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Aggressive Measures to Decrease "Door to Balloon" Time and Incidence of Unnecessary Cardiac Catheterization: Potential Risks and Role of Quality Improvement

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Abstract

Objective: To assess the impact of an aggressive protocol to decrease the time from hospital arrival to onset of reperfusion therapy ("door to balloon [DTB] time") on the incidence of false-positive (FP) diagnosis of ST-segment elevation myocardial infarction (STEMI) and in-hospital mortality.

Patients and Methods: The study population included 1031 consecutive patients with presumed STEMI and confirmed ST-segment elevation who underwent emergent catheterization between July 1, 2008, and December 1, 2012, On July 1, 2009, we instituted an aggressive protocol to reduce DTB time. A quality improvement (QI) initiative was introduced on January 1, 2011, to maintain short DTB while improving outcomes. Outcomes were compared before and after the initiation of the DTB time protocol and similarly before and after the QI initiative. Outcomes were DTB time, the incidence of FP-STEMI, and in-hospital mortality. A review of the emergency catheterization database for the 10-year period from January 1, 2001, through December 31, 2010, was performed for historical comparison.

Results: Of the 1031 consecutive patients with presumed STEMI who were assessed, 170 were considered to have FP-STEMI. The median DTB time decreased significantly from 76 to 61 minutes with the aggressive DTB time protocol (P=.001), accompanied by an increase of FP-STEMI (7.7% vs 16.5%; P=.02). Although a nonsignificant reduction of in-hospital mortality occurred in patients with true-positive STEMI (P=.60), a significant increase in in-hospital mortality was seen in patients with FP-STEMI (P=.03). After the QI initiative, a shorter DTB time (59 minutes) was maintained while decreasing FP-STEMI in-hospital mortality.

Conclusion: Aggressive measures to reduce DTB time were associated with an increased incidence of FP-STEMI and FP-STEMI in-hospital mortality. Efforts to reduce DTB time should be monitored systematically to avoid unnecessary procedures that may delay other appropriate therapies in critically ill patients.

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Management of acute ST-segment elevation myocardial infarction (STEMI) has undergone substantial changes in recent decades. The introduction of primary coronary intervention as the principal method of reperfusion resulted in decreased morbidity and in-hospital mortality.[1] The time from hospital arrival to onset of reperfusion therapy ("door to balloon [DTB] time") is an important determinant for outcomes.[2-8] The American College of Cardiology/American Heart Association guidelines were updated in 1999 to create a benchmark DTB time of less than 90 minutes for patients presenting with STEMI to a hospital capable of primary coronary intervention.[9] There has been marked improvement in DTB time in recent years.[10,11] However, the new concept of time from first medical contact to reperfusion and the

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pressure to reduce this time to less than 90 minutes has led to additional effort to reduce the DTB time even more because shorter times may improve clinical outcomes and DTB time is being used as a measure of quality by many organizations.[12]

Efforts to reduce the DTB time require a rapid triage decision with faster dispatch to the catheterization laboratory. However, this process may come at the expense of increased risk of incorrect triage decisions and an increased rate of false-positive STEMI diagnoses (FP-STEMI), ie, a patient is taken emergently to the catheterization laboratory but no STEMI is found. Many of these patients with FP-STEMI are critically ill, and triaging them to unnecessary procedures in the cardiac catheterization laboratory may lead to suboptimal outcomes due to delay of disease-appropriate therapy. Although many studies have reported the benefits of shorter DTB time, few data exist on the incidence and outcomes of FP-STEMI.[2-8,13,14] However, concerns about FP-STEMI and the effect on outcomes have been raised.[15-17] The aim of this study was to calculate the rate of true-positive STEMI diagnoses (TP-STEMI) and FP-STEMI and to assess the association between an aggressive campaign to further reduce DTB times and median DTB time, the incidence of FP-STEMI, and in-hospital mortality.

