Critical Pathway Improves Arrival-In-Cath-Lab Interval for Patients With Acute Myocardial Infarction in the Emergency Department

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A newly developed critical pathway has been applied to emergency medical care of patients with acute myocardial infarction (AMI) in the emergency department. The arrival-in-cath-lab interval (ACI) was selected as a clinical indicator of quality assurance, according to American Heart Association and American College of Cardiology guidelines. This report describes the first experience of applying the critical pathway to patients with AMI in an emergency department in Japan. The ACI of 35 AMI patients who underwent primary percutaneous transluminal coronary angioplasty during a 24-month period following application of the pathway were compared with those of 50 AMI patients during the 48 months before application of the pathway. The median ACI value was significantly reduced from 65.5 min to 50.0 min. Also, the proportion of patients with acceptably short ACI (<60 min) significantly improved from 42.0% to 68.6%. (*Jpn Circ J* 2001; 65: 849–852)

Key Words: Acute myocardial infarction; Arrival-in-cath-lab interval; Clinical indicators; Critical pathway; Emergency department

Critical pathways are management plans that display goals for patients and provide the sequence of optimal efficiency! They have been developed not only for nursing, but also for medical care, to reduce costs and improve quality of care. Many pathways for cardiovascular diseases have been developed to date, including those for emergency cardiovascular care.²

In the treatment of acute myocardial infarction (AMI), early recanalization of the infarct-related coronary artery is the first priority and there is considerable evidence of the significance of reducing the time interval between symptom onset and initiation of thrombolytic therapy (onset-to-drug time)^{3–6} or balloon inflation in percutaneous transluminal coronary angioplasty (PTCA) (onset-to-balloon time).⁷ Both the American Heart Association (AHA) and the American College of Cardiology (ACC) recommend in their 1996 guidelines⁸ that the goal of emergency care for AMI is a door-to-drug (thrombolytic agent) interval less than 30 min or an arrival-in-cath-lab interval (ACI) of less than 60 min. Cannon et al reported that after implementation of the AMI protocol in the Emergency Department of Brigham and Women's Hospital,⁹ the door-to-drug time was significantly reduced from 76 min to 29 min.

However, in Japan, measurement of time intervals as clinical indicators and application of critical pathways are not yet popular among physicians. The purpose of this study was to clarify whether application of a critical pathway in the emergency department (ED) of an urban

university hospital would reduce the ACI in the management of patients with AMI.

Methods

The study was conducted prospectively with ACI as the outcome measured among patients with AMI who presented in 1999 and 2000. The data were compared to those obtained from historical control patients seen between 1995 and 1998. Between the 2 periods, the systems of emergency medical services were similar; all patients who presented to the ED by ambulance were initially treated by emergency attending physicians who supervised emergency residents.

The Critical Pathway (Table 1)

The critical pathway was used in the ED as of January 1999. It is actually a sheet of paper in the emergency room that describes each step of the initial evaluation and treatment according to the time course, from the patient's arrival in the ED until arrival in the catheterization laboratory (cath lab). The emergency physicians and residents who use this pathway have to write the actual time taken for each step of medical care carried out in the ED. After the patient arrives in the cath lab, the physician calculates the ACI and fills out the sheet, which is then filed in the hospital chart. Additionally, the physician must describe the actual reason for prolongation of the time interval if the ACI is more than 60 min.

Enrolled Patients

From January 1995 to December 2000, 19,279 patients were brought to the Department of Emergency Medicine at Keio University Hospital by ambulance. Among them, 102 patients were diagnosed as having AMI with possible indications for reperfusion therapy: (1) chest pain persisting

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Table 1 Critical Pathway for AMI Patients in the Emergency Department

