Characterization of Call Prioritization Time in a Medical Priority Dispatch System

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Keywords:
Response time, Medical Priority Dispatch System, dispatch prioritization, NFPA 1221.

Citation:
Scott G, Olola C, Toxopeus C, Clawson J, Johnson A, Schultz B, Miller K, Richmond N, Robinson D, Zavadsky M, Burnette L, Barron T, Patterson B. Characterization of call prioritization time in a Medical Priority Dispatch System. Annals of Emergency Dispatch & Response. 2016;4(1):27-33.

ABSTRACT

Introduction: Emergency Medical Services (EMS) agencies have a pressing need to understand call prioritization time (CPT), a key sub-component of call processing time in Emergency Medical Dispatch, as it impacts response time to specific cases and overall EMS agency response time performance.

Objective: The objective of this study was to determine median CPT by dispatch priority level and Chief Complaint type.

Methods: This retrospective study included data from six emergency communication agencies, each accredited by the International Academies of Emergency Dispatch (IAED). The sample included all the available emergency medical calls handled between January 2006 and December 2014.

Results: A total of 3,234,290 cases were collected. After excluding outliers and corrupted data, a sample of 3,162,290 (97.8%) was analyzed. Wide differences in CPT were also noted by both priority level and Chief Complaint type.

Conclusion: EMD call prioritization time is a measurable component of call processing time. Median times vary significantly. The most time-critical cases, or ECHO-level calls, had the shortest median prioritization time, followed by BRAVO- and DELTA-level calls. A "one-size-fits-all" time standard is insufficient to represent the wide spectrum of Chief Complaint types and priority levels handled by Emergency Medical Dispatch agencies.

INTRODUCTION

Call processing time in emergency dispatch continues to be a topic of much discussion in public safety, and in emergency medical services in particular. The most widely used definition of call processing (also known as alarm processing) is: "Alarm processing begins when the alarm is answered by the telecommunicator, includes interrogation of the caller, and ends at the beginning of emergency unit notification."[1] A call processing time standard for emergency medical calls in the United States has been codified by the National Fire Protection Association in its standard, NFPA 1221 (7.4.2). The latest version of this standard (January, 2016) states: "Emergency alarm processing for the following call types shall be completed within 90 seconds 90 percent of the time and within 120 seconds 99 percent of the time: (1) Calls requiring Emergency Medical Dispatch questioning and pre-arrival instrucitons."[2]

Yet a single "one-size-fits-all" time standard may be insufficient, since it does not account for the specific type of event (Chief Complaint) and individual case circumstances—including those cases with a true need for a rapid emergency medical services (EMS) response.[3,9] Many EMS systems include dispatch call processing time as part of their reported EMS unit response time to the scene, affecting response time performance statistics for the EMS response agency. This in turn prompts those response agencies to pressure the emergency dispatch center to shorten call processing times—in most cases without evaluating the efficacy of the entire calltaking process—including how much time is actually necessary for the Emergency Medical Dispatcher (EMD) to collect and transmit critical case information with a high degree of accuracy and completeness. Further, with the

