients with an ejection fraction lower than 40%, in-hospital smoking cessation counseling, and door-to-needle time of 30 minutes or less; and (3) ACC/AHA guideline recommended measures which included, in addition to the aforementioned measures, in-hospital low-density lipoprotein assessment, lipid-lowering therapy use at discharge, clopidogrel use at discharge, cardiac rehabilitation referral, and dietary/weight management counseling among patients with a body mass index greater than 25 (calculated as weight in kilograms divided by height in meters squared). Composite process measure performance was calculated as the number of times the selected care process was provided to eligible patients divided by the total number of eligible patients (ie, absence of contraindications) for that measure who were treated at a selected hospital. Patients who died within the first 24 hours (n=855) were excluded from the denominator for assessment of admission process performance, and those who died (n=2068) or were transferred out to another institution for inpatient care (n=1589) were excluded from the discharge process performance assessment. On a hospital level, the median proportions of patients who died within 24 hours, died during hospitalization, and were transferred for further inpatient care did not change significantly between the early and later periods: 1.3%, 4.7%, and 2.1%, respectively, in the early period and 1.3%, 4.5%, and 2.3%, respectively, in the later period.

Changes in DTB time (ΔDTB) and composite process measure performance were calculated as that of the later minus the early period. Although ΔDTB was analyzed as a continuous variable, hospitals were also divided into quartiles by ΔDTB for de-

Table 2. Patient Characteristics Stratified by Quartiles of Change in DTB Time

Variable	Improvement in DTB Time Most → Least: First Quartile	Second Quartile	Third Quartile	Fourth Quartile	*P* Value for Trend
Hospitals, No.	25	25	26	25	
Patients with AMI, No.	8129	11 322	13 125	11 102	
Demographics, %					
Age, median (IQR), y	65 (54-76)	67 (55-78)	65 (55-77)	65 (55-77)	.22
Female sex	34.8	37.2	34.8	36.4	.77
Non-white race	27.9	19.3	17.9	27.4	.04
No insurance	9.2	7.4	9.5	13.1	<.001
Clinical history, %					
Prior MI	16.9	20.0	16.4	18.3	.12
Prior HF	12.8	16.5	9.6	12.3	<.001
Prior stroke	7.6	8.1	6.4	7.9	.87
Peripheral arterial disease	7.9	8.7	8.0	8.0	.61
Diabetes	30.3	29.6	27.0	28.8	.31
Hypertension	64.5	62.8	57.9	60.4	.004
BMI, median (IQR)	28 (24-32)	28 (24-32)	28 (25-32)	28 (24-32)	.003
Renal insufficiency	9.5	9.5	5.9	8.4	<.001
Systolic BP, median (IQR), mm Hg	135 (116-154)	135 (116-155)	136 (117-155)	134 (116-154)	.51

Abbreviations: AMI, acute myocardial infarction; BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); BP, blood pressure; DTB, door-to-balloon; HF, heart failure; IQR, interquartile range; MI, myocardial infarction.

scriptive purposes. For each ΔDTB quartile, hospital and patient characteristics were compared. Median (interquartile range) values and frequencies were reported for continuous and categorical variables, respectively. Because ΔDTB quartile group is an ordinal variable, the tests of trend across quartile groups were performed using Cochran-Mantel-Haenszel row-mean scores tests for categorical and Cochran-Mantel-Haenszel nonzero correlation tests for continuous variables.[14] Door-to-balloon times, raw measures of process measure adherence, and mortality rates were reported on the patient level in early and late periods and in each quartile. Comparisons between the early and later periods were made using χ^2 tests.

