



Original Contribution

Description of procedures performed on patients by emergency medical services during mass casualty incidents in the United States^{☆,☆☆}Mazen El Sayed, MD, MPH^{a,b,*}, Hani Tamim, PhD, MPH^c, N. Clay Mann, PhD, MS^d^a Department of Emergency Medicine, American University of Beirut Medical Center, Beirut, Lebanon^b Emergency Medical Services and Prehospital Care Program, American University of Beirut Medical Center, Beirut, Lebanon^c Department of Internal Medicine, American University of Beirut Medical Center, Beirut, Lebanon^d Department of Pediatrics, University of Utah School of Medicine, Salt Lake City, UT, USA

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ABSTRACT

Background: Emergency medical services (EMS) preparedness is essential to reduce morbidity and mortality from mass casualty incidents (MCIs).**Objectives:** We sought to describe types and frequencies of common procedures performed during MCIs by EMS providers at different service levels.**Methods:** This study was carried out using the 2012 US National EMS Public-Release Research Dataset maintained by the National Emergency Medical Services Information System. Emergency medical services activations coded as MCI at dispatch or by EMS personnel were included. The Center for Medicare and Medicaid Services service level was used for the level of service provided. A descriptive analysis characterizing the most common procedure types and frequencies by service level was carried out.**Results:** Among the 19831 189 EMS activations in the 2012 national data set, 53 334 activations had an MCI code, of which 26 110 activations were included. There were 8179 advanced life support (31.3%), 5811 basic life support (22.3%), 399 air medical transport (air transport fixed or rotary) (1.5%), and 38 specialty care transport (0.2%) activations. A total of 107 different procedure types were reported. The most common procedures by procedure count were “spine immobilization” (21.8%) followed by “venous access extremity” (14.1%) and “assessment adult” (13.4%). A similar order was found for procedure frequencies by included EMS activations (24.1%, 19.3%, and 18.3%, respectively). Top 20 procedures had different frequencies by levels of care except for “medical director control” ($P = .19$).**Conclusions:** Advanced EMS interventions are not frequent during MCIs in the United States. Emergency medical services systems with other types of providers or MCI response patterns might report different findings.

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1. Introduction

Mass casualty incidents (MCIs) can overwhelm emergency medical services (EMS) systems. Although historically considered infrequent, MCIs are increasing in frequency with a reported estimate of 36 529 MCI EMS responses (95% confidence interval, 35 431–37 626) in the United States for the year 2010 [1]. The surge capacity of an EMS system to respond to MCIs is highly dependent on planning using the best

available evidence. However, most of the published literature involving MCIs consists of specific event descriptions or brief reports recounting anecdotal information. Lessons learned from different MCIs frequently cite challenges in command structure, coordination, and communication and emphasize the need for resource coordination, preplanning, quick triage, assignment of transport priorities, and limited on-scene interventions with appropriate casualty distribution to receiving facilities [2–4].

On scene, medical interventions usually consist of lifesaving interventions, part of a triage system for mass casualties. SALT triage system (sort, assess, lifesaving interventions, treatment/transport) that was proposed by the Centers for Disease Control and Prevention as a national guideline for mass casualty triage lists the following interventions as lifesaving: controlling major hemorrhage, opening the airway, chest decompression, and autoinjector antidote administration [5].

Over time, different procedures, such as prehospital tourniquet use for life-threatening hemorrhage control, are advocated (or discouraged) for victims with critical injuries or illnesses during an MCI [6,7]. Limited data are available on the types and frequencies of procedures done by EMS providers in the prehospital setting for MCI patients in general.

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Quantifying the current practice in MCIs and identifying if this practice varies by EMS service level can be very helpful for preparing and training EMS providers for procedures that would be required in MCIs.

The National Emergency Medical Services Information System (NEMSIS) maintains a US national EMS database, which, for 2012, includes EMS activations submitted by EMS agencies in 42 states and territories [1,8,9]. This repository allows us to examine MCIs at a national level, to evaluate trends in the prehospital management of MCI patients, and to estimate resource requirements at a local level in the event of an MCI. In this study, we used the NEMSIS 2012 data set to describe the types and frequencies of procedures or medical interventions done during MCIs by different levels of EMS providers. The goal of this project is to provide EMS agencies at all service levels with information regarding procedure use for better planning and estimation of resource requirements for field management of MCI victims.

2. Methods

2.1. Study design

This retrospective cross-sectional study used the NEMSIS 2012 public research data set released by the NEMSIS Technical Assistance Center. Institutional review board exemption for use of this deidentified data set was obtained from the institutional review board of the American University of Beirut.