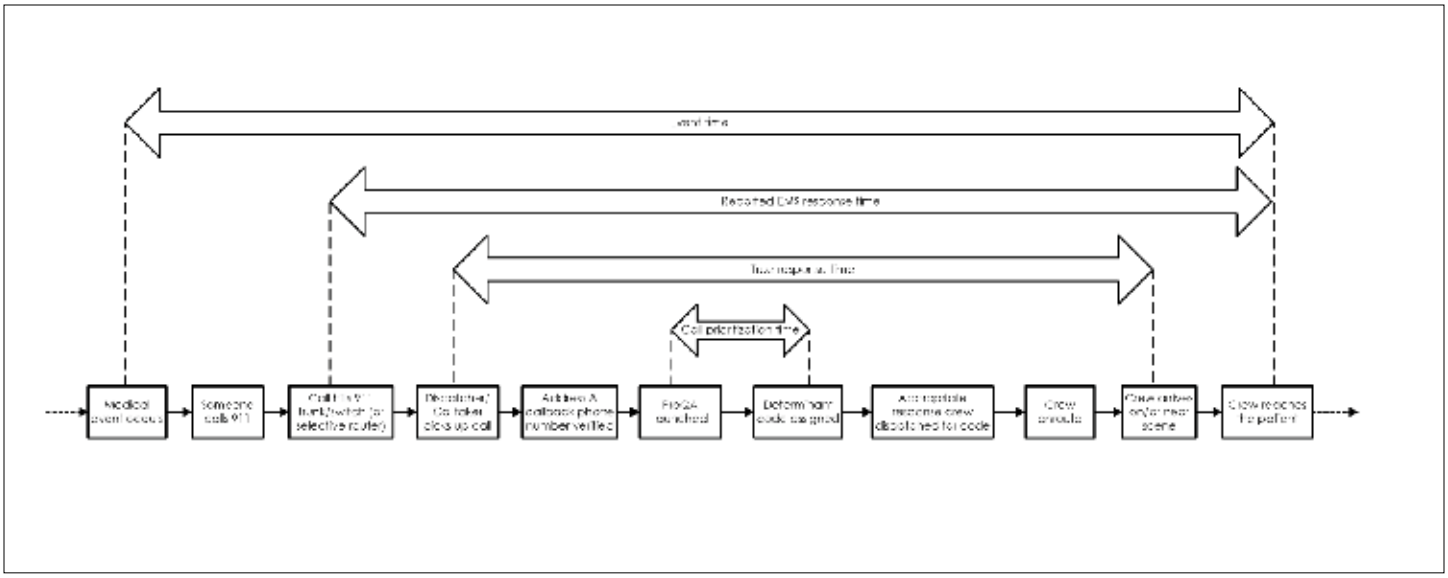

Figure 1. Call prioritization time as a component of EMS response time (*not to scale)

exception of the relatively few cases of sudden cardiac (or respiratory) arrest, there exists very little evidence that incrementally shorter EMS response times actually improve patient outcomes,[4,5,6,7,9] so there appears to be little reason not to allow EMDs to complete a thorough evaluation of the patient and emergency situation before notifying response crews.

Call prioritization time (CPT) is a key sub-component of call processing time, as it includes the gathering of the patient's Chief Complaint and primary symptoms and scene safety and hazard information, as well as assigning the correct priority level and determinant coding. In the Medical Priority Dispatch System (MPDS®), the CPT begins after address and phone number verification, at the start of the Case Entry query, "Okay, tell me exactly what happened," and ends once the MPDS determinant code has been assigned to the case (see Figure 1). EMS agencies whose dispatch centers use the MPDS software—ProQA®—can measure CPT consistently, making it readily available for study. ProQA is an expert system that directs the calltaker through a structured questioning sequence, obtaining case information from the caller (including the nature of the incident and critical incident and patient details), and recording those answers in the software program as each answer is provided by the caller. Once the most important information has been obtained, ProQA's logic and domain rules recommend a dispatch determinant code that can be immediately assigned to the case by the EMD, or in rare instances, the EMD can choose to override the recommended code to assign a higher priority coding.

Medical emergencies reported to 911 vary widely in the nature, urgency, and information required to effect a specific dispatch of the correct mix of responder units. There are 33 standard Chief Complaint Protocols in the MPDS (version 12.2, 2012) (see Figure 2), with several others that are used optionally for specialized calls (e.g. medical facility calls, automatic crash notification (ACN), suspected cases of novel flu virus, etc.). Some of these Chief Complaints, such as seizures, require a somewhat longer questioning sequence in order to arrive at the correct prioritization, as compared to others such as cardiac or respiratory arrest—conditions that can be determined in the first several questions for most patients. And typically, the more urgent the need for an immediate EMS response, the shorter the CPT, since high-acuity symptoms (simply referred to as priority symptoms in MPDS parlance) will typically be asked and recorded earlier in the MPDS questioning sequences.

There are six priority levels (see Figure 3) in the MPDS. These levels are used to define the relative urgency and response needs of the patient. There are also several hundred determinant codes that further define the nature of the incident and provide more specific response assignments. Each priority level is associated with a response value or mode: COLD or HOT. The COLD response mode comprises the OMEGA, ALPHA, and CHARLIE-level calls. However, the HOT response mode comprises the BRAVO, DELTA, and ECHO-level calls.

The purpose of this study, therefore, was to determine CPT as a function of MPDS Chief Complaint type and priority level. We hypothesized that the CPT would vary based on the nature of the Chief Complaint and the priority level assigned by the EMD.