PATIENTS AND METHODS

Study Setting

Christiana Care Health System is a tertiary care center where nearly 1800 coronary interventions are performed annually, including approximately 225 annual coronary interventions for STEMI. Emergency department physicians initiate the activation of the catheterization laboratory, but an interventional cardiologist must decide to proceed with emergent angiography. With this strategy and a multidisciplinary effort, we had achieved an excellent median DTB time under the national recommended guideline of 90 minutes.

On July 1, 2009, a more aggressive STEMI protocol was introduced at our institution with a goal of reducing DTB time to less than 60 minutes. The new protocol included more intensive educational efforts to instill the importance of shorter DTB time and more aggressive quality assurance efforts, including positive feedback for shorter DTB time and negative feedback for delayed times.[13,17] Emergency department physicians still activated the catheterization laboratory, but immediate contact with interventionalists via cell phone was provided. Performance improvement goals consisted of (1) a hospital arrival to electrocardiography (ECG) time of less than 5 minutes, (2) immediate contact with an interventionalist (<5 minutes), (3) after-hours arrival of staff to catheterization laboratory within 30 minutes, and (4) an overall DTB time of less than 60 minutes. Real-time feedback and notes of appreciation were given to all the staff involved in cases in which the DTB time was less than 60 minutes. The DTB time and FP-STEMI rates were measured.

Patient Selection

Data from consecutive patients who presented to our hospital with symptoms suggestive of STEMI and underwent emergency cardiac catheterization from July 1, 2008, to November, 30, 2012, were analyzed. Two attending cardiologists who were unaware of the patients' clinical course independently evaluated ECGs. We excluded patients who did not meet ECG criteria for ST-segment elevation from further analysis (ie, high-risk non-STEMI), leaving a study population of patients who underwent emergent catheterization and had electrocardiographic criteria for ST-segment elevation. An interventionalist who performed the procedure made interventional decisions. True-positive STEMI was defined as identification of a culprit lesion regardless of whether the patient underwent coronary intervention, coronary artery bypass grafting, or medical therapy. A culprit lesion was defined as an occluded coronary artery or severe (>70%) coronary stenosis in a location that could produce the ST-segment elevation. False-positive STEMI was defined as the absence of a culprit lesion or severe coronary artery disease on coronary angiography and no increase in cardiac biomarkers with the temporal characteristics of acute coronary syndrome. We compared the DTB time, the incidence of FP-STEMI, and the incidence of in-hospital mortality in patients with TP-STEMI and FP-STEMI within 12 months before and 12 months after the implementation of the new strategy to reduce DTB time. Similarly, the DTB time, the incidence of FP-STEMI, and the incidence of in-hospital mortality in patients

with TP-STEMI and FP-STEMI were compared in the transitional period of 6 months during which the efforts to reduce DTB were implemented. In-hospital mortality was assessed at the time of hospital discharge. Debriefings were usually performed after FP-STEMI to elucidate factors responsible for the clinical misdiagnosis. During the time of this study, previous ECGs were not always readily available or sought by the emergency department staff before catheterization laboratory activation. With the occasional exception of low-dose heparin boluses, no thrombolytic or antithrombotic agents were administered before patients were taken to the catheterization laboratory.

A review of the emergency catheterization database for the preceding 10-year period from January 1, 2001, through December 31, 2010, was performed to assess historical rates of FP-STEMI.

