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Emergency Medical Services First Responder Certification Level's Impact on Ambulance Scene Times

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This is to certify that the doctoral dissertation by

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has been found to be complete and satisfactory in all respects,
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Abstract

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MS, University of San Diego, 2002

BS, University of Phoenix, 1999

Dissertation Submitted in Partial Fulfillment

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Doctor of Philosophy

Public Policy and Administration

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Abstract

The foundation of modern-day emergency medical service (EMS) systems began in 1966, based on hospital medical care. Demand for evidence to support prehospital practices that have been in existence for the past half-century has continued to grow; yet, researchers have not adequately explored the relationship between the medical certification level of emergency first responders and the amount of time an ambulance spends on the scene. The purpose of this quantitative study was to examine and compare ambulance scene times for emergency responses when basic life support (BLS) certified first responders or advanced life support (ALS) first responders are first on the scene, and whether the level of first responder training reduces the time spent on the scene by a paramedic ambulance. A final research question dealt with whether there is a relationship between how long the first responder is on the scene and the amount of time an ambulance spends at the scene of an emergency. The publicly available archival data used for the study were from a community that had BLS and ALS first responders. Data analysis involved *t*-tests of the hypotheses for the first 2 research questions and a linear regression analysis of the hypotheses for the third research question. The findings showed that there is a clear difference in ambulance scene times based on the certification level of the first responders. Advanced life support first responders significantly reduced the scene time of ambulances when they arrived at the scene prior to the ambulance. Positive social change could result from this study if understanding the impact that ALS first responders have on ambulance scene times leads EMS planning managers to deploy resources more strategically, thus improving the efficiency of the public safety system and saving lives.

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Dedication

I dedicate this study to the men and women first responders who work in the public safety arena. All too often the job they do goes unrecognized; yet, were it not for paramedics, firefighters, and law enforcement personnel, the streets, businesses, and homes of communities would be strewn with the memories of avoidable tragedy and the sadness of unplanned loss. First responders make it safe for people to walk, live, and sleep well at night. Thank you and always be safe.

Acknowledgments

No one can complete a dissertation without the help, support, encouragement, love and critical eye of many. My journey towards completion was slow and not always steady, but complete it, I did. While there have been many who helped me achieve this goal I would be remiss without acknowledging those who have been with me every step of the way. At the very beginning of my doctoral process I was assigned Dr. Robert Levasseur as my mentor, and I was fortunate enough to convince him to remain on as my committee chair. Dr. L, as he is known by his mentees, was always fair, responsive, understanding and most importantly, supportive. He encouraged me every step of the way, and I do not doubt that without his commitment to my success it would have never been realized. I shall always be indebted to Dr. L and words will never truly express my full appreciation. My committee included Dr. Patricia Ripoll and Dr. Daniel Jones, both of whom provided invaluable input on how I could strengthen my research and improve this paper. Additionally, the editing assistance of Lynn Feneis helped my paper appear scholarly and read intelligently. My research involved the cooperation and trust of two first responder agencies. Mike Murphy is the Regional Manager of American Medical Response in San Diego and someone whom I’ve known for more than 35 years. His support of me and willingness to provide me with the data I needed to complete this project was unwavering. Mike has been a friend, a mentor and a vital source for guidance. At the Chula Vista Fire Department, Fire Chief Jim Geering has always greeted me with a smile and encouragement. He supported me by providing the necessary data I needed from his agency to complete my research. Along with the men and women who work for him, the Chula Vista Fire Department strives to provide its citizens with excellent service and compassionate care. Over the years I have worked with many outstanding EMT’s, paramedics, nurses, and physicians. They probably never realized it, but with every conversation, I learned from them and much of who I am today as a paramedic and as an instructor reflects the amazing, and many times, thankless job they do. Finally, there is no question I am my parents’ son. Although they are both so different, the one common characteristic they share is the desire to continuously be learning. Whether it is reading, visiting museums, taking classes, or seeking new experiences, my parents have led by example and instilled in me the desire to always be learning. My parents have always supported my desire to pursue higher education, and although they may occasionally shake their heads at my pursuit to experience the world, it is only because of my parents that I can write this paragraph of acknowledgment. Without them, success would never have been realized. Thank you both.

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Chapter 1: Introduction to the Study

The impact emergency medical services (EMS) have had on emergency health care, and public emergency response models are not well known. This leads stakeholders and community members to question the validity and efficacy of EMS (Wilson, 2016). According to Bass (2015), beginning in the mid-1980s, the federal funding for EMS diminished, and the decision-making and financing of local and regional EMS systems switched to the states and their communities. With these added responsibilities, "managers of EMS systems, just like their counterparts elsewhere, needed to know which components of the system were crucial, and which could be deleted if funding was limited" (Bass, 2015, p. 9). There is little research on the role of emergency first responders and their contribution to overall EMS system effectiveness, or the impact of care provided by emergency responders. According to MacFarlane and Benn (2003), "it has not been possible to assess, adequately, the efficacy of prehospital care, due to the difficulty of developing appropriate indicators" (p. 189). Results of this study will contribute to the already existing literature on EMS, more specifically, in the realm of tiered response with first responders and how they impact emergency response times.

In today's two-tiered EMS systems, fire departments provide first responder services, which may include basic life support personnel (BLS) or advanced life support (ALS) personnel who typically arrive at the scene of an emergency before the transporting ambulance (Boland et al., 2015). Ambulance personnel may also be BLS, ALS, or a mixed-model. There is minimal research on EMS system design, specifically which models have the best patient outcomes and EMS system efficiency (Bass, Lawner, Lee, & Nable, 2015; MacFarlane & Benn, 2003). To better allocate resources, EMS system leaders could benefit from knowing which model shortens a patient's time in the field or an ambulance's time in transit. In Chapter 5, I provide suggestions for more efficient EMS system design, including a better deployment of emergency response resources, that could result in a potential reduction in suffering and lives lost by those serviced by the EMS system.

This chapter includes a summary of the literature on EMS, identified gaps in research, and potential suggestions to fill these voids. The chapter contains a purpose statement, three research questions, the subsequent description of variables and methodology for the proposed research, the definitions of specific terms, the scope, delimitations, and limitations of this research. Finally, this first chapter concludes with the significance of the study and possible contributions the EMS industry could adopt. These findings may provide leaders, and those responsible for EMS system design, a better understanding of the impact first responders have on the overall time involved in the care and transport of prehospital emergencies.

Background of the Study

In 1966, many U.S. citizens were dying on the nation's highways. The National Academy of Sciences commissioned a study on behalf of the federal government. This report led to the creation of the modern prehospital emergency medical services system. Paramedics today still abide by these outdated suggestions developed in the 1960s (National Academy of Sciences, 1966). Before 1966 and well into the 1970s, mortuaries or police paddy wagons provided most prehospital care (Simpson, 2013). A subsequent report released 30 years later called for research on the value of prehospital care providers and EMS system design (Stewart, 2005). Stewart (2005) went on to say, "despite excellent pockets of clinical research into the outcome of patients in EMS systems, few convincing data could be cited as favorable to any particular system design in the first two decades of modern EMS history" (p. 12). Since Stewart's paper, the number of dissertations containing *emergency medical services* in the title has tripled (ProQuest, 2012) and additional searches revealed far more research conducted with varying themes involving EMS. Despite this surge of research, 911 response calls and the various layers of the EMS response system remain largely unexplored. Managers and physicians responsible for EMS system oversight continue to call for an evidence-base and an examination of the quality of emergency care delivery (Glind et al., 2016).