OBJECTIVES

The primary objective of this study was to determine median CPT by MPDS priority level and Chief Complaint type. A secondary objective was to quantify and qualify any differences in CPT as associated with the priority level and Chief Complaint.

Figure 2. Medical Priority Dispatch System Chief Complaint Protocols v12.2

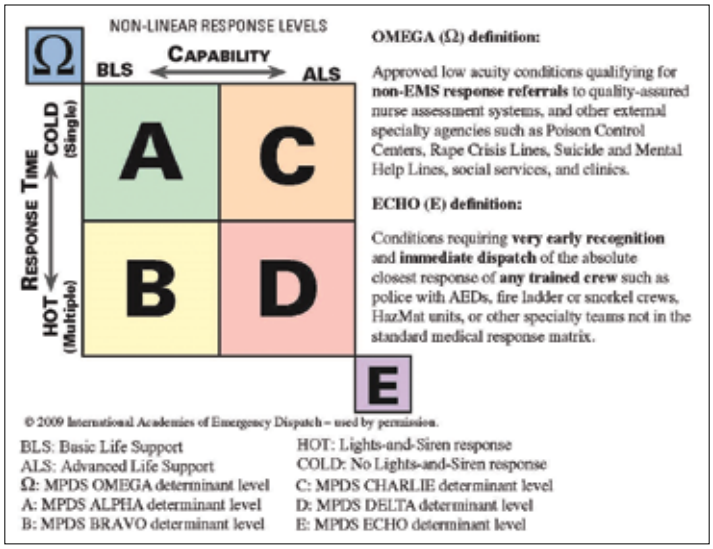

Figure 3. International Academies of Emergency Dispatch non-linear response matrix.

METHODS

Design and Setting

This retrospective study included six emergency communication agencies, each accredited by the International Academies of Emergency Dispatch (IAED) as Emergency Medical Dispatch Centers of Excellence: Austin-Travis County EMS, Austin, TX, USA; Emergency Medical Services Authority (EMSA), Oklahoma City and Tulsa, OK, USA; Louisville Metro EMS/MetroSafe (LMEMS), Louisville, KY, USA; Mecklenburg EMS (MEDIC), Charlotte, NC, USA; MedStar Mobile Healthcare, Fort Worth, TX, USA; Salt Lake City Fire Department/SLC 911 (SLCFD), Salt Lake City, UT, USA. The study was approved by the International Academies of Emergency Dispatch (IAED) Institutional Review Board.

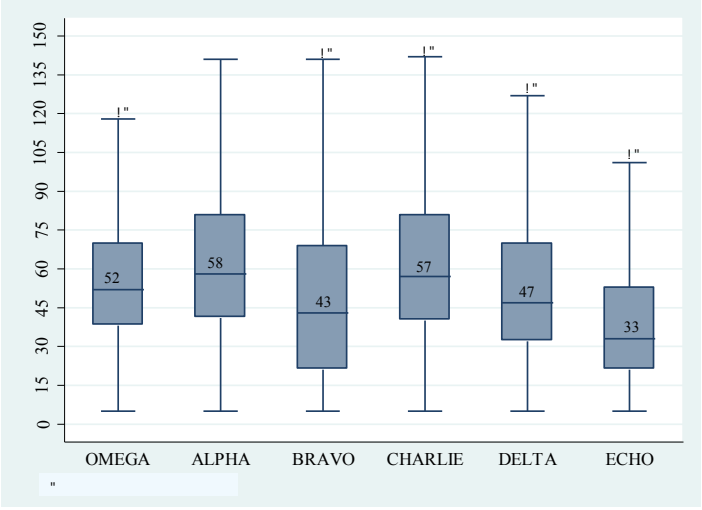

Figure 4. Overall median call prioritization time by priority level

Study population

The study sample included all the available emergency medical calls (during the study period from January 2006 to December 2014) that were handled using the MPDS software (ProQA®): Austin EMS (11/09/2009 - 04/14/2014 [52 months]), EMSA (04/01/2004 - 12/31/2014 [129 months]), LMEMS (07/07/2009 - 10/08/2014 [62 months]), MEDIC (09/01/2011 – 01/26/2015 [41 months]), MedStar (01/10/2006 – 04/05/2014 [99 months]), and SLCFD (04/26/2012 – 12/31/2014 [32 months]).