The correlation between hospital ΔDTB and change in composite process measure performance (as continuous variables) was determined using Spearman correlation coefficients. Similarly, the association between hospital ΔDTB and change in in-hospital mortality was also evaluated. Patients who were transferred out to another institution for inpatient care (n=1589) were excluded from the denominator of mortality assessment. Multivariate logistic regression analysis using the generalized estimating equations approach[15] was performed to compare adjusted mortality in the later vs early period for each ΔDTB quartile of hospitals. This method accounted for within-hospital correlation of responses; ie, patients at the same hospital were more likely to have similar responses relative to patients in other hospitals.[5] Variables for adjustment were adapted from the validated Global Registry of Acute Coronary Events (GRACE) mortality risk model for patients with AMI (c-index=0.83)[16] based on variables collected in the GWTG registry data collection form. These included age, sex, race, insurance status, body mass index, prior myocardial infarction, prior coronary artery disease, prior heart failure, prior stroke/transient ischemic attack, peripheral vascular disease, atrial fibrillation/flutter, diabetes, hyperlipidemia, hypertension, chronic lung disease, renal insufficiency, chronic dialysis, anemia, tobacco use, and depression. Variables incorporated into the models were missing in less than 7% of patients, except for body mass index, which was missing in 11% of patients and thus imputed to sex-specific median values. Interaction *P* values compared changes in outcome from the early to later period across quartiles, using the fourth quartile (hospitals with the least DTB time improvement) as the reference group.

We performed several secondary analyses to evaluate the robustness of our results. First, we restricted the sample to only hospitals starting with a lower CMS/JCAHO composite score (bottom half of all sites) and assessed the correlation between ΔDTB and changes in composite score performance. Next, we examined the correlation between ΔDTB, change in composite score, and change in mortality only among patients with STEMI.

A 2-sided *P* value of <.05 was considered statistically significant for all tests. No adjustments were made for multiple comparisons. All statistical analyses were performed using SAS software (version 9.1; SAS Institute Inc, Cary, North Carolina).

RESULTS

CHANGES IN DTB TIME

A total of 43 678 patients were treated for AMI during the 2 study periods, 24 162 early and 19 516 later. Between the early and later periods, DTB times among eligible patients with STEMI undergoing primary PCI improved significantly; hospital geometric mean DTB times decreased from 101 minutes during the early period to 87 minutes in the later period ($P<.001$). Changes in DTB times, however, varied considerably among US hospitals (**Figure 2**). When hospitals were stratified by quartiles of ΔDTB, the mean changes in DTB time were −51 minutes, −22 minutes, −8 minutes, and +22 minutes, respectively, for quartiles 1 through 4, with hospitals in the lowest quartile actually having longer DTB times in the later period compared with the early period. As given in **Table 1**, hospitals with greater DTB time improvement were smaller and less likely to be teaching hospitals and had higher starting DTB times. Baseline patient characteristics were similar among hospitals in each quartile of ΔDTB (**Table 2**).

Table 3. Changes in Process Measure Performance and In-Hospital Mortality Stratified by Quartiles of Change in DTB Time