Utilizing a Delphi model, Glind et al. (2016) surveyed 48 research topics to identify and rank unexplored areas of research, the fourth of which was "performance measures for quality of care" (p. 5) behind three other nonpatient care oriented items. In the absence of statistical backing, the Delphi model allows researchers to have structured communications, which allow individual and group feedback, revisions, and if necessary, anonymity for the respondents (Okoli & Pawlowski, 2004). This presents researchers examining the question about whether there is remaining research in the field of emergency medical services the opportunity to investigate without necessarily drawing attention to their domain or area of unsubstantiated interests. As a result, questions remain about which emergency response model provides the most efficient service for a community, and, more importantly, which model has the greatest impact on human life. Examining EMS research Maguire, O'Meara, and Newton (2015) stated:

> As a profession, include setting systems in place to support not only medical based research but also operations, education and systems research that will ensure that our operations, education and systems are based on the best evidence for effective, efficient and safe delivery of out of hospital care. The same rigor that is applied to ensure that the drugs we administer are safe and effective needs to be used to ensure that our operations and practices are safe and effective. (p. 4)

The standard for emergency medical response has been to have a first responder at the scene of the emergency within 4 minutes 90% of the time, and an ALS ambulance on the scene within 8 minutes (National Fire Protection Association, 2010). The examination of response and scene times prehospital intervals has been the subject of previous research (Carr, Caplan, Pryor, & Branas, 2006). Response time and the amount of time it takes a patient to receive care at an emergency facility has an impact on patient outcomes (Blackwell & Kaufman, 2002; Blackwell, Kline, Willis, & Hicks, 2009; Pons, Haukoos, Cribley, & Markovchick, 2005); however, it is only in the past decade there has been research focused on outcomes and quality improvement indicators (Howard, Cameron, Wallis, Castren, & Lindstrom, 2017).

A two-tiered 911 EMS system dispatches fire department personnel and ambulances simultaneously; however, fire personnel begin the patient assessment and integrating treatment protocols before the arrival of the ambulance (Eckstein, 2011). Sometimes, if dispatched at all, first responders arrive on scene at the same time as the ambulances or afterward. In each case, researchers focused on the amount of time it took for a patient to receive emergency medical care; despite this, researchers seemingly neglected the actual EMS system that transported patients.

Examing the subject in greater detail, Callaham and Madsen (1996) focused on the time between the arrival of first responders and the initiation of ALS intervention, and looked at its impact on patient morbidity and mortality, concluding there was no change in patient outcomes other than the time it took to begin CPR or utilize an AED. Park et al. (2017) corroborated these finding and concluded that it was the early application of quality CPR that had the greatest impact on patient survival in OHCA. The question of how the actions of first responders impact the efforts and scene times of ALS transport ambulances remains. While patients may benefit from timely performed ALS procedures (Boland et al., 2015; Callaham & Madsen, 1996; Carlson et al., 2016), the certification level of providers is not abundantly clear. Larsen, Eisenberg, Cummins, and Hallstrom (1993) found patient survival was "dependent on the full continuum of care" (p. 1656) which includes layperson recognition, early access to BLS care, and the initiation of ALS care which Martinell et al. (2017) contradicted noting that two of the essential tasks performed by paramedic (intubation, administration of Epinephrine) contributes to poorer outcomes (p. 7). This further supported by Fujii et al. (2017) who found that even establishing intravenous access "was negatively associated with 1-month survival with a favorable neurological outcome" (p. 3) and found no relationship between Epinephrine administration and improved patient outcome. Larsen et al. (1993) did not provide the extent of care involved; however, they identified a 5.5% decrease in patient survival for every minute they did not receive CPR, defibrillation, and ALS intervention; but, the emphasis remains on quality CPR (Park et al., 2017).

According to their certification level, first responders may provide BLS or ALS. Some researchers looked at the impact first responders have when caring for patients suffering from cardiac arrest or strokes (Rea & Page, 2010); however, there is scant literature on how first responders influence the actions of ALS ambulances and the amount of time required for ambulances to spend at the scene of the emergency (Isenberg & Bissell, 2005). There are many researchers who demonstrated that ALS ambulances do remain on scene longer than BLS ambulances in both cardiac emergencies and major trauma victims (Sanghavi, Jena, Newhouse, & Zaslavsky, 2015). It is not known if having a BLS or an ALS first responder on the scene influences the actions of the ALS ambulance, and therefore, how long an ALS ambulance must remain on scene.

Problem Statement

There is limited scholarly research on how the certification levels of first responders impacts the time spent at the scene of an emergency by transport ambulances. Multidisciplinary groups are making a strong push to correct this and substantiate current practices by engaging in research and encouraging EMS professionals to do the same (Bigham & Welsford, 2015; Eisenberg & Bissell, 2005; Institute of Medicine Committee on the Future of Emergency Care in the US Health System, 2007; Jenson & Travers, 2017; MacFarlane & Benn, 2003; Stewart, 2005). Rea and Page (2010) examined the impact first responders had on cardiac arrest and stroke patients but failed to address how first responder actions impacted the ALS ambulance response. Waalewijn, de Vos, Tijssen, and Koster (2001) compared cardiac resuscitation success rates between laypeople, first responders, and paramedics; they suggested the level of training determined the impact. They did not examine the amount of time an ALS ambulance was on scene and how this measurement affected resuscitation success rates but found instead other more important variables which impacted outcomes. This included whether a cardiac arrest was witnessed, had early CPR, or the application of an AED, which continue to be proven as the two most important variables in OHCA (Nehme, Andrews, Bernard, & Smith, 2015).

Other researchers examined the golden hour in trauma. It is in the first 60 minutes after a traumatic event when most deaths will occur leading to the term *golden hour* (Cales & Trunkey, 1985). Researchers were unable to find any association between EMS intervals (i.e., time spent in the field) and patient mortality with trauma patients who had physiologic finding in the field (Newgard et al., 2010); however, researchers have argued for and against prehospital treatment modalities, including the differences between BLS and ALS responders (Boland et al., 2015; Carlson et al., 2016; Esmaeiliranjbar, Mayel, Movahedi, Emaeiliranjbar, & Mirafzal, 2016; Harmsen et al., 2015; Newgard et al., 2015). Blanchard et al. (2012) examined the relationship between emergency response times and patient mortality, concluding that further research examining various response time components was necessary. The amount of time it took an ambulance to become available from the hospital based on the patient's acuity directly impacts an EMS system's ability to handle their demand for services, Vandeventer et al. (2011) researched this question and concluded that patient acuity affected how long an ambulance remained at a hospital.

Not many researchers have investigated ambulance time spent on the scene, or how responder first certification levels affected the amount of time an ambulance spent with a patient. There is conflicting research on the impact EMS certification levels have on patient outcomes (Bakalos et al., 2011; Seamon et al., 2013; Vopelius-Feldt, Coulter, & Benger, 2015; Vopelius-Feldt, Branding, & Bender, 2017). Stiell et al. (2008) recommended EMS systems re-evaluate the use of ALS providers when caring for patients suffering from major trauma because mortality was greater with system-wide implementation of ALS services when caring for a subset of trauma patients. Researchers supported the belief that the longer a seriously injured trauma patient spends in the prehospital environment, the more likely they would suffer increased morbidity and mortality (Harmsen et al., 2015; McCoy, Menchine, Sampson, Anderson, & Kahn, 2013). But, in a comprehensive review of England's trauma system, researchers found a greater relationship between a patient's physiological findings and survival than the level of care the patient received by prehospital personnel (Thompson, Hill, Davies, Shaw, & Kiernan, 2017).

One of the challenges researchers have examining the impact EMS has on patient outcomes, or evaluating EMS system models, is that much of the research has only focused on out of hospital cardiac arrest or trauma patients (Myers et al., 2008) leaving most prehospital emergency responses out of the analysis. There is a need for additional research in this area because of the lack of consensus and high volume of conflicting information on the subject (Coster, Irving, Turner, Phung, & Siriwardena, 2018).

Purpose of the Study

The purpose of this retrospective analysis is to find a relationship between certification levels of first responders and the amount of time an ALS ambulance spent on scene. The control group consisted of a set of responses where first responders were dispatched and arrived at scene first or they arrived after the ALS ambulance had already established patient contact. Certification level helped identify the two treatment groups, BLS or ALS. Inferential statistics helped determine and assess the statistical significance of the differences between the scene times of the respective groups.

Research Questions and Hypotheses

RQ1. What is the impact of first responder certification level (BLS vs. ALS) on the amount of time the transport ambulance spends on the scene when first responders are on scene before the transport ambulance?

$H_0 1$: First responder certification level does not impact scene times of transport ambulances.

$H_a 1$: First responder certification level does impact the scene times of transport ambulances.

RQ2. What is the difference in scene times between when first responders are on scene before the transport ambulance and when they are on scene after the transport ambulance?