Outcome measures

The primary endpoints in this study were the median CPT for each Chief Complaint and each priority level, and the percentage of cases prioritized within 15, 30, 45, 60, 70, 80 , 90, 120, and 180 seconds.

Data analysis

STATA software for Windows (StataCorp. 2015. Stata Statistical Software: Release 14. College Station, TX: StataCorp LP.) was used for data analysis. All cases that had a CPT <5 seconds or dispatch time >300 seconds were excluded from analysis. Descriptive statistics such as median CPT (including percentiles), frequencies, and percentages were used to profile the distributions. Case distributions were presented by priority Chief Complaint Protocols and priority levels—for each agency and overall.

The nonparametric Pearson's chi-square median test was used to assess whether the median CPT values for the study groups were statistically identical—at a 0.05 level of significance. Response levels were also classified as COLD (i.e., OMEGA-level, ALPHA-level, and CHARLIE-level) or HOT (i.e., BRAVO-level, DELTA-level, and ECHO-level). Comparison of median CPT values for these two study groups was also performed.

Agency	N	Dispatch priority levels: n (%)					
		OMEGA	ALPHA	BRAVO	CHARLIE	DELTA	ECHO
ATCEMS	354,929	3,992 (1.1)	65,822 (18.6)	77,801 (21.9)	62,724 (17.7)	128,676 (36.3)	15,914 (4.5)
EMSA	1,514,033	78,041 (5.2)	236,153 (15.6)	446,747 (29.5)	310,374 (20.5)	418,080 (27.6)	24,638 (1.6)
LMEMS	472,343	24,061 (5.1)	85,092 (18.0)	81,855 (17.3)	115,739 (24.5)	160,519 (34.0)	5,076 (1.1)
MEDIC	156,063	2,101 (1.4)	23,748 (15.2)	28,959 (18.6)	40,911 (26.2)	57,624 (36.9)	2,720 (1.7)
MedStar	617,396	12,603 (2.0)	135,111 (21.9)	161,815 (26.2)	153,777 (24.9)	146,043 (23.7)	8,047 (1.3)
SLCFD	47,526	530 (1.1)	9,881 (20.8)	8,809 (18.5)	8,628 (18.2)	18,623 (39.2)	1,051 (2.2)
Overall	3,162,290	121,328 (3.8)	555,807 (17.6)	805,986 (25.5)	692,153 (21.9)	929,565 (29.4)	57,446 (1.8)

ATCEMS = Austin-Travis County EMS, Austin, Texas, USA. *EMSA* = Emergency Medical Services Authority, Tulsa, Oklahoma, USA. *LMEMS* = Louisville Metro EMS, Louisville, Kentucky, USA. *MEDIC* = Mecklenburg EMS Agency, Charlotte, North Carolina, USA. *MedStar* = MedStar-Mobile Healthcare, Ft. Worth, Texas, USA. *SLCFD* =

Table 1. Distribution of cases by agency and priority level.

RESULTS

A total of 3,234,290 cases were collected in this study. Of these cases, 0.55% (n = 17,703) were excluded as outliers, considered to be the result of data entry errors for having a CPT <5 seconds (n = 560) or >300 seconds (n = 17,143). An additional 0.42% (n=13,618) cases were excluded due to coding errors, and 1.3% (n=40,676) as test calls, resulting in a sample size of 3,162,290 (97.8%). Of this study sample overall, 29.4% were DELTA-level, 25.5% were BRAVO-level, 21.9% were CHARLIE-level, 17.6% were ALPHA-level, 3.8% were OMEGA-level, and 1.8% were ECHO-level calls (Table 1).

In terms of median CPT, generally, all call types were prioritized in under 60 seconds median time (see Figure 4 and Table 2). Specifically, overall, ECHO-level calls were prioritized in 33 seconds, followed by BRAVO-level (43 seconds), DELTA-level (47 seconds), OMEGA-level (52 seconds), CHARLIE-level (57 seconds), and ALPHA-level calls (58 seconds). Compared to the ALPHA-level calls (the reference measure), the median time values for each of the other priority level calls were significantly different ($p<0.001$).