	Overall			Improvement in DTB Time Most → Least: First Quartile		Second Quartile		Third Quartile		Fourth Quartile	
Variable	Early	Late	*P* Value	Early	Late	Early	Late	Early	Late	Early	Late
Hospitals, No.	101	101		25	25	25	25	26	26	25	25
Patients with AMI, No.	24 162	19 516		4603	3526	6570	4752	7452	5673	5537	5565
CMS/JCAHO core measures, %											
Aspirin at admission	92.3	97.4	<.001	95.3	98.0	93.5	97.5	87.5	97.8	94.8	96.5
Aspirin at discharge	97.8	97.6	.08	98.2	97.9	96.8	96.7	98.8	98.2	97.4	97.5
β-Blocker use at admission	89.0	95.2	<.001	91.9	95.7	90.1	95.3	84.2	95.1	91.4	95.1
β-Blocker use at discharge	96.5	97.1	.001	96.0	95.7	96.1	96.8	97.3	97.7	96.1	97.5
ACEI/ARB use at discharge if EF <40%	83.4	90.9	.01	83.0	88.7	84.0	90.5	83.5	90.4	83.0	92.7
Time to fibrinolysis <30 min	37.4	43.8	.30	57.5	60.0	26.2	25.0	35.4	48.2	38.6	32.0
Smoking cessation counseling	92.9	96.2	<.001	93.7	95.5	93.8	97.6	92.6	95.2	91.5	96.6
Composite CMS/JCAHO score	93.4	96.4	<.001	94.6	96.2	93.4	96.2	92.6	96.7	93.6	96.4
Other ACC/AHA recommendations, %											
In-hospital LDL assessment	70.7	70.3	.34	73.7	69.0	69.0	70.0	74.9	75.1	64.5	66.3
Lipid-lowering therapy at discharge	85.6	90.7	<.001	86.8	90.2	81.1	89.9	89.0	92.2	85.3	90.4
Clopidogrel use at discharge	82.8	88.7	<.001	83.8	90.1	78.5	88.3	84.9	87.8	83.6	89.1
Cardiac rehabilitation referral	44.9	47.3	<.001	53.2	60.2	45.6	47.1	43.8	46.0	39.2	41.1
Dietary counseling if BMI >25	87.9	88.2	.40	85.7	89.2	90.6	87.6	95.5	87.6	75.9	88.8
Composite ACC/AHA score	82.0	84.2	<.001	84.4	86.1	81.5	84.2	82.9	84.6	79.4	82.5
In-hospital mortality, geometric mean (95% CI)	5.1 (4.8-5.4)	4.7 (4.4-5.0)	.09	5.5 (4.8-6.2)	4.8 (4.0-5.5)	6.0 (5.4-6.6)	5.5 (4.8-6.1)	4.2 (3.7-4.6)	4.2 (3.6-4.7)	4.9 (4.4-5.5)	4.6 (4.1-5.2)

Abbreviations: ACC/AHA, American College of Cardiology/AHA, American Heart Association; ACEI, angiotensin-converting enzyme inhibitor; AMI, acute myocardial infarction; ARB, angiotensin receptor blocker; BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); CI, confidence interval; CMS/JCAHO, Centers for Medicare and Medicaid Services/Joint Commission on Accreditation of Healthcare Organizations; DTB, door-to-balloon; EF, ejection fraction; LDL, low-density lipoprotein.

CHANGES IN PROCESS MEASURE PERFORMANCE

Table 3 gives the changes in individual care measures for hospitals stratified by ΔDTB. Among the CMS/JCAHO core measures, use of aspirin and β-blockers at admission, use of angiotensin-converting enzyme inhibitors and/or angiotensin receptor blockers among patients with left ventricular systolic dysfunction, as well as delivery of smoking cessation counseling showed the most improvement. Most of the other ACC/AHA guideline recommendations, such as use of lipid-lowering therapy and clopidogrel use at discharge and cardiac rehabilitation referral, also showed significant improvement. Overall, composite CMS/JCAHO core process measure performance improved significantly between the early and later periods, increasing from a mean of 93.4% to 96.4% ($P < .001$). The performance of the composite ACC/AHA guideline recommended measures also improved from 82.0% to 84.2% ($P < .001$).

As shown in **Figure 3**A and B, there was no significant correlation between ΔDTB and changes in process-measure performance as assessed by either the composite CMS/JCAHO core process measures ($r = -0.061$, $P = .55$) or the composite ACC/AHA guideline recommended measures ($r = -0.173$; $P = .08$). This lack of association persisted after multivariable adjustment for differences in patient characteristics (**Figure 4**A and B).

