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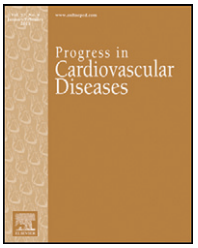

Door to Balloon Time: Is There a Point That Is Too Short?

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ABSTRACT

The duration of ischemic time is directly related to permanent myocardial damage and mortality in the setting of ST-elevation myocardial infarction (STEMI). Rapidly restoring myocardial blood flow to limit the total ischemic time is a priority. The time duration between a patient entering the medical system and being treated with percutaneous coronary intervention to open the occluded culprit vessel is termed door-to-balloon (DTB) time, which is publicly reported and used to judge hospital quality of care. While longer DTB time is associated with increased mortality in the setting of STEMI, efforts to lower DTB time have not translated into decreased mortality. Here we review the literature on DTB time, explore the factors thought to influence the interpretation of the association between DTB time and mortality, and make suggestions on goals for future efforts related to DTB time.

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Acute myocardial infarction (AMI) is a clinical syndrome characterized by symptoms of myocardial ischemia and biomarker positivity. ST-elevation myocardial infarction (STEMI) is a subset of AMI defined by characteristic electrocardiographic (ECG) changes, and is caused by the abrupt onset of myocardial ischemia. A conservative estimate of the incidence of AMI in the United States (US) is 595,000 annually, with STEMI representing approximately 30% of this total[1,2]; the incidence of STEMI has declined over time.[3]

Prolonged and sudden myocardial ischemia results in a wave of myocardial necrosis, and longer ischemic time is associated with an increased risk of permanent myocardial damage and mortality.[4] As a result, accelerating the process of restoring myocardial blood flow in the setting of STEMI has become a priority of the American College of Cardiology (ACC), American Heart Association (AHA), and other organizations with an interest in promoting improved quality of care in the setting of AMI. Specifically, the goal has been to limit the duration of myocardial ischemia, hence improving the chance for myocardial recovery and minimizing poor outcomes after AMI. In current clinical practice, the most common method of recanalizing the occluded culprit vessel is via percutaneous coronary intervention (PCI).

Over the past two decades, efforts have been redoubled with regard to achieving timely reperfusion for STEMI. In contemporary clinical practice, the ideal is that a patient with STEMI be quickly triaged through a complex medical system in order for reperfusion to occur rapidly. As such, each factor responsible for a patient efficiently navigating the emergency medical service (EMS)–emergency department (ED)–heart catheterization laboratory axis has received close attention. Door-to-balloon (DTB) time is a measure, in minutes, of the time that elapses between a patient's arrival to an emergency room "door" with a STEMI and when PCI is in effect, "balloon."

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Abbreviations and Acronyms

ACC = American College of Cardiology

AHA = American Heart Association

AMI = acute myocardial infarction

CADILLAC = Controlled Abciximab and Device Investigation to Lower Late Angioplasty Complications

CMS = Centers for Medicare and Medicaid Services

DIDO = door in door out

DTB = door to balloon

ECG = electrocardiogram

ED = emergency department

EMS = emergency medical service

ESC = European Society of Cardiology

FMC = first medical contact

GUSTO = Global Utilization of Streptokinase and Tissue Plasminogen Activator for Occluded Coronary Arteries

HQA = Hospital Quality Alliance

LVEF = left ventricular ejection fraction

NCDR = National Cardiovascular Data Registry

NRMI = National Registry of Myocardial Infarction

PAMI = Primary Angioplasty in Myocardial Infarction

PCI = percutaneous coronary intervention

PTCA = percutaneous transluminal coronary angioplasty

STEMI = ST-elevation myocardial infarction

TIMI = Thrombolysis in Myocardial Infarction

US = United States

VF = ventricular fibrillation

VT = ventricular tachycardia

DTB time is now a publicly reported measure of hospital quality of care. The percentage of hospitals achieving the performance measure has increased from 87% in 2009 to 96% in 2013, which has been publicized as evidence of improved care for STEMI patients.[5] In this article, we aim to explore the existing literature on DTB time as it pertains to current clinical practice. Further, we will suggest considerations for the future, based on shortcomings in the current system.

Defining the ischemic phase

The extent of myocardial damage is directly related to the duration of myocardial ischemia.[6] The benefit of restoring blood flow is greatest when it occurs early, prior to irreversible myocyte necrosis. From a clinical perspective, total ischemic time can be thought of as two segments: (1) the time between symptom onset (roughly representing the onset of myocardial ischemia) and when a patient enters the medical system, and (2) the elapsed time from patient presentation to when myocardial blood flow is restored. The period between the initiation of symptom onset and when the patient enters the medical system has been referred to as *symptom onset to hospital arrival*, or *symptom onset to presentation*. Notably, in some patients, symptom onset time may not mirror the onset of ischemia, such as in diabetics or women, in whom symptoms may be atypical or absent. The total ischemic time has been termed *symptom onset to treatment* or *symptom onset to balloon time*.

Aside from resolution of signs and symptoms of myocardial ischemia, documentation of restoration of myocardial blood flow occurs via coronary angiography. Angiography also aids in confirming the underlying pathophysiology of a patient's clinical presentation. When treatment for STEMI is via PCI, the point at which blood flow to the culprit vessel is restored is termed *Balloon time*. The elapsed time from patient presentation to when myocardial blood flow is restored via PCI is termed DTB time. In patients who do not undergo coronary angiography and PCI for STEMI, DTB time can be neither measured nor reported. Consequently, when considering median DTB times in STEMI patients, it is important to recognize that the cohort does not represent all patients with STEMI, but rather denotes patients with STEMI who undergo PCI. In short, when interpreting the association between DTB time and mortality, one must consider that mortality due to STEMI which occurs prior to PCI is not represented by this relationship. Mortality which occurs prior to presentation to the medical system, such as in the setting of cardiac arrest at home or en route, or in the emergency room after arrival, would not be counted in the mortality rates reported to be associated with DTB time.

Not all centers have a heart catheterization laboratory with PCI capability; therefore patients with STEMI presenting to a non-PCI capable hospital require interhospital transfer. Patients with STEMI who initially present to non-PCI capable hospitals are either treated with fibrinolytics, if it is thought that the *first medical contact* (FMC) *to balloon time* will be >120 min, or transferred for PCI, with a goal *door in door out* (DIDO) time of ≤30 min and a goal FMC to balloon time of ≤120 min.[6]

DTB time: a chronological perspective

The importance of rapid reperfusion for STEMI was described initially in the context of thrombolytic therapy, which is meant to dissolve thrombus within the occluded coronary artery. The mortality benefit of thrombolysis for STEMI is dependent on the time from symptom onset to treatment, as described in the revolutionary studies of thrombolytics.[7,8] When thrombolytics were administered early after symptom onset, the associated mortality was lower.[7–9] Longer time (>4 h) from symptom onset to hospital arrival and longer time (>90 min) from hospital arrival to initiation of thrombolytic therapy were associated with increased mortality relative to the reference groups of < 1 h.[9] In addition to improved myocardial salvage, the benefit of early treatment with thrombolytics was attributed to improved Thrombolysis in Myocardial Infarction (TIMI) flow grade, less myocardial rupture, and a decreased incidence of hemorrhagic stroke.[4,9,10]

These findings had bearing on the next era of treatment for STEMI, percutaneous transluminal coronary angioplasty (PTCA), found to be more effective than thrombolytic therapy at preventing mortality, reinfarction, and stroke.[11] Multiple

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