The median time for a COLD response was significantly higher than median time for a HOT response (57 seconds and 45 seconds; $p<0.001$, respectively).

Overall, the highest percentage of ECHO-level (35%) and BRAVO-level calls (22%) were prioritized in 15-30 seconds (see Figure 5). Most of the DELTA-level calls (25%) were prioritized in 30-45 seconds, and the OMEGA-level calls in 30-90 seconds (22%). However, most of the ALPHA-level (30%) and CHARLIE-level calls (28%) were prioritized in 60-90 seconds.

Cumulatively, over 91% of calls were prioritized in 120 seconds or less (see Figure 6). Additionally, ECHO-level calls were prioritized in 90 seconds or less 91.4% of the time, and in 120 seconds or less 95.2% of the time. 81.7% of the calls that received a (default) COLD response, and 86.5% of calls that received a (default) HOT response, were prioritized in 90 seconds or less.

Overall, calls were prioritized in a median 51 seconds across all the agencies studied (Table 2). The three Chief Complaints that recorded the shortest CPTs were: Unknown Problems (29 seconds), Traffic/Transportation Incidents (30 seconds), and Cardiac Arrest (37 seconds). The three Chief Complaints that recorded the longest CPTs included: Inaccessible Incident/Other Entrapments (81 seconds), Pregnancy/Childbirth/Miscarriage (76 seconds), and Traffic/Transportation Incidents (73 seconds).

The Animal Bites/Attacks Chief Complaint Protocol had the longest CPT for OMEGA-level (73 seconds), and Inaccessible Incident/Other Entrapments had the longest BRAVO-level CPT (89 seconds). The Heart Problems/AICD and Stroke (CVA)/Transient Ischemic Attack (TIA) Chief Complaints had the longest CPTs in the ALPHA level (both 110 seconds), while Convulsions/Seizures had the longest CPTs at the CHARLIE level (92 seconds), and Pregnancy/Childbirth/Miscarriage had the longest CPTs at the DELTA level (82 seconds). However, the Unconscious/Fainting (Near) Chief Complaint Protocol had the longest CPT for the ECHO-level calls (46 seconds). On the other hand, the Abdominal Pain Chief Complaint Protocol had the shortest CPT for OMEGA-level (29 seconds), ALPHA-level (36 seconds), and CHARLIE-level (49 seconds) calls. The other Chief Complaint Protocols that had the shortest CPTs were: Unknown Problems for BRAVO-level (25 seconds), Diabetic Problems for DELTA-level (27 seconds), and Burns/Explosion for ECHO-level calls (12 seconds).

In each Chief Complaint Protocol, the median time for HOT responses was significantly shorter than median time for COLD responses ($p<0.05$), except for Back Pain,