$H_0$2: There is no difference in scene times between when first responders are on scene before the transport ambulance and when they are on scene after the transport ambulance.

H_a2: There is a difference in scene times between when first responders are on scene before the transport ambulance and when they on scene after the transport ambulance.

RQ3. What is the relationship between the first responder arrival time in relation to the transport ambulance arrival time and the amount of time the transport ambulance spends on the scene?

$H_0$3: There is no relationship between the first responder arrival time in relation to the transport ambulance arrival time and the amount of time the transport ambulance spends on scene.

H_a3: There is a relationship between the first responder arrival time in relation to the transport ambulance arrival time and the amount of time the transport ambulance spends on the scene.

Theoretical Foundation

The National Academy of Sciences (1966) white paper is the theoretical foundation for this study because it provided the basis for modern EMS system development in the United States. The white paper discussed the role of first responders, patient transport, and set the guidelines for prehospital patient care. In 2005, Stewart updated the paper by questioning the decisions that led to the current EMS system design and practices. Stewart and others have called upon industry professionals to engage in the process of critical evaluation and research of current practices, stating that without research-based validation current practices might not last (Glind et al., 2016; Maguire, O'Meara, & Newton, 2016; Stewart, 2005).

Current EMS system design includes the roles and certification levels of first responders and the utilization of ALS transport ambulances. Chapter 2 is an expansion of these variables, relating current practices to the original 1966 publication. The need for evidenced-based research will be defended and examining an EMS system which provided BLS prehospital emergency response, and later, ALS prehospital emergency response, the bigger question raised by Stewart (2005) will be acknowledged.

Nature of the Study

Initially, EMS systems only provided first responders trained and certified in BLS, but industry standards within the local community upgraded to ALS. Using publicly available archival data in this quantitative study, I compared a local EMS system before and after the implementation of ALS first responders, showing differences between scene times of ALS transport ambulance with both BLS and ALS first responders. The control group (dependent variable) included patients who had no first responder services or responders who arrived after the ALS transport ambulance.

I collected archival data over two, 30-day periods from the local 911 communications center, which receives all responses for emergency requests. Dispatchers record and maintain logs of each emergency response (e.g., time call received, time unit dispatch, time unit arrives at scene, time unit transports patient, time unit arrives at hospital, and time unit become available for another emergency response). All the response time data are entered via a dispatch computer or the mobile data terminal (MDT) located in the emergency vehicles and is maintained on a secure mainframe computer with redundancies built in throughout the system. In-house personnel and independent external auditors monitor the data in real-time, verified through human interaction, and audited daily and monthly.

I compared the relative differences in mean scene times for each certification type of first responder and compare them using inferential statistics, specifically analysis of variance (ANOVA). I used a simple linear regression analysis to determine the relationship between first responder time on scene before the arrival of the ALS ambulance and the scene time of the ALS ambulance, as well as how long a first responder must be on the scene before the arrival of the ALS ambulance to shorten the scene time of the ALS ambulance.

Definitions

Advanced Life Support (ALS): Life-support activities that go beyond basic procedures to include adjunctive equipment and invasive procedures such as intravenous therapy, drug therapy, intubation, and defibrillation (Bledsoe, Porter, & Cherry, 2007a).

At Scene (ATS): When apparatus or resources assigned to an emergency arrive at the reported location of the incident. Can also be a function button on the MDT (Pendleton, 2017).

Automatic External Defibrillator (AED): Is a lightweight, portable device that delivers an electric shock through the chest to the heart. Used to correct abnormal heart rhythms and allow a normal rhythm to resume following a sudden cardiac arrest. Carried by first responders and found accessible in many public and private locations (American Heart Association, 2017).

Basic Life Support (BLS): Basic life-saving procedures such as artificial ventilation and cardiopulmonary resuscitation (Bledsoe et al., 2007a).

Bystander: Other persons who were present and had intervened but had not been dispatched (Hansen et al., 2015).

Code 2: Responding to requests for medical aid with without lights and sirens (Ho & Casey, 1998).

Code 3: Responding to requests for medical aid with lights and sirens (Ho & Casey, 1998).

Computer Aided Dispatch (CAD): Allow for the prioritization of calls by providing an automated means of classifying and prioritizing calls for service (Stroshine, 2015).

Deploy: Strategy used by an EMS agency to position its ambulances and resources to meet system demands and reduce response times (Bledsoe et al., 2007a).

Dispatched: Apparatus or resources assigned to a reported emergency and sent information via radio or CAD about where respond or the reported nature of the emergency (Pendleton, 2017).

Emergency Medical Services (EMS): A comprehensive network of personnel, equipment, and resources established for delivering aid and emergency medical care to the community (Bledsoe et al., 2007a).

Emergency Medical Technician (EMT): An EMT has completed the basic national standard training course or its equivalent and its training in all phases of basic life support, including using the pneumatic anti-shock garment. In addition to patient care education, EMT's receive training in ambulance vehicle operations (Sanders, 1994).

Enroute: The status of apparatus or personnel who are responding to the location of a reported emergency but not yet at the scene. Can also be a function button on the MDT (Pendleton, 2017).

First Responder: Personnel who responded to the medical emergency in an official capacity as part of an organized medical response team but who were not the designated transporter of the patient to the hospital. First responders are police officers, firefighters, rescue squads, or life-saving crewmembers trained to perform basic life support until the EMS team arrives and who are were called to the scene by emergency dispatch centers (Hansen et al., 2015).

Golden Hour: The concept that the first 60 minutes after traumatic injury is a critical period for transporting patients to a trauma center (the golden hour) has been deeply ingrained in trauma systems, national field triage guidelines, emergency medical services (EMS), and clinical care (Newgard et al., 2015).

HIPAA: Health Insurance Portability and Accountability Act of 1996 provides protects patients, giving them control over who has access to their medical information (Office for Civil Rights Headquarters, 2017).

Incident Command System (ICS): A managed approach developed to assist with controlling, directing, and organizing an incident with multiple resources or a hierarchy of roles (Bledsoe et al., 2007a).

Mobile Army Surgical Hospital (MASH): Forward operating medical hospitals which brought surgical personnel and equipment closer to the battlefield and is attributed to saving lives and reducing preventable deaths. Similar facilities still used today in Iraq and Afghanistan (King & Jatoi, 2005).

Mobile Data Terminals (MDT): The MDT is an emergency application solution specifically for police, ambulance services, and emergency response services. MDTs typically are a ruggedized mobile laptop built and installed in fire engines, police cars, and ambulances to suit the needs of an extreme environment. It has a reliable wireless connection via 3G using the Internet or intranet for remote information access (Yang, Yang, & Plotnick, 2012).

Paramedic: The paramedic is a state or nationally certified EMT who has completed the National Standard Training Course for paramedics or its equivalent. Paramedics are trained in all aspects of BLS and ALS procedures relevant to prehospital emergency care (Sanders, 1994).

Prehospital Care: Treatment which takes place in the dynamic, out-of-hospital environment. Trained healthcare professionals for “analytic, resuscitative, stabilizing or preventative purposes” provide this type of care within communities before and during transportation to a medical facility (McManamny, Sheen, Boyd, & Jennings, 2014).

Public Safety Answering Point (PSAP): A PSAP is a call center responsible for answering calls to an emergency telephone number for police, firefighting, and ambulance services (Sutter et al., 2015).

Return of Spontaneous Circulation (ROSC): In a post cardiac arrest scenario when the patient regains a pulse they are deemed to have a return of spontaneous circulation (Callaway et al., 2015).

Stage: To position one's self away from a possible threat in a manner which allows for quick access while maintaining distance or behind a protective shield (Pendleton, 2017).

Stand-back: To position one's self away from a perceived threat in a manner which allows for quick access while maintaining a barrier of distance or shield (Pendleton, 2017).

Sudden Cardiac Death: Refers to unexpected death without an obvious non-cardiac cause occurring within 1 hour of symptom onset (witnessed), or within 24 hours of last being observed in normal health (Stecker et al., 2014).

System Status Management (SSM): A computer-enhanced means of deploying and dispatching ambulances (Bledsoe et al., 2007a).