Quality Improvement Initiative

After reviewing our internal data, we decided to implement a more robust internal quality improvement (QI) process on January 1, 2011. We identified the risk of FP-STEMI and associated potential adverse outcomes. Although we accepted the risk of having a higher incidence of FP-STEMI, we wanted to ensure no increase in the incidence of in-hospital mortality in this group. We extensively reviewed the database of all catheterization laboratory activations and emergency catheterizations for presumed STEMI for the preceding 10-year period. True-positive STEMI as well as FP-STEMI were identified as explained previously. We identified potential patients with FP-STEMI that have the highest risk of in-hospital mortality when appropriate care is delayed because of cardiac catheterization (ie, those with pulmonary embolism, central nervous system event requiring hypothermia, sepsis, misinterpretation of long-term ECG changes as the cause of an acute illness). We used the lessons from reviewing these cases to develop a teaching intervention for all involved caregivers to encourage a higher-quality, albeit rapid, clinical evaluation to exclude these possibilities before sending a patient with suspected STEMI to the catheterization laboratory. Presenting features of these cases were provided to emergency department attending physicians and residents as well as interventional cardiologists and fellows. At monthly QI meetings, these cases were reviewed with slides providing potential suggestions to avoid such outcomes. The main goal was to maintain the shorter DTB for STEMI while ensuring that patients with other life-threatening disorders were not diverted to the catheterization laboratory, depriving them of early diagnosis and needed treatment. Diagnostic algorithms for pulmonary embolism and catastrophic intracerebral events were reviewed and emphasized. Systematic comparison of presenting ECGs with previous tracings was strongly recommended. The intensive QI initiative utilizing lessons learned from the previous 10 years of data was undertaken from January 1, 2011, through December 31, 2012. We defined the first 12 months of this initiative as a transition time. The monthly QI meetings after the transition time addressed new cases and new goals for QI. The DTB times, rates of FP-STEMI, and in-hospital mortality before the transition time were compared with those during the transition time and for 12 months after the transition time (January 1, 2011, through December 31, 2011, and January 1, 2012, through December 31, 2012, respectively).

Statistical Analyses

Summary statistics included median DTB time; FP-STEMI and in-hospital mortality rates and odds ratios of FP-STEMI were compared in the intervals before, during the transition, and after the implementation of the aggressive DTB protocol and before, during the transition, and after the implementation of the aggressive QI initiative. Continuous variables were summarized using median (range), and categorical variables were summarized using number (percentage). Odds ratios were calculated for TP-STEMI, FP-STEMI, in-hospital mortality in all patients with STEMI, in-hospital mortality in patients with TP-STEMI, and in-hospital mortality in patients with FP-STEMI. The Student t test for continuous variables and χ^2 test for categorical variables were used to compare univariate changes in outcomes between different groups. Logistic regression was used for multivariate analysis to control for confounders, permitting adjusted comparison of outcomes. Covariates used for adjustment were time of presentation (ie, day vs night and weekday vs weekend/holiday), years of experience of interventional cardiologists, and years of

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experience of emergency department physicians. All tests are 2-tailed with $P<.05$ considered significant. We used SPSS Statistics for Windows, version 14.0 (SPSS Inc).

RESULTS

A total of 1031 patients with suspected STEMI were included, 861 of whom had TP-STEMI and 170 who had FP-STEMI.

Impact of Aggressive Shorter DTB Time Before QI Implementation

Data from 233 patients seen before the aggressive DTB protocol were compared with those from 123 patients seen during the transition period and 224 patients seen after the transition period. Details about TP-STEMI and FP-STEMI in this cohort are displayed in Table 1.

After the implementation of the new protocol to reduce DTB time, median DTB time decreased significantly from the previous level of 76 minutes to 61 minutes ($P=.001$) (Figure). The decrease in observed median DTB time was accompanied by an increase in the percentage of FP-STEMI from 7.7% to 16.5% ($P=.02$) (Table 1). The aggressive DTB protocol was not associated with a significant change in in-hospital mortality in patients with TP-STEMI ($P=.60$). However, in-hospital mortality in those with FP-STEMI increased from 5.6% to 21.6% from the time before the aggressive DTB protocol was initiated to after the protocol was initiated ($P=.03$)(Table 1).

TABLE 1. DTB Time, STEMI Diagnoses, and In-hospital Mortality Rates Before Implementation of the Aggressive DTB Protocol, During the Transition Period, and After Transition[a,b]