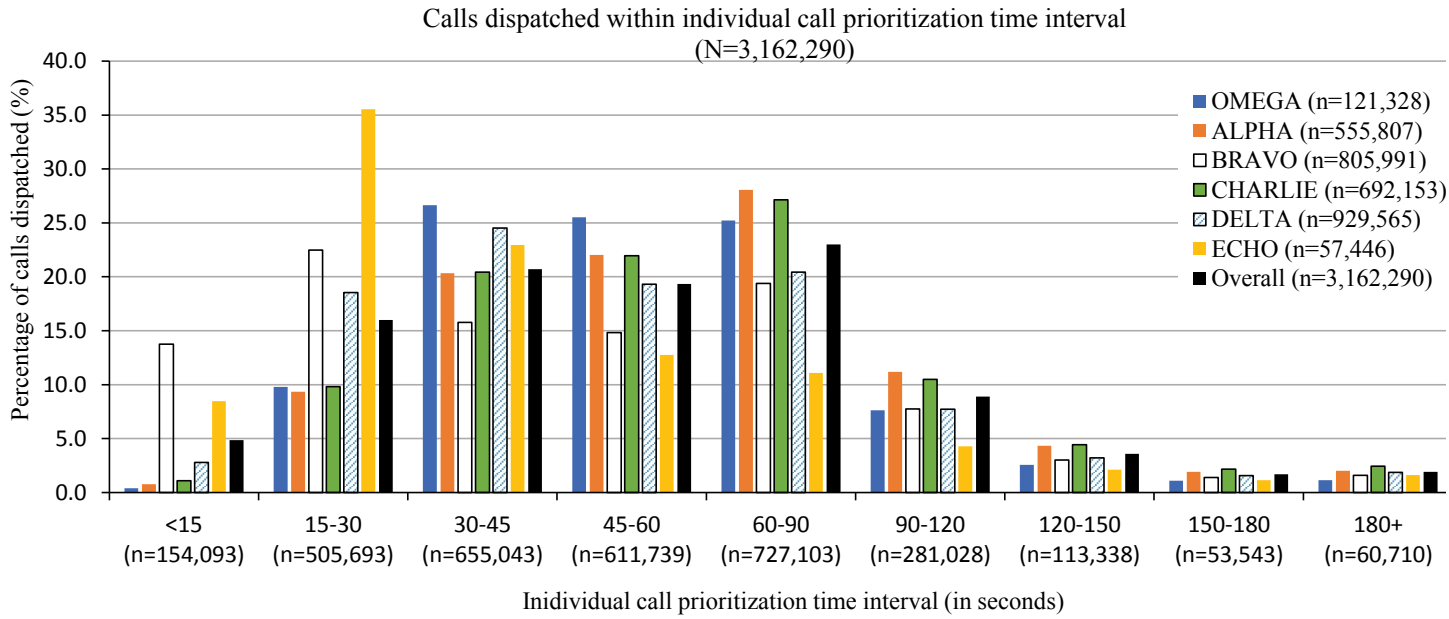

Figure 5. Distribution of calls prioritized within individual call prioritization time interval.