Tiered Dispatch: System that allows multiple vehicles to arrive at an EMS call at separate times, often providing distinct levels of care or transport (Bledsoe et al., 2007a).

Triage (Trier): Originally a business concept which meant "to sort" and "divide into three" which French Surgeon Baron Dominique-Jean Larrey developed into a means by which injured soldiers could be assessed on the battlefield as having the potential of returning to the fight if treated first. Today triage is used to sort patients in order of priority from the sickest to the not so sick (Nakao, Ukai, & Kotani, 2017)

Turn-out Time: The time between when emergency apparatus (i.e. Fire engine, ambulance, police car) are dispatched to an emergency and when the emergency vehicle starts moving (DeRuyter et al., 2017).

Unit Hour: A unit hour is defined as a fully equipped and staffed ambulance on a response or waiting for a response for one hour (Fischer, et al., 2011).

911: The 9-1-1 public EMS system is utilizing the National Academy of Emergency Dispatch: Medical Priority Dispatch System to process and prioritize all the calls, then dispatch ambulances to the scene for further patient assessment and subsequent transport. (Fessler, Simpson, Yancey II, Colman, & Hirsh, 2014).

Assumptions

I assumed all dispatch times were accurately entered and reflected the true times associated with the emergency response. Because my goal was to analyze time associated with emergency responses and the differences between BLS and ALS scene times, accurate time records were imperative.

Scope and Delimitations

The study involved the retrospective comparative analysis of data collected from two 30-day periods (from March 1, 2013 to March 30, 2013, and March 1, 2014 to March 30, 2014) when approximately 1500 emergency medical responses occurred. Data were compared using publicly available archival data from the City of Chula Vista, which only had had BLS responders in 2013. In the second half of 2013, the Chula Vista Fire

Department began integrating ALS trained personnel onto emergency responses and is now a full ALS first responder agency (Chula Vista Fire Department, 2017). Comparing old data (i.e., before the department's implementation of ALS services) with the new data provided greater insight and opportunities for a conclusion to the research questions outlined in this study. Because I only used one first responder agency (sole source data), it reduced concerns about the effect of multiple agencies, dispatch center, and data sources on the study data. Equally important is the ambulance provider was the same for both study periods.

Not every emergency response is the same, and many factors may affect the dispatch times associated with the response. First is the nature of the emergency response and what protocol it may dictate. In the case of a person suffering from a heart attack, the first responder and the ambulance will respond Code 3 (with lights and sirens) without delay. In emergency responses or incidents where a hostile perpetrator remains on the scene or the patient may pose a life-safety threat, both the first responder and the transport ambulance must stage some distance from the scene until cleared by law enforcement officials. This could include "assault/rape, unknown problems/man down, overdose, psychiatric/suicide attempt and stab/gunshot wounds" (Gratton, Garza, Salomone, McElroy, & Shearer, 2010) or incidents where the 911 dispatcher has information which leads them to believe an imminent life-safety threat exists for the first responders. In this situation, the response times for both sets of responders will be skewed due to the delayed access to the patient. These incidents must be excluded from the data set.

Another situation which will impact the scene times are incidents where the patient is difficult to access due to entrapment or inaccessibility. In the former case, patients involved in a vehicle accident requiring extrication with specialized equipment or personnel will delay the scene times for the transport ambulance and must be excluded. In the latter incident, there are patients who are located inside their house, but due to their medical condition or emergency, they are unable to provide access to the responders, requiring forcible entry into the house. Many times, the first responders wait until law enforcement arrives, which once again potentially skews the data and will be excluded.

An additional data-set that needed to be excluded are those responses where the responding unit (e.g., fire truck, ambulance) failed to advise their status changes (e.g., on scene, transporting) via the CAD or through their dispatch center, which will result in inaccurate times and potentially skew the analysis. Incidents when time measurements are known or suspected to be inaccurate must be excluded. All incidents excluded from the data analysis were documented, and an explanation was provided, thereby ensuring transparency in the process.

Limitations

I acknowledge working for the ALS transport ambulance provider included in this study and having previously worked as a responder in the community of interest. To obviate this threat to study validity, thereby helping to ensure its objectivity and to eliminate the Hawthorne Effect, where the study subjects are aware they are being observed (Campbell, Maxey, & Watson, 1995), all data used in the comparison were historical data based on emergency responses made prior to the development of this study. The risk associated with this approach is that without having prior knowledge of a study involving response and scene times, the study subjects may not have been as conscientious of how their behavior either before or after the emergency response would impact the times. The benefits outweigh the concerns associated with eliminating the Hawthorne Effect.

The validity of the study is dependent on the meticulous attention to detail on behalf of the responders and dispatch centers. It is imperative that the accuracy of their data entry is reliable and valid; when the data review revealed any instances of uncertainty, those responses were set aside and individually examined to determine their impact. If alternative sources of information could have been used to verify or disclaim the data, a final determination on whether to include the data was made using this additional information.

The Chula Vista Fire Department and American Medical Response (AMR) provided the study data. Both agencies signed a data use agreement (see Appendices A and B) allowing use of their data. Their ongoing cooperation was necessary to produce a valid study and draw whatever conclusions may present. This research was completely dependent on their assistance. Both entities are continuously updated on the progress of this paper, and the need for their data and their continued support is constantly being affirmed.

I did not examine scene times in specific medical emergencies. Although I referenced heart attacks, strokes, and trauma, it was because they are frequent types of emergencies and there is significant public education about these emergencies (Banharak, Zahrli, & Matsuo, 2018). The focus of this study was on the overall impact of first responders on scene times.

Significance

This project will add knowledge to the field of emergency medical services, which has limited research (Boland et al., 2015; Gunderson, 2015; Stewart, 2005). The investment communities make on their first responder services must demonstrate a positive impact on the community other than just lives saved (Glind et al., 2016; Maguire et al., 2016). This could include reducing the need for ALS transport vehicles, increasing the capabilities of first responders, or better serving their community when disaster strikes. According to Chroust, Ossimitz, Roth, Sturm, and Ziehesberger (2015), first responders are trained and equipped to help mitigate disasters in the short-term.

Citizens dial 911 when they have a medical emergency expecting emergency personnel will rapidly arrive on scene, assess, treat when able and then transport the patients quickly to an appropriate facility. With more than 17.4 million EMS emergency responses per year in the United States (Wang et al., 2013), there is a demand for services, and civic leaders have a responsibility to ensure adequate resources and efficient utilization of those resources. I examined one small piece of the over-all EMS response package but one that has received minimal attention. While Rea and Page (2010) identified the positive impact first responders have on overall patient outcomes, others suggested first responder certification needs further examination in the context of EMS system design and patient outcomes (Bigham & Welsford, 2015; Eisenberg & Bissell, 2005; Institute of Medicine Committee on the Future of Emergency Care in the US Health System, 2007; Jenson & Travers, 2017; MacFarlane & Benn, 2003; Stewart, 2005). The results of this study will add to the body of knowledge from which the medical community can best advise civic leaders how to design effective EMS systems, while also demonstrating the financial implications of how scene times of ambulances impact the operating efficiency of an EMS system.

Summary

Every day, communities across the nation lose and save lives as citizens call 911 and access their local emergency medical services system (Eid, Abougergi, Albaeni, & Chandra-Strobos, 2017; Nehme, Andrews, Bernard, & Smith, 2015). Since the publication of the 1966 National Academy of Sciences white paper, EMS systems have evolved over time yet with little research to support their design (Bigham & Welsford, 2015; Eisenberg & Bissell, 2005; Institute of Medicine Committee on the Future of Emergency Care in the US Health System, 2007; Jenson & Travers, 2017; MacFarlane & Benn, 2003; Stewart, 2005). One major component of EMS system design is the role and impact first responders have on patient outcomes and system efficiency (Boland et al., 2015). DeRuyter et al. (2017) highlighted the “on feet interval” (p. 54) which was time first responders spent getting dressed for an emergency response, or the amount of time it took them to arrive at the patient’s side once they got to the scene of the emergency. I attempted to answer the following question: How do first responders affect the actions and scene times of transporting ambulances?