Variable	Before aggressive DTB protocol (July 2008-June 2009)	Transitional period (July-December 2009)	After aggressive DTB protocol, before QI initiative (January-December 2010)	*P* value
All STEMI	233	123	224	NA
DTB (min)	76 (39-261)	67 (33-229)	61 (31-157)	.001
TP-STEMI	215 (92.2)	112 (91.1)	187 (83.5)	.01[c]
Odds ratio	1.0 (Reference)	0.9 (0.4-1.9)	0.4 (0.2-0.8)	
FP-STEMI	18 (7.7)	11 (8.9)	37 (16.5)	.02[c]
Odds ratio	1.0 (Reference)	1.2 (0.5-2.6)	1.8 (1.0-3.2)	
In-hospital mortality				
TP-STEMI	8/225 (3.6)	7/112 (6.2)	2/187 (1.1)	.60[c]
Odds ratio	1.0 (Reference)	1.8 (0.6-5.1)	0.3 (0.1-1.4)	
FP-STEMI	1/18 (5.6)	3/11 (27.3)	8/37 (21.6)	.03[c]
Odds ratio	1.0 (Reference)	6.3 (0.6-71.3)	4.7 (0.5-4.8)	

[a]DTB = "door to balloon" (time from hospital arrival to onset of reperfusion therapy); FP = false-positive; NA = not applicable; STEMI = ST-segment elevation myocardial infarction; TP = true-positive.
[b]Data are presented as median (range) or No. (percentage).
[c]*P* value for the score test for trend of odds.

Analysis of the 10-Year Data Used for Quality Improvement Initiative

A review of the emergency catheterization database revealed that over the preceding 10 years (January 1, 2001, through December 31, 2010), the in-hospital mortality of all patients with TP-STEMI undergoing emergent coronary intervention was 6.1% (105 of 1721 patients), while the in-hospital mortality of patients with FP-STEMI was 12.2% (89 of 728).

Table 2 summarizes the causes of ST-segment elevation in all patients with FP-STEMI and in deceased patients with FP-STEMI in the historical 10-year and 2008-2010 cohorts. The discrepancy in distribution of ST-segment elevation etiology between the whole FP-STEMI cohort and the deceased cohort identified a higher-risk group of disorders in which early recognition may be essential to avoid unnecessary procedures that would delay appropriate care and may be harmful. Furthermore, the disorders leading to ST-segment elevation in the deceased patients with FP-STEMI are disproportionately represented in the 2008-2010 cohort compared with the historical cohort, possibly because the abbreviated clinical evaluation to minimize DTB time led to missed clinical clues to some of the high-risk disorders other than STEMI that can cause ST-segment elevation.

Debriefing after FP-STEMI usually revealed that clinical evaluation was abridged in part by concerns about not delaying DTB time if the patient was to be sent to the catheterization laboratory. All involved caregivers—paramedics, emergency department nurses and physicians, and interventionalists—expressed the same concerns.

Impact of Aggressive Shorter DTB Time After Implementation of QI Initiative

The QI process was carried out intensively from January 1, 2011, through December 31, 2011, and was continued thereafter. Data from the transitional period (January 1, 2011, through December 31, 2011) and the 12 months thereafter (January 1, 2012, through December 31, 2012) that included 234 and 217 patients with