CORRELATION BETWEEN DTB TIME, PROCESS MEASURES, AND IN-HOSPITAL MORTALITY

Overall in-hospital mortality was 5.1 in the early and 4.7% in the later period ($P = .09$). There was no significant association between improvements in DTB time and changes in mortality (Table 3 and Figure 3C). This lack of asso-

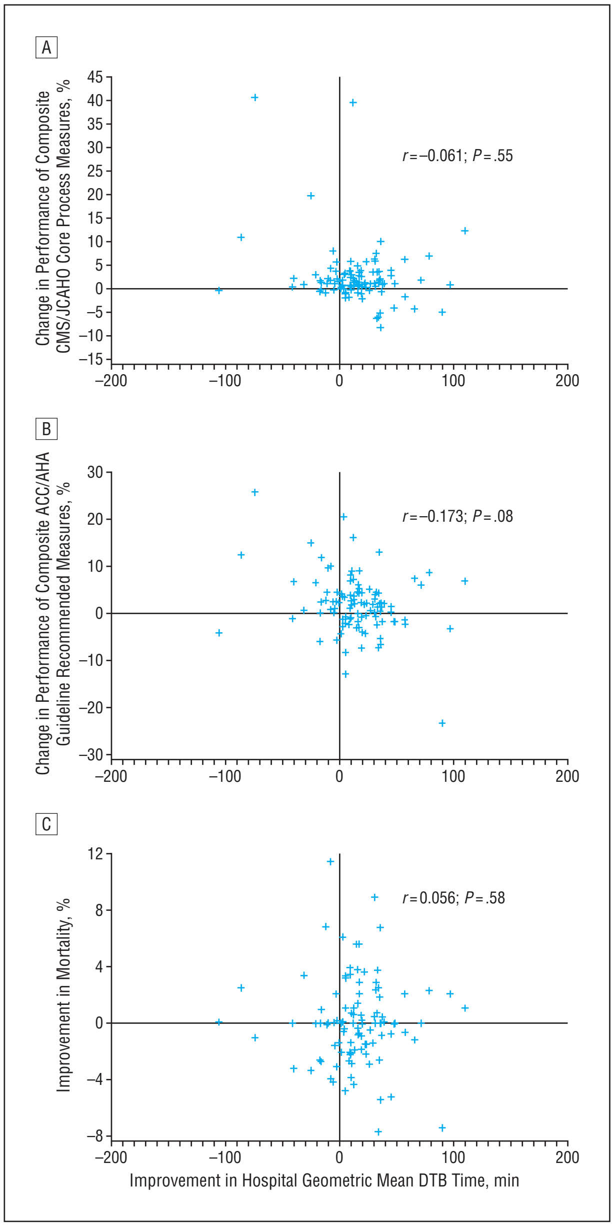

Figure 3. Correlation between improvements in DTB time and performance of composite CMS/JCAHO core process measures (A), composite guidelines recommended measures (B), and in-hospital mortality (C). ACC/AHA indicates American College of Cardiology/American Hospital Association; CMS/JCAHO, Centers for Medicare and Medicaid Services/Joint Commission on Accreditation of Healthcare Organizations; and DTB, door-to-balloon.

ciation persisted after multivariable adjustment for differences in patient characteristics (Figure 4); the risk-adjusted mortality differences from the early to later period were not statistically different across ΔDTB quartiles.

Although not statistically significant, there was a suggestion of mortality reduction in hospitals with improvements in both DTB time and CMS/JCAHO composite quality performance. From the early to later periods, in-hospital mortality increased 0.9% in hospitals with DTB improvements alone, increased 0.1% with CMS/JCAHO core measure improvements alone, and decreased 0.5% in hospitals with improvements in both CMS/JCAHO and DTB performance (*P* value for trend, .07).

Our results did not differ substantially in several secondary analyses. When the population was restricted to those 50 hospitals (bottom half) with a lower starting CMS/JCAHO composite score (score ranging from 55.2%-94.8%), there remained no significant correlation between improvements in DTB time and change in CMS/JCAHO composite score ($r=-0.031$; $P=.83$) or between improvements in DTB time and change in mortality ($r=-0.088$; $P=.54$). Our results were consistent if we limited the analysis population to the 13 835 patients treated for STEMI. Among these patients, hospital mean composite CMS/JCAHO scores improved from 94.4% to 96.8% ($P<.001$), and the performance of composite ACC/AHA guideline recommended measures showed a trend toward improvement from 84.4% to 86.6% ($P=.05$). However, there was no correlation between improvements in DTB time and change in CMS/JCAHO composite score ($r=0.075$; $P=.46$), between improvements in DTB time and change in ACC/AHA composite score ($r=0.11$; $P=.26$), or between improvements in DTB time and change in in-hospital mortality ($r=0.026$; $P=.80$).