Chapter 1 was an overview of EMS system design, first responder models and the importance of prehospital care times. Chapter 2 is a comprehensive review of the foundational and supporting literature which examines emergency medical services system design, the role of first responders, and the impact prehospital certification levels have on patient outcomes and response time measurements. By comparing the relevant literature, a gap in existing research will further demonstrate the need and rationale for this study.

Chapter 2: Literature Review

Introduction

The field of prehospital care provided by paramedics and first responders is a newcomer to the medical field when compared to the history of medicine. There is very little research on the relationship between emergency medical first responders and the effect on transport ambulance scene times. The purpose of this retrospective analysis was to determine whether a relationship exists between the certification levels of first responders and the amount of time an ALS ambulance spends on the scene. Much of prehospital care emerged from mimicking the services found inside of the hospital emergency department or based on military experiences. Over time, practitioners within the profession have advocated for evidence-based research to support practices or identify those needing improvement.

The role of the first responder in prehospital care has minimal research to support its presence. Similarly, the impact that first responders have on the role of transporting paramedic ambulance receives little attention. To date, most researchers have focused on early interventions and its impact on patient outcomes. System administrators and municipal leaders need more information on the fiscal and health impact first responders may have on over-all EMS system design.

In Chapter 2, I provide a comprehensive review of existing literature addressing the relationship between first responders and ALS ambulances. I will also provide a brief review of the literature search strategy and the theoretical foundation. Next, I analyze the literature for supporting arguments and examine it for contrasting information, ultimately highlighting the gap in the literature necessary to find the relationship between first responders and ALS ambulances. To conclude this chapter, I review the research questions and show the relationship between the literature and the questions.

Literature Search Strategy

To ensure a comprehensive review of the literature, I conducted an exhaustive search of library databases and used multiple search engines. I used a broad range of key search terms to reduce the odds of overlooking relevant studies or information. Much of the foundational literature, which provides the historical perspective of the development of EMS, dates back many years, as do several of the seminal papers which served as the catalyst for the modernization of EMS in the United States. Over the past 10 years, a lot of research expanding on the foundational literature has emerged; including many international studies, which help support assertions made in domestic research.

I attempted to locate as much research that directly addressed the questions of this study, to no avail. This lack of available scholarly resources merits the additional investigation in this area. As such, I tried to bridge this gap by researching specific patient medical conditions and the impact time and time at scene had on the patient, as well as patient treatment modalities and what impact time had on their success or the patient outcomes. I examined the frequency of utilization of different life-saving skills, focusing on the emergency responders’ certification level.

I accessed multiple library databases to retrieve relevant information on the subject including electronic access of Walden University, the University of San Diego Copley Library, the Southwestern Community College Library, San Diego State

University, and the library at the University of California - San Diego. In addition to electronic access, I made in-person visits to libraries at the University of San Diego, San Diego State University, the University of California-San Diego Medical Center, Sharp Chula Vista Hospital Medical Center, San Diego County Public Library, and the City of Chula Vista Public Library.

I used a number of search engines to locate materials such as, Academic Search Complete, Academic Search Premier, Business Search Premier, CINAHL and Medline Simultaneous Search, Dissertations and Theses at Walden University, Dissertations and Theses Full Text, EBSCO Books, Google Books, JSTOR, Lexis/Nexis Academic Universe, Medline with Full Text, ProQuest Central, ProQuest and Health Complete, ProQuest Nursing and Allied Health Source, PubMed, Sage Premier Journals, Science Direct, and Wiley Interscience Journals.

I used key terms in the initial research stages to find the relevant areas. In many cases, this led to secondary and tertiary terms not originally considered, fanning the research in many directions. Key terms included: *ambulance response times, ambulance transport times, Advanced Cardiac Life Support (ACLS), Advanced Emergency Medical Technician (AEMT), Advanced Life Support (ALS), allied health care, Basic Life Support (BLS), cardiac arrest, CPR (cardiopulmonary resuscitation), Emergency Medical Services (EMS), Emergency Medical Technician (EMT), First Responder, first responder response times, Fire Departments, history of EMS, Major Trauma Victims (MTV), paramedic, paramedicine, prehospital medical care, Prehospital Trauma Life Support (PHTLS), response times,* and *system status management.*

The scope of the literature search included references, which cited data going back as far as 1500 years (Garrison, 1921). While there is scant research directly dealing with a similar focus area of this research, there are seminal works which account for the bulk of the historical data. These historical texts are the foundation for modern research and served as the platform for explaining the need for this study. Seminal works included the National Academy of Sciences (1966) "Accidental Death and Disability: The Neglected Disease of Modern Society" as well as Stewart's (2005) "History of EMS: Foundation of an EMS System." Stewart and most EMS researchers attribute the modernization of emergency medical services in the United States to the publication of the National Academy of Sciences paper, but Stewart laments that one of the key principles identified in the 1966 paper was not pursued. Namely, the lack of data collection analysis or research for newly implemented practices and standards within this new industry (Stewart, 2005). Because of this and the specificity of the research questions proposed in this study little original research exists further supporting the need for this retrospective analysis.

Theoretical Foundation

Time is a frequently measured benchmark in prehospital care (Harmsen et al., 2015; Patel et al., 2014; Squire, Tamayo-Sarver, Rashi, Koenig, & Niemann, 2013). Some researchers have examined the impact a responder's certification level have on prehospital care (Hansen et al., 2014; Rappold et al., 2015; Winship, Boyle, & Williams, 2014). Time as a standard in prehospital care and the effect a responder's certification level has on a patient's prehospital care serves as the foundation for this study and are further developed throughout the remainder of this chapter. Concluding remarks and recommendations will be in Chapter 5 of this study and directly tie back to these important concepts.

Before the 1966 National Academy of Sciences' white paper, the idea of time was primarily associated with war-time efforts and injured soldiers. Bell (2009) reported that the developments of patient transport hinged on people understanding the importance of getting a wounded soldier to care, as this would increase their odds of survival and return to the battlefield. In the 19th century during the Napoleonic Wars, French surgeon Larrey introduced trier or triage which directed rescuers to save the sickest or gravely wounded first, thus reducing the time an individual spent before receiving care from a physician (Nestor, 2003).

During wars in the mid-20th century, specifically the Korean war, the United States Army adopted forward operating medical units, such as the MASH units (King & Jatoi, 2005), thus bringing emergency medical care closer to the battlefield. These units, combined with the new use of helicopters as patient transport vehicles reduced war-time deaths by more than half (Holcomb, Stansbury, Champion, Wade, & Bellamy, 2006). Some researchers attribute helicopter use for the reduction in wartime deaths to 2.4% of the total casualties (Driscoll, 2001; King & Jatoi, 2005). While some of this can be attributed to advances in medicine and knowledge gained during the Second World War, much of the increased survival was associated with bringing prehospital care to the patient's side, rapid transport, and rapid access to definitive care such as surgery or hemorrhage control (King & Jatoi, 2005). The adage that "a man dies in a period of time, not over a distance of miles" (Driscoll, 2001, p. 290) hastened the use of helicopters in medical evacuation, and medical personnel called them "air ambulances" (King & Jatoi, 2005, p. 653).

Nearly 40 years later, MacFarlane and Benn (2003) identified the lack of research within the EMS industry and questioned whether existing practices and standards were valid. As a result, clinicians, first responders, and EMS system administrators began to question their systems resulting in a revival of scholarly research. Researchers have made great strides in this area, but there are still many unanswered questions. For instance, Glind et al. (2016) identified more than 48 prehospital related subjects needing immediate investigation; they narrowed it down to 12 areas concluding that "these topics provide a focus for future research efforts to improve the evidence-base and clinical practice of prehospital emergency medical services" (p. 8). In a 2016 editorial, Jensen and Travers advocated for evidence-based research, stating:

> Clinicians and leaders will understand and use the best available evidence for clinical and administrative decision-making, to improve patient health outcomes, the capability and quality of EMS systems of care, and safety of patients and EMS professionals. (p. 10)

If the profession of paramedicine or prehospital emergency medical services is to grow as a health profession, it must be based on research and evidence (O'Meara, Maguire, Jennings, & Simpson, 2015). According to the National Highway Traffic Safety Administration (2001):

> EMS systems must justify their role in the health care process. They must prove that the care and transportation they provide is necessary and delivered in an effective and economical manner. These mandates can only be achieved by true integration of the research process into the system. (p. 12)

In the 1980s, less than a quarter of all interventions were evidence-based practices and most interventions over-relied on the opinion of experts (Lang et al., 2012). According to National Highway Traffic Safety Administration (NHTSA), EMS professionals are not taking ownership of research and integrating it into their practice. Some explanations may be due to funding, not understanding the need for evidence-based practice supported by research and the segregation of research and patient outcomes (O'Meara et al., 2015).