2.2. Study setting

The NEMSIS Technical Assistance Center maintains a national EMS database that collects 83 variables using standardized definitions and formats from US states and territories [9]. Data are collected locally by different EMS agencies and aggregated at the state level and submitted to the NEMSIS national database. Submissions from different states vary in terms of inclusion criteria and proportion of EMS activations submitted [1]. The NEMSIS is considered a convenience sample, on a national scale, for EMS activations in the United States [9]. A single patient activating the EMS system might be represented in the national database more than once, due to multiple EMS vehicles responding to the patient care event and reporting to the state database. Thus, the term *EMS activation* represents a patient encounter by a single responding vehicle. The unit of analysis in this study was “EMS activation” rather than individual patients because the national EMS database provides a deidentified database structure, prohibiting analysis at a patient level. Each activation was, therefore, treated as an independent entry.

2.3. Study population

The 2012 NEMSIS national data set contains information on 19831189 EMS activations [9]. We included EMS activations that were recorded as MCI either at dispatch (the complaint dispatch reported to the responding unit) or on scene by the EMS provider.

2.4. Available data

The primary objective of this study was to describe types and frequencies of procedures performed by different levels of EMS providers during MCIs. Standardized definitions in the NEMSIS manual were used. An *MCI* is defined as “an event which generates more patients at one time than locally available resources can manage using routine procedures or resulting in a number of victims large enough to disrupt the normal course of emergency and health care services and would require additional non-routine assistance” [1,10]. A procedure is an intervention performed on a patient and that is part of the “list of procedures that the agency has implemented and is available for use.” Procedures are coded and reported in a standardized manner. The number of procedure attempts is also reported. For level of care of providers, we used the

Center for Medicare and Medicaid Services (CMS) service level for the EMS encounter and divided the levels into 5 categories: unknown, basic life support (BLS [BLS and BLS emergency]), advanced life support (ALS [ALS level 1, level 1 emergency, and level 2]), air medical transport (AMT) including both fixed wing (airplane) and rotary wing (helicopter), and specialty care transport (SCT). Additional variables that were analyzed to better characterize the study population included the following: urbanicity (population setting using US Department of Agriculture and Office of Management and Budget definitions) [1], primary role of the responding unit, patient's sex, incident location type, and if there was a possible injury and its cause.

2.5. Data analysis

The SAS version 9.1 (SAS, Cary, NC) was used for the management and analyses of the data. Nonparametric techniques (ie, χ^2 tests) were conducted to evaluate differences in procedure use by EMS level of service. Categorical variables were summarized using frequencies and percentages.

We initially conducted an overall count of all procedures done for all MCI-related activations and calculated frequencies by types and count. We then carried out a descriptive characterization of the study population followed by an analysis of the types of procedures and corresponding frequencies performed by different EMS service levels. We relied on 2 different denominators (total procedures count and total MCI activations) to report percentages. Procedure frequency is the count of a specific procedure divided by the total count of all reported procedures. For example, if the total count of all procedures is 10 and the count of a specific procedure is 2 regardless of whether the same activation or different activations (ie, a procedure could be repeated), then that procedure frequency is 20%. Procedure frequency per activation is the percentage of EMS activations for which a procedure was reported divided by total number of activations. For example, if 10 activations were available and activation 1 had the same procedure done once or twice, then that procedure frequency per activation is 10%. Neither measure takes into account multiple attempts to complete a procedure.

We also assessed whether the reported procedure frequencies by different service levels varied by urbanicity. For these analyses, we grouped AMT and SCT service level categories to account for low frequency distributions. Homogeneity across strata of urbanicity was assessed through the likelihood ratio test (χ^2 test). Statistical significance level was set at $P < .05$.

3. Results

A total of 53334 EMS activations were recorded as an MCI. We excluded MCI-related activations recorded as “call cancelled,” “no patient found,” or “patient refused treatment.” The 26110 remaining MCI activations were included and analyzed. More than half of the activations (63.1%) were in an urban setting. The primary role of the EMS unit reporting the activation was transport (91.0%). Injury was reported in 14481 activations (55.5%) with unknown cause of injury accounting for 53.7% of activations followed by motor vehicle traffic accidents (33.5%). The 5 categories of EMS level of care were identified with “unreported” accounting for a large portion of the activations (44.7%; Table 1).

3.1. Procedure frequencies

A total of 107 different procedure types were reported during MCIs with 41798 procedures reported for all MCI activations (Table 2). The 10 most frequently attempted procedures in descending order were as follows: “spine immobilization” (21.8%), “venous access extremity” (14.1%), “assessment adult” (13.4%), “pulse oximetry” (11.5%), “cardiac monitor” (7.5%), “pain measurement” (6.3%), “blood glucose analysis” (3.6%), “wound care—general” (2.4%), “patient loaded” (2.0%), and “assessment pediatric” (1.6%). Among all reported procedures, 43

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