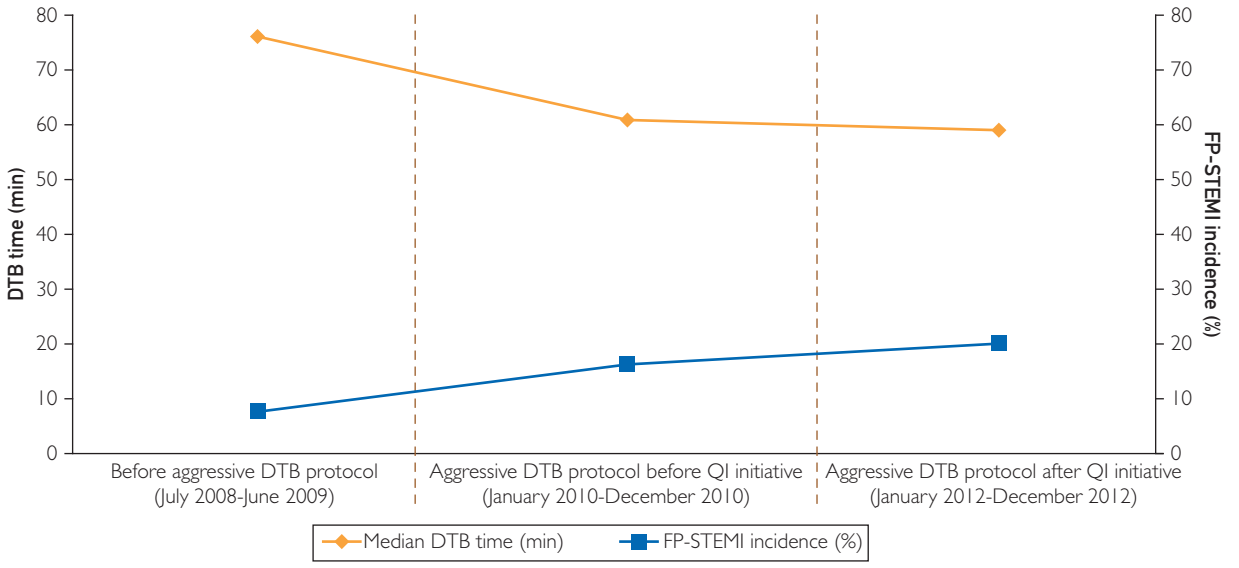

FIGURE. The impact of aggressive "door to balloon" (DTB) time (time from hospital arrival to onset of reperfusion therapy) protocol on median DTB time and incidence of false-positive ST-segment elevation myocardial infarction diagnoses (FP-STEMI) from 3 comparator intervals: baseline, after DTB time reduction protocol, and after quality improvement (QI) initiative. Transition periods are not shown.

STEMI, respectively, were compared with the aggressive protocol data before the QI initiative (Table 3). The results revealed that the trend for shorter DTB time was still successful (DTB time was decreased to 59 minutes). The FP-STEMI rate remained high (there was still intense pressure to minimize DTB times). However, the in-hospital mortality in patients with FP-STEMI appeared to decline significantly (from 21.6% to 4.5%; P=.03), while the low in-hospital mortality rate in patients with TP-STEMI remained essentially the same (Table 3). The Figure illustrates the DTB times and FP-STEMI rates in the 3 comparator groups (baseline, after DTB time reduction protocol, and after QI project). Transition periods were not included.

DISCUSSION

In this study, an intensive effort to reduce DTB time led to an increase in unnecessary emergency cardiac catheterization and a trend toward an increase in in-hospital mortality in the FP-STEMI group. Debriefings after unnecessary catheterization revealed that physicians, paramedics, and nurses involved in the care of patients with possible STEMI were aware of the need to avoid long DTB time and hurried clinical evaluations. A review of a 10-year database of in-hospital mortality after unnecessary catheterization for suspected STEMI similarly revealed that this is a high-risk group. Focused efforts to exclude life-threatening causes of ST-segment elevation that are not STEMI before proceeding with emergent catheterization may offer the opportunity to avoid an unnecessary procedure and provide more pertinent appropriate therapy. Special emphasis on excluding life-threatening causes of ST-segment elevation other than STEMI (pulmonary embolism, catastrophic intracerebral event, preexisting ST-segment elevation with a superimposed severe illness that is not STEMI) is likely particularly important because these patients gain no benefit and may possibly be harmed by unnecessary cardiac catheterization. We believe this is why our FP-STEMI mortality declined without a substantial change in the FP-STEMI rates.

Achieving shorter DTB time is difficult, but it is achievable with numerous hospital-wide efforts to encourage speed of diagnosis and treatment.[11,18,19] The pressure to expedite care might lead to excessive or inappropriate cardiac catheterization in patients with suspected STEMI.[15,16,20] Although cardiac catheterization is considered a relatively low-risk procedure, catheterization of patients with

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TABLE 2. Causes of ST-Segment Elevation and Disorders Leading to Death in Patients With FP-STEMI in the 10-Year Historical and 2008-2010 Cohorts[a,b]