Since then, evidence-based practice in EMS has become the standard for prehospital care (Glind et al., 2016; O'Meara et al., 2015). Previously, much of what paramedics and other first responders were based on emergency department standards or adopted with the mantra "everyone already is doing it" (Sackett, Rosenberg, Gray, Haynes, & Richardson, 1996) which ultimately failed the patients and the systems they depend upon. Much of the prehospital research conducted came under the umbrella of "emergency medicine research" (Sackett et al., 1996, p. 207), which was a subset of hospital-based research (Institute of Medicine Committee on the Future of Emergency Care in the US Health System, 2007). The committee emphasized the need for research and advocated for evidence-based changes when altering EMS practices or procedures

(Institute of Medicine Committee on the Future of Emergency Care in the US Health System, 2007).

Corbin and Strauss (1998, as cited in Campeau, 2008) defined theory as a "set of well-developed concepts related through statements of relationship, which together constitute an integrated framework that can be used to explain or predict phenomena" (p. 15). Campeau (2008) wrote, "to fully capture paramedic knowledge, one needs theory" (p. 2) and not just base practices on specific patient conditions or emergency situations. The Federal Interagency Committee on EMS (FICEMS) and the National EMS Advisory Council (NEMSAC) joined forces to create a model which EMS system leaders, medical practitioners, and professionals within the EMS field could use to ensure decisions made about prehospital care were evidence-based and had a quality improvement component which ensures continuous review and revision of the standards (Lang et al., 2012).

The National Prehospital Evidence-Based Guideline Model (Figure 1; Lang et al., 2012) encouraged multiple sources of information for input, including established protocols, scopes of practice and the input of EMS researchers and professionals. Of the eight-step model, two are devoted to ensuring the validity and scholarly value of the information gathered which help meet the standard that decisions about EMS protocols and guidelines are evidence-based. In addition to the dissemination of the updates, the designers ensured an evaluative step was included in the model, which required professionals and EMS system designers to review the effectiveness and outcomes of changes. This formal quality improvement step was new to the cycle of developing EMS guidelines (Lang et al., 2012) and told researchers "pertinent quality improvement indicators should be monitored, and benchmarks should be developed” (p. 206). The National Association of State EMS Officials (NASEMSO) endorsed the National Prehospital Evidence-Based Guideline Model (Lang et al., 2012; Wright, 2014) and had used and proven to it to be an effective mechanism for establishing prehospital treatment guidelines and EMS system design (Brown et al., 2014).

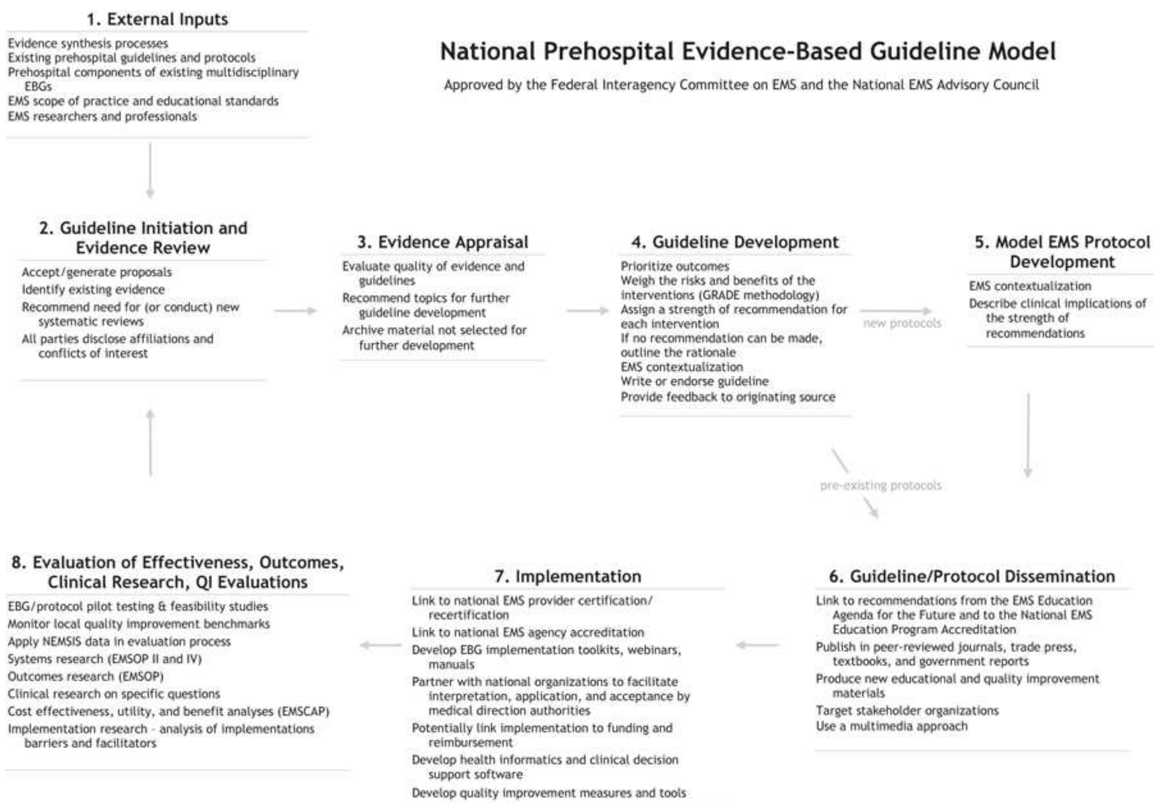

Figure 1. National Prehospital Evidence-Based Guideline Model. Lang, E. S., Spaite, D. W., Oliver, Z. J., Gotschall, C. S., Swor, R. A., Dawson, D. E., & Hunt, R. C. (2012). A national model for developing, implementing, and evaluating evidence-based guidelines for prehospital care. *Academic Emergency Medicine, 19*(2), 201-209. doi:10.1111/j.1553-2712.2011.01281.x. Reprinted with permission.

Canadian-based researchers also embraced evidence-based practice (EBP) as the benchmark to change or to establish standards within their prehospital and emergency medical community. According to Jensen and Travers (2016), Canadians have found EBP difficult to implement as “meaningful incorporation into clinical and administrative practice in Canadian EMS remains a challenge nationally and at the local EMS system level” (p. 2).

Since evidence-based research has become the standard, there has been considerable investigation into the relationship between the time a patient becomes injured or ill and when a physician sees them. Researchers who simply research patients who are saved and who died do not have enough information because “there is uncertainty about when a save occurs” and such definitions are based on the nature of a specific study (National Highway Traffic Safety Administration, 2001, p. 11). It is also difficult to determine the overall impact prehospital care providers have on patients. While considerable evidence supports the need for early recognition of cardiac arrest and major trauma victims, it remains unclear whether a professional first responder changes the outcome.

Kidane et al. (2016) examined a subset of trauma patients and found increased mortality when paramedics spent a shorter period in the field with those patients and speculated the increased mortality represented those patients who were most gravely wounded and the paramedics simply elected to transport immediately rather than initiate any prehospital care. Blanchard et al. (2012) examined emergency patients response times (i.e., how long it took an ambulance to respond to the scene of an emergency) and found that “at a 4-minute response time, the difference in the risk of mortality for a response time of ≥ 4 minutes was 1.41….and a secondary analysis stratified at a 9-minute response showed no association with mortality” (p. 146). There was very little difference in patient survival based on the response time of the ambulance.