_____ :	1. Arrival of a patient with chest pain in ED
_____ :	2. Vital signs, ECG and blood pressure monitoring, IV-line, CBC & blood chemistry 12-lead ECG
_____ :	3. Decision of emergency physician If following 3 items are positive, consider AMI with indications for reperfusion therapy. a. ST elevation >0.1 mV in more than 2 leads or new LBBB b. chest pain lasting more than 30 min c. within 12 h from symptom onset
_____ :	4. Page an on-call cardiologist, while paging, do following procedures Oxygen Nitroglycerin spray: 2 puffs if systolic blood pressure >100 mmHg Chest X-ray Echocardiogram Heparin 5,000 IU IV Aspirin 160 mg PO
_____ :	5. Page staff of cardiac catheter team and prepare for emergency CAG
_____ :	6. Departure from ED
_____ :	7. Arrival in cath lab
	Calculate the arrival-in-cath-lab interval: _____ min
	Signature of attending physician _____ date _____

Table 2 Patient Characteristics

	Pre-pathway group (1995–1998, n=50)	Post-pathway group (1999–2000, n=35)	p value
Age (years)*	63.0 (10–90)	64.0 (40–91)	0.696
Male	40 (80.0%)	29 (82.9%)	0.740
Onset-to-hospital arrival interval (min)*	118.0 (22–643)	116.0 (17–450)	0.517
Infarct-related coronary artery			
LMT	2 (4.0%)	2 (5.7%)	
RCA	24 (48.0%)	18 (51.4%)	0.653
LAD	21 (42.0%)	13 (37.1%)	0.389
LCX	3 (6.0%)	0 (0%)	
Normal CAG	0 (0%)	2 (5.7%)	
Primary PTCA	46 (92.0%)	31 (88.6%)	0.712
Final diagnosis			
AMI	46 (92.0%)	31 (88.6%)	0.712
Unstable angina	3 (6.0%)	1 (2.9%)	
Vasospastic angina	1 (2.0%)	1 (2.9%)	
Myocarditis	0 (0%)	1 (2.9%)	
Aortic dissection	0 (0%)	1 (2.9%)	

*Values for age and onset-to-hospital arrival interval are expressed as the median, with range in parentheses.

Table 3 Arrival-in-Cath-Lab Intervals (ACI)

	Pre-pathway group (n=50)	Post-pathway group (n=35)	p value
ACI (min)*	65.5 (26–140)	50.0 (15–116)	0.0331
ACI <60 min	21 (42.0%)	24 (68.6%)	0.0157

*Values for ACI are expressed as the median and range (in parentheses).

more than 30 min with onset within 12 h; and (2) ST segment elevation (≥ 0.1 mV) in 2 or more contiguous ECG leads. Eighty-five patients were directly transported to the cath lab, underwent emergency coronary angiography (CAG) and were enrolled in this study. In the remaining 17 patients, emergency CAG was not performed because of (1) lack of availability of hospital beds or transportation to other hospitals (3 patients), (2) failure to obtain informed consent (2 patients), (3) institution of intravenous thrombolysis (2 patients) and (4) unknown reasons (10 patients).

The 85 patients who underwent emergency CAG were divided into 2 groups: those treated in the absence of the critical pathway (pre-pathway group, 1995–1998, n=50), and those treated under the guidance of the critical pathway (post-pathway group, 1999–2000, n=35).

Statistical Analysis

Patient age, onset-to-hospital arrival interval and ACI were compared between the pre-pathway and post-pathway groups by Mann-Whitney's U test. Gender, infarct-related

arteries and the incidences of primary PTCA and an acceptable ACI (within 60min) were compared between the 2 groups by chi-square analyses.

Results

Age and gender, onset to hospital arrival interval, infarct-related arteries, incidence of primary PTCA, and the incidence of a final diagnosis of AMI were comparable between the 2 groups (Table 2).

Following institution of the critical pathway, the median ACI was significantly shortened from 65.5min (26–140 min) in the pre-pathway group to 50.0min (15–116min) in the post-pathway group (Table 3), which fulfilled the goal of the AHA/ACC Guidelines (ACI <60min) of a significant improvement (from 42.0% to 68.6%).

In the post-pathway group, the ACI of 11 patients was more than 60min and 5 patients had an ACI of more than 90 min. The reasons for the prolonged ACI in the 5 patients were delay in diagnosis in 2 patients, delay in the response of the cardiac catheter team in 2 patients and unavailability of the cath lab in 1 patient.