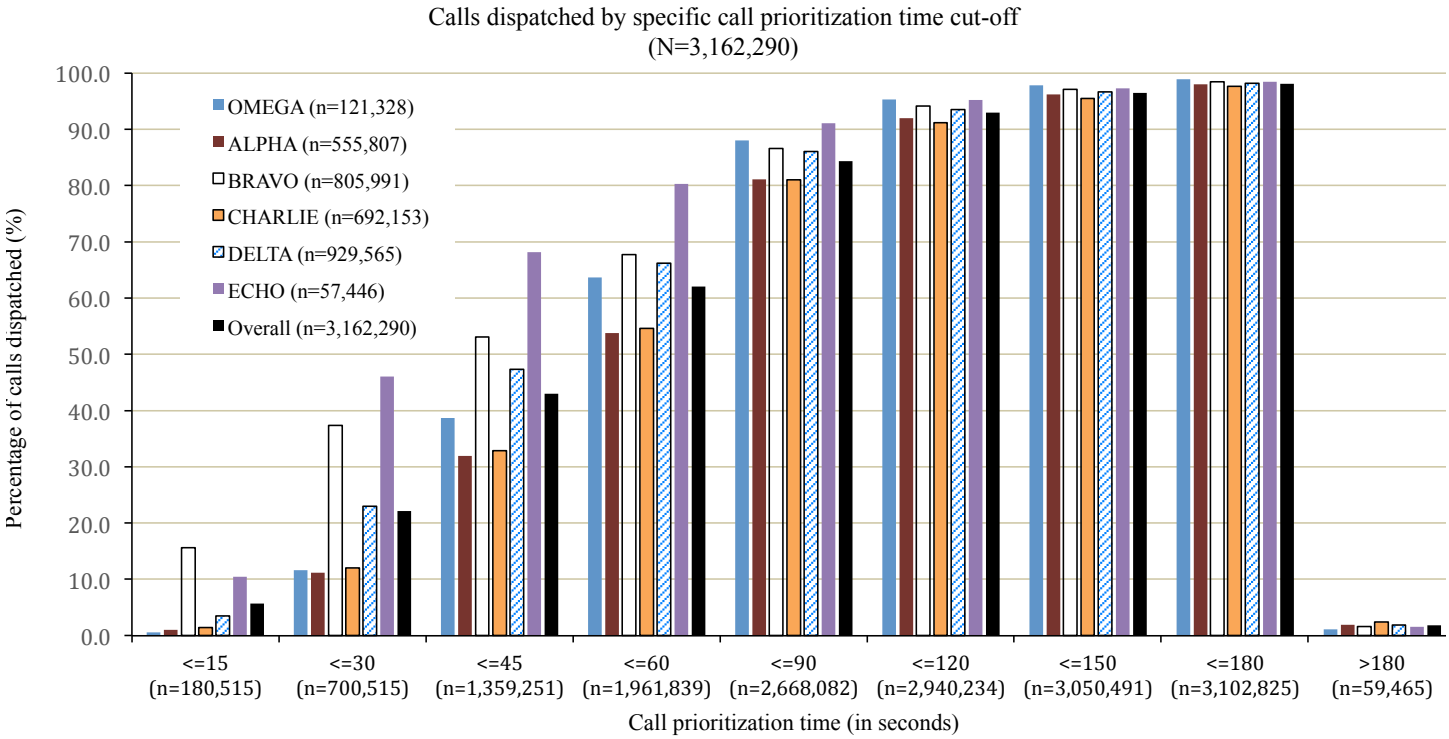

Figure 6. Distribution of calls prioritized by specific call prioritization time cut-off.

Eye Problems/Injuries, Headache, and Pregnancy/Childbirth/Miscarriage Protocols, where CPT values for COLD response were lower. However, there was no significant difference in CPT values between HOT and COLD responses for Falls, Inaccessible Incident/Other Entrapments, Traumatic Injuries (Specific), and Pandemic/Epidemic/Outbreak Chief Complaint Protocols.

A median test comparison of CPT values for the 5 most frequently used Chief Complaint Protocols (Sick Person, Breathing Problems, Falls, Traffic/Transportation Incidents, Chest Pain) showed a significant difference between CPT values for each Chief Complaint compared to overall median CPT by priority level. For example, a coding of 17 DELTA (71 seconds) was significantly higher ($p < 0.001$) than the overall median time for DELTA (47 seconds). In other words, it appears that Chief Complaint type makes more difference than priority level alone in determining CPT.

Finally, given our results showing wide variations in times by Chief Complaint Protocol, any time standard applied to an individual dispatch agency must necessarily account for the mix of Chief Complaint types handled by that agency. For example, if agency X had double the number of DELTA-level Pregnancy/Childbirth/Miscarriage calls (82 seconds median CPT) than agency Y—which in turn had twice the number of DELTA-level Diabetic Problems cases (27 seconds median CPT)—Agency Y would clearly have a shorter overall CPT for DELTA-level calls, assuming the mix of other DELTA-level calls was roughly equal between the two agencies. Regional and local differences in demographics, traffic patterns, and even air quality could change the mix of Chief Complaint types encountered by a dispatch agency. Indeed, given the wide variations in CPT by Chief Complaint type, as well as the very demonstrable differences in the Chief Complaint mix between 911 jurisdictions, a one-size-fits all nationwide time standard appears not only unrealistic, but self-defeating.

Limitations

As was noted in the introduction, and illustrated in Figure 1, this study does not evaluate the entire call processing time according to the widely accepted definition. The CPT is a portion of the overall call processing time and should be viewed strictly as means of understanding the medical and situational assessments that an EMD performs after the address and phone number have been verified. Future studies are necessary to examine the complete call processing time, i.e., the elapsed time from phone pickup to response unit notification.

CONCLUSION

EMD call prioritization time is a measurable component of call processing time. Median times vary significantly by both Chief Complaint (call nature) and assigned priority level. The most time-critical cases, or ECHO-level calls, had the shortest median prioritization time, followed by BRAVO- and DELTA-level calls. Wide variations in median times are seen between the various Chief Complaint Protocols. At the DELTA level, the Pregnancy/Childbirth/Miscarriage Protocol (Protocol 24) had the longest median time (82 seconds), while the Diabetic Problems Protocol (Protocol 13) had the shortest (27 seconds). A "one-size-fits-all" time standard is insufficient to govern the wide spectrum of Chief Complaint types and priority levels handled by Emergency Medical Dispatch agencies. The NFPA standard requiring 90% of call processing to be completed in 90 seconds and 99% in 120 seconds is not supported by this study's results.

ACKNOWLEDGMENTS

The study investigators wish to thank Brandee Rowley, Administrative Assistant, IAED, for coordinating the study and manuscript logistics and tracking; Jay Dornseif, Fire Protocols Consultant, Priority Dispatch Corp., for the initial coordination of data requests to the study sites; and to study sites for providing the data.

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