10-Year historical cohort (N=728)		2008-2010 Cohort (N=66)	
Causes of ST-segment elevation	Clinical disorders in deceased patients (N=89)	Causes of ST-segment elevation	Clinical disorders in deceased patients (N=12)
LVH: 232 (31.9)	Out-of-hospital cardiac arrest: 27 (30.3)	LVH: 17 (25.8)	Massive pulmonary embolism: 3 (25.0)
Early repolarization: 131 (17.9)	Sepsis with LBBB: 12 (13.5)	LBBB: 9 (13.6)	Catastrophic intracerebral event: 2 (16.7)
Pericarditis: 138 (19.0)	Aortic dissection: 9 (10.1)	Early repolarization: 8 (12.1)	Severe sepsis with Takotstubo cardiomyopathy: 2 (16.7)
Electrolyte abnormalities: 86 (11.8)	Sepsis with Takotsubo cardiomyopathy: 7 (7.9)	Pericarditis: 8 (12.1)	Out-of-hospital cardiac arrest: 2 (16.7)
LBBB: 109 (15.0)	Massive pulmonary embolism: 6 (6.7)	Takotsubo cardiomyopathy: 8 (12.1)	Aortic dissection: 1 (8.3)
Takotsubo cardiomyopathy: 16 (2.2)	Catastrophic intracerebral event: 5 (5.6)	Electrolyte abnormalities: 6 (9.1)	Undetermined: 2 (16.7)
Secondary to other systemic illness (eg, pulmonary embolism, catastrophic intracerebral event): 16 (2.2)	Undetermined: 23 (25.8)	Secondary to other systemic illness (eg, pulmonary embolism, catastrophic intracerebral event): 10 (15.2)	

[a]FP-STEMI = false-positive ST-segment elevation myocardial infarction diagnoses; LBBB = left bundle branch block; LVH = left ventricular hypertrophy.
[b]Data are presented as No. (percentage) of patients. Percentages may not total 100 because of rounding.

FP-STEMI, who often have serious disorders not related to STEMI, may carry increased risks. Although all of the FP-STEMI cases before 2011 had independent confirmation of their ST-segment elevation and were not instances of misread ECGs, many serious medical conditions can present with ST-segment elevation in the absence of STEMI.[21,22] These patients are then exposed to the small risk of the angiographic procedure as well as the more problematic risks of delayed diagnosis and specific treatment for their acute problems. In several of our patients, this delay was believed to play a role in their poor outcome. Once a FP-STEMI catheterization is concluded, an interventional cardiologist is not the optimal physician nor is the catheterization laboratory the optimal location for further evaluation and treatment of these patients. Indeed, there may be uncertainty about which physicians should continue the emergency care and in which hospital site, leading to treatment delays that may have negative consequences. For instance, in patients with pulmonary embolism, delays in treatment initiation are associated with increased in-hospital mortality.[23] Similarly, in patients with suspected STEMI after cardiac arrest, in whom simultaneous hypothermia and rapid catheterization are difficult to achieve, each hour delay in effective hypothermia increases in-hospital mortality by 20%.[24] Treatment delay may also have increased in-hospital mortality for the other serious medical conditions seen in our FP-STEMI group.

Our statistical analyses suggested that decreasing DTB time was associated with an increased incidence of FP-STEMI and in-hospital mortality in this group. The increased risk of in-hospital mortality of FP-STEMI can be attributed to the fact that at least a subset of this patient group is at high risk from their acute condition, and any delay in specific treatment of that condition can be substantially harmful and should be avoided. Although our data come from only a single center, large databases like the National Cardiovascular Data

TABLE 3. DTB Time, STEMI Diagnoses, and In-hospital Mortality in Patients Who Underwent Emergency Cardiac Catheterization Before the Quality Improvement Initiative, During the Transition Period, and After Transition[a,b]

Variable	Aggressive DTB protocol before QI initiative (January-December 2010)	Aggressive DTB protocol during QI initiative transition period (January-December 2011)	Aggressive DTB protocol after QI initiative transition period (January-December 2012	*P* value
All STEMI	224	234	217	NA
DTB (min)	61 (31-157)	57 (29-154)	59 (28-163)	.03
TP-STEMI	187 (83.5)	174 (74.4)	173 (79.7)	.30[c]
Odds ratio	1.0 (Reference)	0.6 (0.4-0.9)	0.8 (0.5-1.3)	
FP-STEMI	37 (16.5)	60 (25.6)	44 (20.3)	.30[c]
Odds ratio	1.0 (Reference)	1.7 (1.1-2.8)	1.3 (0.8-2.1)	
In-hospital mortality				
TP-STEMI	2/187 (1.1)	2/174 (1.1)	2/173 (1.2)	.90[c]
Odds ratio	1.0 (Reference)	1.1 (0.2-7.8)	1.1 (0.2-7.8)	
FP-STEMI	8/37 (21.6)	5/60 (8.3)	2/44 (4.5)	.03[c]
Odds ratio	1.0 (Reference)	0.3 (0.1-1.1)	0.2 (0.1-0.9)	

