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The impact of first responder turnout and curb-to-care intervals on survival from out-of-hospital cardiac arrest☆

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ABSTRACT

Purpose: Patients with out-of-hospital cardiac arrest (OHCA) more likely survive when emergency medical services (EMS) arrive quickly. We studied time response elements in OHCA with attention to EMS intervals before wheels roll and after wheels stop to understand their contribution to total time response and clinical outcome.

Methods: We analyzed EMS responses to OHCA from 2009–2014 in an urban, fire department based system. The Call-to-Care Interval, from call receipt to hands-on EMS care, was comprised of four time intervals: 1) call received to EMS notification (Activation), 2) EMS notification to vehicle wheels rolling (Turnout), 3) wheels rolling to arrival at scene (Travel), and 4) arrival at scene to hands-on EMS care (Curb-to-Care). We created a new time interval (On-Feet) comprised of the turnout and curb-to-care intervals. Using logistic regression, we evaluated whether the total EMS response interval and discrete time intervals were related to survival to discharge.

Results: Of 1,831 cases, 1,806 (98.6%) had complete information. The mean lengths for the intervals were 7.2 ± 3.6 min. (call-to-care), 58 ± 39 s (activation), 63 ± 29 s (turnout), 2.5 ± 1.3 min (travel), 2.4 ± 1.6 min (curb-to-care), and 3.5 ± 1.7 min (on-feet). After adjustment, "On Feet" interval was associated with OHCA survival (OR = 0.91 [95% CI = 0.83–1.00] for each additional minute).

Conclusions: Turnout and curb-to-care intervals were half of the total response interval in our EMS system. Measurement should incorporate these two intervals to accurately characterize and possibly reduce the professional response interval.

Introduction

More than 300,000 Americans and a similar number of Europeans die annually from out-of-hospital cardiac arrest (OHCA). Survival varies five-fold across communities.[1,2] Commonly measured data elements account for only about 40% of variation in survival to hospital discharge in OHCA, suggesting an incomplete understanding of prognostic characteristics.[3]

Importantly, resuscitation is critically time-dependent and better characterization of time-related care may help explain outcome variability and provide new opportunity to improve care. The time interval from collapse to initiation of cardiopulmonary resuscitation (CPR) and defibrillation is a critical measure that influences the likelihood of survival.[4,5] However, the full interval from 9-1-1 activation to hands-on EMS care (Call-to-Care Interval) is infrequently measured. There are discrete time components within this full interval that include call receipt to EMS notification (Activation Interval), EMS notification to vehicle wheels rolling (Turnout Interval), EMS wheels rolling to scene arrival (Travel Interval), and scene arrival to hands-on EMS care (Curb-to-Care Interval). Little

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is known about the distribution of these different components and how they contribute to the total interval. This insight is important because effective efforts to decrease call-to-care intervals may depend on which component of response is contributing to delay. There is a proposed national standard that the turnout interval should not exceed 60 s for 90% of calls.[6] There is little evidence evaluating actual turnout intervals and outcomes following OHCA.

The purpose of this study was to describe the time response in OHCA with special attention to EMS intervals before wheels roll and after wheels stop to understand how these components contribute to total time response and how they relate to clinical outcomes. We hypothesized that the turnout and curb-to-care intervals contribute importantly to the call-to-care interval and the distribution of these discrete intervals provides an opportunity for improvement.

Methods

Study setting and design

This was a retrospective cohort investigation of prospectively collected data consisting of EMS responses to OHCA in Seattle, Washington during a six-year period between January 1, 2009 and December 31, 2014. Seattle Fire Department deploys a two-tiered EMS response system, dispatched by a uniformed fire fighter staffing a public safety answering point (PSAP) that receives all 9-1-1 medical emergency calls following transfer from the Seattle Police answering point. A Seattle Fire Department basic life support (BLS) fire company initially responds to each call. A Seattle Fire Department advanced life support (ALS) dual paramedic staffed ambulance simultaneously responds to calls of higher acuity such as suspected cardiac arrest, respiratory distress, and major trauma.

The University of Washington IRB reviewed and approved this study under applicable regulations.