COMMENT

The AHA GWTG program provided a unique opportunity to examine the influence of a national campaign targeting a single AMI process measure (DTB time) on overall quality of care and outcomes for patients with AMI. Our study found that while hospital DTB times improved significantly over time, this was not associated with improvements in the performance of other hospital process measures or with a reduction in mortality.

Recent efforts, such as the D2B Alliance and Mission: Lifeline Initiative, have increased national awareness of the need for timely reperfusion. Door-to-balloon time measures are now firmly defined within professional guideline recommendations and are further established as a publicly reported quality metric as well as a component of quality incentivization programs.[6,9,17,18] Our study, echoing previous observational findings, shows that a significant improvement in DTB times over time among community-based hospitals of varying size and location are likely a result of these quality-improvement initiatives.[19-21] However, DTB time is only one of several quality measures delineated by the ACC/AHA clinical practice guidelines.[10] The evidence favoring implementation of these other AMI quality measures is similarly robust, with hospital adherence to these recommendations correlating directly with risk-adjusted survival among patients with AMI.[3] Yet, these evidence-based care processes are still not optimally used.[22]

Because many of these care processes are amenable to similar quality-improvement interventions, one might expect them to be strongly correlated at the hospital level; that is, hospitals championing the initiative to reduce DTB time should also be those with an inherent interest in quality improvement and would likely perform well in these other care metrics. Yet this was not observed in the present study: whether one looked at the CMS/JCAHO core process measures or the ACC/AHA guideline recommended performance measures,[5,10] there was no corre-