[a]DTB = "door to balloon" (time from hospital arrival to onset of reperfusion therapy); FP = false-positive; NA = not applicable; QI = quality improvement; STEMI = ST-segment elevation myocardial infarction; TP = true-positive.
[b]Data are presented as median (range) and No. (percentage).
[c]*P* value for the score test for trend of odds.

Registry cannot address this issue because they do not track FP-STEMI catheterizations.[25]

Pressure to reduce DTB time can lead to suboptimal evaluation of the patient in the emergency department by cardiologists, paramedics, nurses, and emergency department physicians because all are very concerned about prolonging DTB time. In fact, vigorous efforts to decrease DTB times have increased FP-STEMI without having an effect on DTB time, a potentially serious unintended consequence.[26] Our hospital, like many, consistently celebrates short DTB times and vigorously investigates excessive DTB times to improve. However, there is no acknowledgment of efforts when a FP-STEMI is avoided.

Evaluation of the patient with suspected STEMI is at times difficult, and it is likely that some of our patients with FP-STEMI would have undergone catheterization even with a more thorough clinical evaluation. However, acknowledgment of any important downsides of catheterization and the possible resulting delay of more appropriate care has heretofore been missing from any risk-benefit analysis of striving for shorter DTB time.[11,18,19]

There are also detrimental aspects of emergent cardiac catheterization for FP-STEMI not related to the patient. In addition to the taxing of limited medical resources, there is the considerable disruption of catheterization laboratory workflow and the care of other patients awaiting catheterization procedures during the workday. During evenings and nights, emergency procedures are usually carried out by physicians and staff who will work the next day, potentially increasing fatigue-related errors.[27]

Finally the pervasive attention to shorter DTB times may be somewhat illogical for many hospitals that have achieved reasonable DTB times because although the curve relating in-hospital mortality benefits to DTB time is steeper at greater than 90 minutes (times relatively common when lowering DTB times became a priority), it is relatively flat at the 60- to 90-minute interval.[7,8] Recent data even suggest that there is no benefit whatsoever in lowering DTB time further once it is less than 90 minutes.[28,29] The limited benefit of in-hospital mortality associated with more aggressive protocols coupled with the increased cost and potential harms of unnecessary cardiac catherizations and delay in care raises concerns, especially in hospitals that already have reasonable DTB time. The overutilization of resources, the potential costs, and staff fatigue are especially worrisome because some centers have reported FP-STEMI rates as high as 36%.[26]

Our study has some limitations. This is a single-center, retrospective study. Our numbers are relatively small, especially for in-hospital mortality, so the findings must be interpreted with caution. Our patients with suspected STEMI had subsequently validated ST-segment elevation. Other studies have used different definitions, often suspected STEMI based on emergency physician decision without cardiologist review, which may result in a higher FP-STEMI rate and a somewhat different patient population.

CONCLUSION

Aggressive measures to reduce an already acceptable DTB time can increase the incidence of FP-STEMI. Efforts to reduce DTB time should be monitored systematically to avoid unnecessary procedures and the associated delay in appropriate care for life-threatening noncardiac conditions because FP-STEMI may be associated with poor outcome. Achieving some balance by

addressing both FP-STEMI and DTB times may be optimal.

Abbreviations and Acronyms: **DTB** = "door to balloon"; **ECG** = electrocardiography; **FP** = false-positive; **QI** = quality improvement; **STEMI** = ST-segment elevation myocardial infarction; **TP** = true-positive

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