In a multiyear retrospective study of European trauma centers, researchers found mixed results on the impact prehospital personnel have on major trauma patients (Huber et al., 2016). The researchers looked at the differences between survival of patients who arrived at the hospital via private transport, versus patients transported by ambulance. Huber et al. (2016) found patients arrived at the hospital quicker via private transport; yet, these patients also spent more time in the emergency department, suggesting the prehospital assessment and interventions shortened the patient’s stay in the emergency department. Patient’s who arrived via EMS took longer to arrive at the hospital yet had shorter stays in the emergency department. Huber et al. found patients who arrived at the emergency department via private transport had a greater likelihood of surviving their injuries but the acuity of injury factored into the patient outcome.

Researchers examined which medical skills performed in the prehospital environment by emergency medical responders would have the greatest impact on patient outcome (Bakalos et al., 2011; Costantini, Kobayashi, & Coimbra, 2015; Ryynanen, Lirola, Reitala, Palive, & Malmivaara, 2010; Vopelius-Feldt, Coulter, & Benger, 2015; Warren et al., 2015). The certification level of the medical responder based on local EMS system design determines who can provide the various skills employed in the prehospital environment. However, a largely unexplored research area is the examination between the certification level of the first responders and how much time the patient spends in the field. Specifically, how long a patient remains at the scene of an emergency once an ALS ambulance arrives.

Time has an impact on patient outcomes and EMS system design. The national standard dictates first responders arrive at the scene of a medical emergency within 4 minutes, 90% of the time and an ALS ambulance arrive within 8 minutes, 90% of the time (National Fire Protection Association, 2010). These standards are used nationally in the procurement of ambulance services and as a benchmark for all responders regardless of whether they are BLS or ALS. Some researchers questioned the rationale of these metrics, and more research suggests they may be flawed or unnecessary (Blackwell & Kaufman, 2002; Blackwell, Kline, Willis, & Hicks, 2009; Weiss, Fullerson, Oglesbee, Duerden, & Froman, 2013). A more accurate measurement might be “transport time” (i.e., time measured from the time an ambulance departs the scene of an emergency until the patient arrives in the emergency department) instead of the current standard of response time (Takahashi et al., 2011).

The need for additional examination of Takahashi et al.’s (2011) belief that the amount of time a patient is delayed in the field when capable transportation services are available is further supported with growing evidence that “time is tissue” or “time are brain cells” in acute medical emergencies such as strokes and heart attacks (Fonarow et al., 2013). Ho et al. (2014) found a reduction in over-all time from the onset of symptoms and definitive care was the critical factor without mentioning prehospital care or interventions. In a poster presentation on EMS activation in suspected stroke patients

Pittenger et al. (2015) found patients transported by prehospital EMS personnel to stroke centers in Wisconsin reduced the time before a patient arrived at a hospital by nearly 14% and extrapolated that patient outcomes could be improved with a reduction in the amount of time until they receive definitive care. Esmaeiliranjbar et al. (2016) found trauma patients taking longer than 60 minutes to arrive at a hospital increased mortality rate by a factor of 22 (p. 39), although they did not distinguish between gender, blunt vs. penetrating trauma, age, or mechanism of injury and simply focused on the time factor. However, Bagher et al. (2017) disputed Esmaeiliranjbar et al. (2016) findings concluding that time was not much of a factor as were the comorbid variables such as injury severity, age, and mechanism of injury.

Uncertainty over the impact of time and the level of certification of prehospital care personnel more frequently intersect and sometimes collide when caring for trauma patients. For instance, in a systematic review of the literature Harmsen et al. (2015) found a conflict between studies and a lack of consistency in variables; however, Harmsen et al. provided conflicting information when they concluded that a shorter transport time reduced mortality of trauma patients but in certain patient conditions a longer on-scene time might help. Harmsen et al. stated:

> The longer on-scene times is presumably related to the comprehensive care that is delivered prehospitally… [and that…] the emphasis should not be on getting a patient to the hospital as fast as possible but making sure the patients receive proper prehospital care first. (p. 608)

Scene times have been revalidated with wartime conflicts involving U.S. troops in Iraq and Afghanistan. According to Kotwal et al. (2016), reducing the amount of time a medevac helicopter took to reach a patient decreased patient deaths, compared to those injuries and deaths before the use of helicopters as medical transport. The use of a helicopter as transport also saw increased in-transit deaths or deaths upon hospital arrival; however, those patients would have normally died before the widespread use of helicopters so using this transport only changed the location of their deaths (Kotwal et al., 2016). Practitioners and scholars in the field need more research to flesh further out the conclusions they've reached regarding scene times and transport modalities. They also need to focus on the specifics of prehospital care and what makes a difference.

Historical Periods of EMS

The history of EMS, more specifically, the transportation of the sick and injured can be broken down into three distinct time-periods. The first came with the recognition that lives could be saved from the battlefield if they were prioritized by acuity and rapidly transported to field hospitals. The second period of significant development of the EMS system came after the 1966 release of Accidental Death and Disability on America's Highways, published by the federal government. The third period began in the early 1980's when the fire service began providing ALS, and first responder service and prehospital care moved to evidence-based practice.

Europe: War and Influenza

Throughout recorded early history, there is evidence of those gravely wounded or killed in battle were left where they fell, and not dealt with until the battle was complete, or a retreat had occurred (Mitchell, 2013). The impact that the sick, injured or dead had on the morale and capabilities of the remaining troops was not appreciated until recently (Beam, 2003) and neither was the transportation of the sick and injured as a necessary step to help maintain civil order, improve troop morale and keep public health crisis in check. Although some literature refers to similar plans before to him, many scholars credit Mauricius' *Ars Militaris* (590 CE.; Bell, 2009, p. 3) for instituting a squad of horsemen to retrieve wounded soldiers and transport them to medical tents during the Byzantine Wars (Garrison, 1921). The horsemen received compensation for each injured soldier they retrieved, and this system of patient retrieval and rapid transport to medical practitioners is considered the first development of an emergency medical system (Bell, 2009, p. 4). Called "horse ambulances" (Bell, 2009, p. 4) which brought together the three critical components of an EMS system, rescue immediately following an injury, use of specially designed vehicles, and direct transfer to a place of care. These components remain in place today albeit with a modern fleet of vehicles of ambulances and helicopters staffed by highly trained responders.

More than 700 years later, the Brothers of Mercy were founded by Mauricius in Florence, Italy, to help with the transportation of the ill, injured and the dead from the streets and houses of the city (Bell, 2009, pp. 4-5). They first transported their charges in baskets strapped to their shoulders, then by a coffin shaped stretcher and then by horseback and ultimately in custom designed horse-drawn carriages designed specifically for transporting the ill (Bell, 2009; Levin, 2004). Even the Florentine Brothers of Mercy had a triage system, summoned by the peals of the church bells; one peal notifying them of an ill or injured person, two peals for the seriously injured and three, for those who had already died (Bell, 2009). It was widely recognized that the sooner an injured party or deceased individual was removed from the homes and streets of Florence the less likely contamination would occur. This philosophy was further embraced during the influenza outbreak in the early 20th century, and hastened the development of emergency medical services, to remove the dead and dying from the streets.

In the 15th century, Queen Isabella of Spain ordered the design of the first "modern ambulance" (Bell, 2009, p. 11), taking horse-drawn carts, placing padding down and covering them with awnings to provide transport of her wounded soldiers during the Moorish Wars to field hospitals in liberated territories. As this updated mode of transportation evolved, other European countries embraced this approach. These carriages were designed with the comfort of the driver in mind, instead of the comfort of the injured (Bell, 2009; p. 12). Once again, it was recognized that any soldier who received expeditious care had a greater likelihood of survival, which meant a quicker return to the battlefield. When this practice gained traction, transporting the wounded to hospitals helped the morale of soldiers who remained fighting. However, during the Napoleonic wars Larrey recognized the value of bringing medical care to the battlefield; he also designed ambulance volantes, or flying ambulance, and he began dispatching surgeons and medical assistants on to the battlefield, believing that if care was rendered sooner, they might be able to save more lives (Nestor, 2003; Remba, Varon, Rivera, & Sternbach, 2010). Larrey is credited with introducing triage into the battlefield (Bell, 2009, p. 18; Shuja, 2017, p. 75; Nakao, Ukai, & Kotani, 2017, p. 379). Before Larrey, the wounded were treated based on their rank or social status, the higher the rank or more affluent the injured, the sooner they were transported or treated; he instead proposed and implemented a necessity-based approach towards medical care (Nestor, 2003). In other words, those with the worst injuries would receive treatment first, regardless of rank or status. Translated from the French word trier it means “to sort,” or for Larrey’s purpose, to identify those who were the sickest and treat them first (Nestor, 2003). Larrey and his men gained notoriety for treating everyone as equals, but much like the carriages, Queen Isabella commissioned Larrey’s flying ambulances also lacked comfort or equipment. Instead, they served as a simple transportation device designed for the sole purpose of moving the injured. Nevertheless, Larrey gave birth to the idea of transporting the sickest first, thus setting the stage for initial triage and care, and subsequent transport of the sick and injured, a practice still in use today throughout all healthcare.