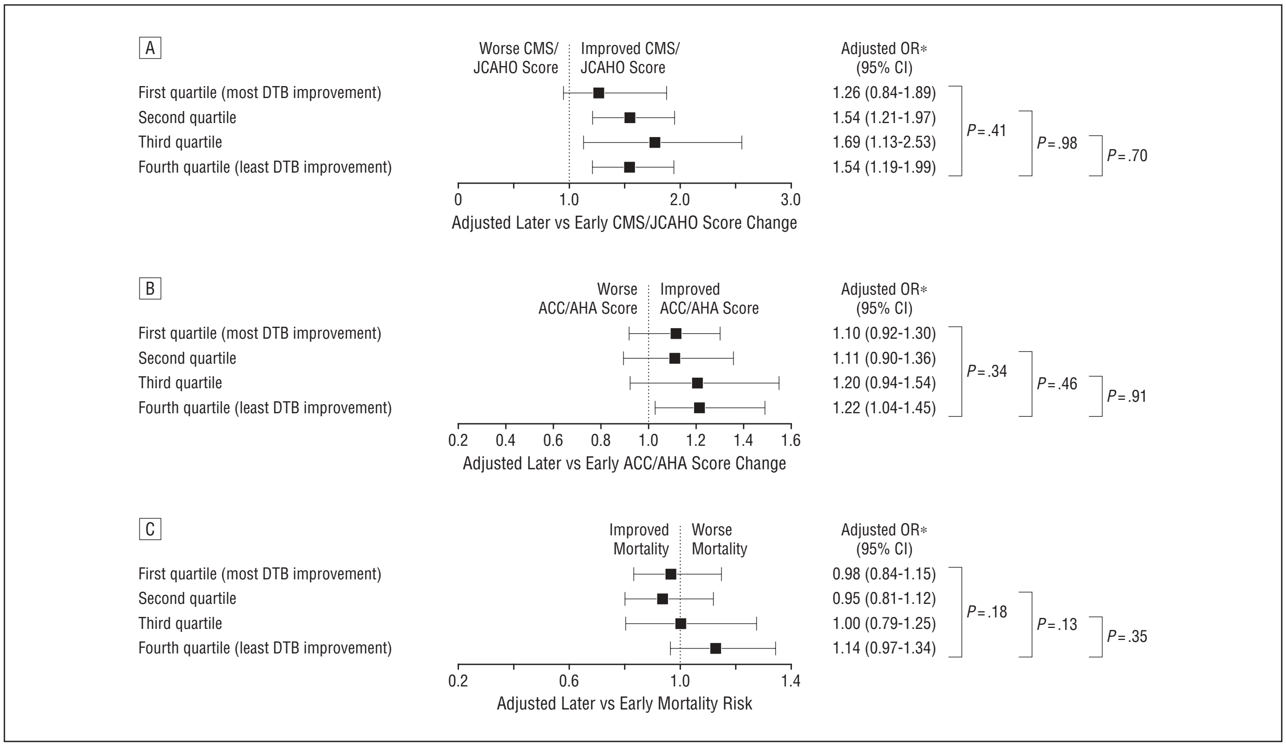

Figure 4. Risk-adjusted odds ratios (ORs) and 95% confidence intervals (CIs). Results are for performance of composite Centers for Medicare and Medicaid Services/Joint Commission on Accreditation of Healthcare Organizations (CMS/JCAHO) core process measures (A), performance of composite American College of Cardiology/American Hospital Association (ACC/AHA) guideline recommended measures (B), and in-hospital mortality in the later period relative to the early period for patients with AMI in each quartile of door-to-balloon (DTB) time improvement (C). The *P* values denote comparison of risk-adjusted mortality of each quartile relative to the fourth quartile (hospitals with the least DTB time improvement). *Mortality adjusted for age, sex, race, insurance status, body mass index, prior myocardial infarction, prior coronary artery disease, prior heart failure, prior stroke/transient ischemic attack, peripheral vascular disease, atrial fibrillation/flutter, diabetes, hypertension, hyperlipidemia, chronic lung disease, renal insufficiency, chronic dialysis, anemia, tobacco use, and depression.

lation between the improvement in DTB time and changes in the performance of other care processes.

Several potential reasons may explain this dissociation between ΔDTB and improvements in other quality-measure performance. First, GWTG hospitals have high starting median CMS/JCAHO composite scores; thus, a ceiling effect may have limited the degree to which any institution could improve their performance. However, the lack of correlation between ΔDTB and performance of other ACC/AHA guideline recommended measures, for which there is greater variability in performance across hospitals, makes this explanation less likely. Furthermore, when the analysis was repeated only among hospitals with lower starting CMS/JCAHO composite scores (ie, hospitals with more room for improvement), there was still no significant correlation between ΔDTB and performance of process measures.

Second, the effort required to implement performance change varies with the particular care process selected.[23] Strategies to reduce DTB time involve facilitated communication between care teams to expedite patient arrival to the catheterization laboratory. Performance improvement of the DTB metric, therefore, requires increasing the efficiency of processes already in place, and can be directly influenced by patient volume with minimal incremental demands on overall health system resources. In contrast, quality improvement in other process measures is built more on educational efforts, investment and implementation of quality-improvement tools, medical record review with data feedback, and availability of counseling and rehabilitative resources. Thus, the discordance in performance improvement may reflect varying levels of institutional commitment and invested resources.[24]

