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Brief Reports

IMPACT OF MODE OF TRANSPORTATION ON TIME TO TREATMENT IN PATIENTS TRANSFERRED FOR PRIMARY PERCUTANEOUS CORONARY INTERVENTION

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☐ **Abstract—Background: Patients suffering ST segment elevation myocardial infarction (STEMI) requiring transfer from a non−percutaneous coronary intervention (PCI) hospital to a PCI-capable hospital often have prolonged treatment times. Objective: For STEMI transfers, we changed from air to ground transportation, and carefully documented the impact on treatment times. Methods: This is a retrospective report between two hospitals within one STEMI system. The referring facility controls both air and ground ambulance services. After a 2-year period of air transportation with suboptimal treatment times, the referring hospital switched to ground transport. All pertinent times were carefully recorded and are reported here. Results: There were 43 patients included, approximately half were transported by air and half by ground. Comparing our early experience (air only) vs. our later experience (predominantly ground-transported patients), median door-in-door-out (DIDO) time at the first facility was 70 min vs. 35 min ($p < 0.001$), median transport time was 20 min vs. 30 min ($p < 0.001$), and median first medical contact to balloon time (FMC2b time) was 123 min vs. 90 min ($p < 0.001$). After changing mode of transport, achievement of the national FMC2b time goal of < 120 min rose from 47% to 92% ($p < 0.001$). Conclusions: We document a significantly reduced DIDO and FMC2b time after changing mode of transportation for STEMI patients transferred 30 miles for primary PCI. Utilizing ground rather than air transportation, the median FMC2b time was reduced from 123 to 90 min. We show that mode of transportation can dramatically reduce both DIDO time and FMC2b time. Published by Elsevier Inc.**

☐ **Keywords—myocardial infarction; emergency medical service; angioplasty**

INTRODUCTION

Patients presenting with ST elevation myocardial infarction (STEMI) obtain the best outcomes when total ischemic time is minimized (1,2). Currently, a strategy of rapid performance of percutaneous coronary intervention (PCI) appears to be the optimal strategy (3–5). Unfortunately, < 25% of all United States hospitals can offer this service on a continuous basis. However, it has been reported that approximately 80% of patients presenting with STEMI live within 60 min of a PCI-capable facility, and among the public who live closest to a non−PCI-capable facility, 74% require a transport time < 30 min to arrive at a PCI center (6).

Through the collaborative efforts of dedicated providers and various professional societies, there have been significant improvements in treatment times for patients presenting with STEMI (7). Recent studies have highlighted that most of the gain has been among patients who initially present to a PCI center; however, the treatment times of patients who require transfer in order to undergo PCI have lagged significantly (8). Among patients presenting to a non-PCI center requiring transfer for

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primary PCI (PPCI), one can subdivide the total ischemic time into discrete measurable intervals. These include the time from symptom onset to presentation at the non-PCI center, time spent in the non-PCI emergency department (ED) (recently dubbed the door-in-door-out [DIDO] time), transfer (i.e., travel) time, and finally, the time from arrival at the PCI center to the time of restoration of coronary blood flow (door-to-balloon time [d2b] time). Except for the exclusively patient-controlled time from symptom onset to presentation, the remaining time from presentation at the non-PCI center until balloon inflation in the catheterization laboratory can be considered the first medical contact to balloon [FMC2b] time. We, as well as others, have found that for many centers, travel time and d2b time at the STEMI receiving center (SRC) are relatively fixed and consistent. However, it has been shown recently that the time spent at a referring ED can be quite long and variable (9). This DIDO time includes the time from arrival to first electrocardiogram (ECG), time for diagnosis and initiation of medical therapy, and time to arrange and execute the transfer (i.e., physical arrangements such as preparing the patient and emergency transport vehicles, as well as securing an accepting institution). Systematic analyses of treatment times for transfer patients have identified that DIDO time might be the most important determinant of system-wide FMC2b time, suggesting that this become a focus of attention of EDs. Longer DIDO times are associated with increased risk of in-hospital mortality (odds ratio = 1.56) (10). Based on publicly reported data, median DIDO times exceed 1 h, with only 9.7% of cases achieving a DIDO time less than the proposed goal of 30 min (9).

We present the results of a continuous quality improvement (CQI) effort between a single SRC with a single STEMI referring center in which a concerted, collaborative effort was made to reduce DIDO and FMC2b times. In this case, we found that mode of transportation had a significant impact on improving treatment times and therefore minimizing total ischemic time.

METHODS

Design and Setting

This is a retrospective analysis of patients presenting with a STEMI diagnosed at Darnall Army Community Medical (DACH), transferred to Scott & White Memorial Hospital (S&W) from November 2007 through February 2012. DACH is a military hospital that supports > 42,000 active-duty personnel and > 145,000 family members and retirees within a 40-mile radius. It is a non-PCI facility and, during this time, patients with an STEMI were transferred exclusively to S&W for PPCI. The hospitals are 30.5 miles apart. DACH controls an air-ambulance service; the helipad is on the military base, although physically located 1 mile from the ED. In order to send a patient via air transport, the patient must be loaded into a ground-transport vehicle by the air transport crew and shuttled to the helipad. DACH also controls a ground emergency medical service (EMS) that services the military base and immediate surrounding area, and can transfer patients off of the base to other facilities. It is staffed exclusively by advanced cardiac life support−level staff, and is headquartered within a block of the ED.

S&W is a PCI-capable facility, a chest pain center accredited by the Society of Chest Pain Centers, and an American Heart Association Mission: Lifeline STEMI Receiving Center. It serves as a regional SRC in the central Texas region with 24/7 PPCI capabilities, performing approximately 200 PPCIs annually by four interventional cardiologists who are active in STEMI systems of care (11).

Both hospitals serve a combined population of 250,000 individuals. During the study period, a total of 43 acute STEMI patients were transferred from this single STEMI referring center to our SRC by either ground or air transportation. Before the period reported here, S&W had launched a formal STEMI program that expanded to include approximately 10 referring hospitals. As each referring hospital was added, formal discussions were completed in order to facilitate rapid transfer of patients, which included a "24/7 guaranteed acceptance" of STEMI patients, preprinted order sets, and plans for ED protocols. During the initial 2 years of this transfer arrangement, DACH utilized air transportation exclusively; after multiple attempts to improve system performance and reduce FMC2b time to recommended goals, leaders of both facilities met in January 2010 as part of an ongoing CQI. At that time, it was agreed to modify our approach to favor ground transportation, hypothesizing that initiation and completion of the transfer may be more rapid overall. No other specific processes to reduce treatment times were identified or implemented. We continued to monitor total treatment times, as well as each component of the whole.

Study Population

A total of 43 acute STEMI patients were transported from DACH to S&W during the study period. All had acute ST segment elevation evident on ECG by standard criteria on arrival to the hospital. After diagnosis, the regional STEMI network was activated and the patient was prepared for either ground or air transportation in the referring ED. The referring emergency physician made the decision about mode of transportation; however, this