Discussion

Application of a critical pathway in the emergency treatment of patients suspected of having AMI has been shown to significantly decrease the ACI and increase the number of patients meeting the ACC/AHA criterion of an ACI less than 60min. Reports from the United States⁹ and the United Kingdom¹⁰ indicate that application of critical pathways or education of emergency staff reduces the door-to-drug (or door-to-needle) time for AMI patients receiving intravenous thrombolytic therapy, and because intravenous thrombolysis usually involves a range of procedures performed by emergency physicians, door-to-drug time has been used as an indicator of the quality of medical care in the ED. The critical pathway has been shown to be necessary for continuous quality improvement of ED care in Western countries, but in Japan, where the incidence of primary PTCA is equal to or more than that of intravenous thrombolytic therapy, there have been few systematic efforts as yet to reduce the interval to reperfusion in the ED. This is the first report from Japan on the application of a critical pathway in the ED to reduce the ACI in the setting of primary PTCA as the emergency treatment goal.

AMI is one of the common diseases in emergency medicine and so it is necessary to establish realistic treatment guidelines in every institute. Critical pathways clarify the goal of therapy not only for emergency physicians or cardiologists, but for all medical personnel involved in the emergency patient's care. It also promotes good collaboration between medical personnel.

Although our data demonstrated that application of a critical pathway in the ED is as effective in Japan as in Western countries, it was difficult to clarify why the pathway was effective in reducing the ACI because medical charts before the introduction of the pathway rarely clarified which treatment process was the true cause of the delay. 'Physician's delay' (patient's arrival-to-physician evaluation interval) is considered to be one of the reasons for in-hospital delay.^{12,13} In 32 patients (64%) of pre-pathway group, the actual time of ECG diagnosis was recorded in the medical charts and therefore could be analyzed. The median time interval between patient arrival

and ECG diagnosis was 6.5min, which was not significantly different from the interval of 5.0min for the post-pathway group. therefore, we speculated that the cause of the prolonged ACI in the pre-pathway group may in the complicated clinical process following the recording of the ECG in the ED. This is most likely where the pathway improves the ACI because it clearly states the process of patient care, standardizes the care and rationalizes the sequence of orders of treatment by medical personnel. Before the implementation of the critical pathway, some emergency physicians performed echocardiography to confirm their diagnosis before deciding to page cardiologists and then the on-call cardiologists repeated the test to confirm the diagnosis for themselves. After application of the critical pathway, echocardiography was standardized so as to consistently be done only after paging the on-call cardiologist (Table 1).

Recently, a new guideline for acute coronary syndrome was published in the International Guidelines 2000 for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care.¹¹ The ACI was changed to door-to-balloon inflation time (90±30min) as the indicator of patient treatment with primary PTCA. Therefore, the indicator of patient treatment with the critical pathway will in the future be changed to door-to-balloon time.

Study Limitations

In the present study, the long-term prognosis of patients was not included in the analysis. The peak serum creatine kinase (2,942±2,228 vs 3,213±3,065 IU/L) and in-hospital mortality (10.0 vs 5.7%) did not differ significantly between the pre-pathway and post-pathway groups. Kelion et al also reported that reduction of the door-to-drug time did not improve the 1-month mortality rate of 142 AMI patients.¹⁰ However, the ACI is a component of the onset-to-reperfusion interval, which has been documented to be a clinical indicator associated with lower mortality.^{3–6} Cannon et al also proved that reducing the door-to-balloon time improved in-hospital mortality in a large scale (27,000 patients) study.⁷ These data support the selection of ACI as the clinical indicator of emergency care because monitoring of the ACI under the guidance of the critical pathway will improve the quality of emergency medical care not only from the viewpoint of time reduction, but also by standardizing the emergency care of patients with AMI. A large scale, randomized study is needed to confirm that the critical pathway reduces the mortality of patients with AMI in Japan.

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