Third, extensive focus on changing the performance of a single measure may be "crowding out" institutional attention and resources for other important care processes.[11,12,25] Making structural changes requires both financial and personnel investment. Ideally, sufficient resources are available to address all quality concerns effectively but, in reality, with finite hospital quality-improvement budgets, initiatives may be forced to compete against each other. Increasing the visibility of a particular initiative, such as DTB time, may displace support from other important programs. The magnitude of this effect depends in part on how complementary the advocated measure is with other care processes. Champions of a particular quality measure need to be sensitive to this "side effect" and actively promote other care goals, especially since making key strategies or overcoming barriers to successfully implement change in one quality measure are likely to motivate and nurture more widespread changes across quality indicators.[26]

Interestingly, improvement in hospital DTB times did not correlate with changes in in-hospital mortality, suggesting that, from a hospital perspective, many other variables influence patient outcomes. There is a suggestion of mortality reduction among hospitals with improvements in both DTB time and performance of composite process measures. Although part of this is mediated via a direct treatment effect (ie, more consistent use of therapies results in better patient outcomes), one concern is that most care metrics are discharge measures that, theoretically, should not influence in-hospital mortality. Hospital performance of these discharge care processes likely correlates with performance of other acute measures that are not routinely assessed but are closely associated with patient outcomes. While identification of these additional measures may more effectively quantify the quality of provided care, our results emphasize the importance of overall quality improvement for AMI rather than focusing on a single process measure. In fact, with increasing complexity of hospital care, clinical outcomes rather than process measures may have intuitive appeal and provide a more complete assessment of hospital quality.

Our results should be interpreted in the light of several considerations. First, while the observational nature of this study permits real-world assessment of care patterns, the association between care processes and outcomes do not necessarily prove causality. Second, currently, GWTG only reports in-hospital outcomes. It will be important to assess the association of DTB time and other improvements in process measures with longitudinal outcomes. Third, while GWTG represents a spectrum of hospital types and sizes, participation is voluntary, reflecting an inherent interest in quality improvement, and thus may not be representative of national care patterns and outcomes. This study population was also limited to mostly tertiary care centers that provided DTB time information. Finally, during the study period, study results emerged that led to modified guideline recommendations (eg, the COMMIT [Clopidogrel and Metoprolol in Myocardial Infarction Trial] study[27] and early β-blocker use). Because these changes were not effected in the CMS/JCAHO core measures until March 2009, we assessed process measures as they were during the study period, acknowledging that practices may have changed but biases should be similarly distributed across hospitals.

In conclusion, there is evidence that national campaigns to minimize reperfusion delays have been successful in improving this component of AMI care yet have had little impact on the performance of other quality metrics and outcomes. Our results highlight the importance of overall quality-of-care improvement for AMI rather than focusing on single process measures.

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Author Contributions: Dr Wang had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. *Study concept and design:* Wang, Fonarow, Ellrodt, Shah, and Cannon. *Acquisition of data:* Fonarow, Ellrodt, Cannon, and Peterson. *Analysis and interpretation of data:* Wang, Fonarow, Hernandez, Liang, Ellrodt, Nallamothu, Shah, Cannon, and Peterson. *Drafting of the manuscript:* Wang and Ellrodt. *Critical revision of the manuscript for important intellectual content:* Wang, Fonarow, Hernandez, Liang, Ellrodt, Nallamothu, Shah, Cannon, and Peterson. *Statistical analysis:* Liang. *Obtained funding:* Fonarow and Peterson. *Administrative, technical, and material support:* Hernandez and Cannon. *Study supervision:* Wang, Fonarow, Ellrodt, Cannon, and Peterson.
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Correction

Numerical Error. In the article titled "Disorders of Balance and Vestibular Function in US Adults: Data From the National Health and Nutrition Examination Survey, 2001-2004," by Agrawal et al, published in the May 25th issue of the *Archives* (2009;169[10]:938-944), a value was reported erroneously. On page 940, "Results" section, right-hand column, fifth paragraph, the second sentence should have read as follows: "We found that these participants had a nearly 12-fold increase in the odds of falling (odds ratio, 12.3; 95% confidence interval, 7.9-16.7) compared with participants with neither of these risks in adjusted analyses (data not shown)."