Patients

Study patients consisted of EMS treated, non-traumatic, adult (≥18 years old) OHCA cases that occurred prior to EMS arrival within Seattle city limits. We excluded patients who received BLS-level care but were declared dead prior to ALS arrival or ALS-level care initiated by another provider, such as a long term care hospital. We also excluded still alarms (i.e. cases in which OHCA patients were brought to a fire station) and special events with prepositioned crews such as collegiate football games.

Data collection

Since 1970, the University of Washington has maintained a prospectively collected registry of OHCA cases within the city of Seattle. The registry codes data according to Utstein definitions.[7] Seattle Fire employs a Computer Aided Dispatch (CAD) system (TriTech Software Systems, San Diego, CA) that automatically collects event time stamps. The Alarm, En Route, and Arrival at Scene times for the first arriving BLS and ALS units were abstracted from the CAD system and keyed into the University of Washington's Research Electronic Data Capture (REDCap) database.

Key time intervals

All timestamps recorded in the Seattle OHCA database are synchronized to the atomic clock using mobile data terminals. Timestamps included: the time the EMS dispatcher answered the emergency call (call received time), the time the dispatcher initiated notification of EMS personnel about the emergency (alarm time), the time first arrival EMS unit wheels started moving upon notification (en route time), the time of arrival at the incident address (arrival at scene time), the time EMS arrived at the patient (arrival at patient time). The arrival at patient time was derived from the earlier of the times when EMS chest compressions were initiated as documented in the audio recordings from the defibrillator or when the AED or manual defibrillator was powered on. Seattle Fire crews are trained to initiate two minutes of chest compressions before analyzing the arrest rhythm. The defibrillator is turned on and defibrillation electrodes are placed during ongoing chest compressions. As part of quality improvement, a nurse (MO) listens and reviews every recording in order to calculate the chest compression initiation time based on the audio recording of crew counting down to complete the initial two minutes of CPR.

Using these time stamps, we calculated the four exclusive time intervals: the interval between call received time and alarm time (Activation Interval), the interval between alarm time and the en route time (Turnout Interval), the interval between en route time and arrival at scene time (Travel Interval), and the interval between arrival at scene time and arrival at patient time (Curb-to-Care Interval). In relation to a prior investigation by Spaite et al., the current study's sum of turnout and travel intervals correspond to Spaite's "Response Interval" while the current study's curb-to-care interval corresponds to the sum of his Patient Access and Initial Assessment Intervals.[5] We also calculated two composite intervals: the overall interval between call received time and arrival at patient time (Call-to-Care Interval), and the sum of turnout and curb-to-care intervals (On-Feet Interval). The call-to-care interval represents the sum of Spaite's Activation, Response, Patient Access, and Initial Assessment Intervals.[5] We calculated the time intervals for the first arriving unit to the scene, regardless of whether it was a BLS or ALS unit. We did not record the time that the dispatcher provided a short radio report about the nature of the event to the EMS crew.

Substitution cases

In approximately 96% of the OHCA events, the first unit dispatched was the first to arrive to the scene. However, there were uncommon instances (4%) where one unit was dispatched initially, but a closer unit subsequently became available to respond. The closer second unit would announce its interest in joining the response on the radio. If the dispatcher agreed, the second unit would be substituted and arrive first. We termed these events "substitution" cases. In these cases, we calculated the turnout interval as the difference between the first unit's alarm time and the second unit's en route time.

Outcome

The registry maintains information about whether the patient was discharged alive as well as their cerebral performance category at the time of hospital discharge. We classified cerebral performance category of 1 or 2 as favorable functional outcome.

Data analysis

The response time components were analyzed primarily as continuous measures. In a discrete analysis, the turnout interval was stratified to <60 and ≥60 s to better understand how this time component reflects the clinical performance guideline. We also categorized events according to whether they occurred during the day or night. Day was defined between the hours of 8 AM and 10 PM, and night was between 10 PM and 8 AM. Personnel work 24-h shifts that begin at 8 AM daily. Responses to OHCA were also divided into "Known OHCA Dispatch" vs. "Not OHCA Dispatch" based upon the dispatcher's initial dispatch code alerting EMS personnel. OHCA