The Recognition of the Role of the Ambulance

In 1832, the first year of an Asiatic cholera outbreak in London killed nearly 50,000 people (Fayrer, 1888). Physicians quickly realized transporting the sick via public conveyance (e.g., cabs and hackneys) propagated the outbreak; so, they needed to isolate infectious patients, which renewed public interest in ambulances (Bell, 2009). The ambulances in circulation at the time were called “fever ambulances” (Bell, 2009, p. 25) and across London sparked fear in people because of their association with sickness and death. Leaders ordered a vehicle design which allowed the sick to be transported out of sight laying down in the back of a covered carriage (Bell, 2009, p. 25).

Despite attempts for nearly 30 years to formalize a London ambulance service, there was no success in organizing a system (Bell, 2009). London ambulances lacked financial backing, and the community had only supported them during a crisis. In 1864, a London Hospital Carriage Fund was established by the unions and the various entities overseeing public health (Bell, 2009, p. 26), soliciting subscriptions to help fund an organized ambulance system in the city. The effort to establish systematic ambulance services did not receive support until 1866 when Parliament passed the Sanitary Act of 1866 as part of Great Britain's effort to raise awareness of public health concerns (Lee, Sim, & Mackie, 2016). This political reform continued and led to sanitation and disinfecting through the 1930s (Pollock, 2013).

It became obvious to public health leaders that one approach towards stopping the cholera outbreak which lasted for thirty years during the middle of the 1800s was by isolating the sick (Bell, 2009; Pollock, 2013). The sick and dying were brought to hospitals and clinics by ambulances and cabs without isolating these patients from the well or not yet sick. Ambulances had to be dispatched by hospitals to care for and transport the sick from their homes and the streets. Ambulance attendants found their roles evolving; they were transporting the sick, working in the clinics, and hospital wards (Bell, 2009).

Before the Great Influenza outbreak of 1918 (Rewegan, Bogaert, Yan, Gagnon, & Herring, 2015), ambulances were evolving from the horse-drawn carriages of the late 19^{th} century to motorized vehicles made by American companies such as Packard, Cadillac, and Ford (Hansen, 1996). When the First World War erupted, Europeans were unable to staff or match the pace of American vehicle production. During this time, volunteers were also scarce, so many American college students and young adult males of the established elite paid money for the opportunity to volunteer their services to drive ambulances in Europe; they were later known as gentlemen volunteers (Hansen, 1996). The war-torn nations welcomed these gentlemen volunteers and immediately put them to work. One notable volunteer was Ernest Hemingway who became a volunteer ambulance driver with the Italian Army and would later use his experiences when writing *A Farewell to Arms* in 1929 (Horst Frenz, 1969; Hansen, 1996).

It also marked the first time ambulances were staged near an event (or battlefield) awaiting patients, instead of patients waiting for an ambulance; another contribution of the gentlemen volunteers (Ginchereau, 2016; Hansen, 1996). Soldiers carried their injured comrades to a first aid station set up in the trenches for initial care and triage; after that, the injured were carried to a field hospital, typically within a mile of the battlefront. The ambulances at the edge of the battlefront were staffed and prepared to transport the wounded towards more definitive care. From these poste de secours, and with their converted automobile they could rapidly transport the injured towards surgical hospitals and more advanced care (Hansen, 1996). The gentlemen volunteers were thought of as heroes for this novel approach which soon became the standard and practice, which continues today (Ginchereau, 2016).

Once again, triage played a role when transporting patients, which gave rise to the idea of a first responder which is defined by Hansen et al. (2015) as “personnel who respond to the medical emergency in an official capacity as part of an organized medical response team, but who were not the designated transporter of the patient to the hospital" (p. 256). Currently, this role is typically filled by firefighters but could also be police officers or those working on a rescue squad (Hansen et al., 2015).

World War II expanded triage and with the advent of penicillin and its broad use (Dowdy & Pait, 2014). U.S. Army surgeons triaged, and dispensed penicillin based on how quickly it would return a soldier to battle, even if it meant treating a soldier with gonorrhea over a soldier with a battlefield injury (Iserson & Moskop, 2007). Similarly, German physicians started to allocate resources "treating those who could most quickly be returned to action with the least expenditure of time and resources" (Iserson & Moskop, 2007, p. 277). The efficient use of resources was a concept in which:

> triage systems tend to direct resources to the care of those patients whose needs are great and for whom treatment is likely to be successful, and to withhold resources from those patients who are not likely to benefit significantly from treatment, because their injuries or illnesses are either too severe to be successfully treated. (Moskop & Iserson, 2007, p. 283)

This practice continues today with the deployment of first responders and life-saving equipment in urban and rural environments. In one example, Masterson et al. (2015) found the distribution of AEDs throughout Ireland had a positive impact on out of hospital cardiac arrest survival rates. In Australia, a retrospective study of out of hospital cardiac arrest patients found that with the addition of EMR first responders trained in the use of AED's, the time between the call was made to emergency services, and the initiation of CPR and the use of an AED decreased (Winship, Boyle, & Williams, 2014).

There was no change in survival rates despite the addition of these resources leading the authors to suggest there were other factors in play which might require the redistribution of resources (Winship et al., 2014).

The concept of rapid triage and early transport of the wounded remained the same in WWII. However, this changed with the modernization of vehicles, armored tanks, and jet aircraft. The ratio of those wounded to those who died was 1.65:1 in World War II but has steadily increased through the current conflicts to 9.19:1, partially because of better surgical techniques and medicine, rapid access to definitive care and the formal implementation of triage and rapid transport (Rohlfs, Sullivan, Treistman, & Deng, 2015; p. 465). New treatments and the value of early surgical intervention was finally beginning to be realized, and most notably in the treatment of head injuries. Neurosurgeon Harvey Cushing would demonstrate that early recognition and intervention in combat head wounds would decrease mortality by nearly 63% (Dowdy & Pait, 2014) serving as an example of how triage and rapid transport benefited patients.

It was in the Korean and Vietnam Wars that triage, deployment of resources, and rapid transport of the wounded was formalized and subsequently used as the foundation for modern-day trauma systems and EMS systems. The most noticeable difference was the use of the helicopter (Bell, 2009; p. 166). Dowdy and Pait (2014) noted the recognition to rapidly transport soldiers injured on the battlefield to higher level care facilities which made a significant impact on patient outcomes and this concept remains powerful today (p. 241). Communities implement trauma systems and EMS systems because rapid recognition of medical emergencies and transportation to definitive care

are two of the most important concepts in patient survival (National Association of EMT's, 2015). The other advancement in the Korean War was the U.S. Army's implementation of MASH units, which brought surgeons and resources closer to the battlefield. If injured in the field soldiers were first sent to Battalion Aid Stations (BAS) for initial triage and care. They were assessed by field medics, nurses and medical officers and if necessary, triaged to a MASH unit for more definitive and advanced level care (King & Jatoi, 2005). A similar concept remains in play today within the civilian world with emergency medical responders, EMTs, and paramedics. Responsibilities can vary with some serving as first responders and other groups charged with providing transportation while also caring for the patient. In hospitals, there are emergency rooms, trauma receiving rooms and in the most serious cases, patients who proceed directly to the operating suite (Costantini, Kobayashi, & Coimbra, 2015).

The development of modern-day EMS systems was in part driven by the experiences of the Korean and Vietnam Wars. The National Academy of Sciences' 1966 white paper recognized the need for an integrated prehospital emergency medical care system, which included trained prehospital care personnel with basic or advanced medical training, as well as the creation of trauma systems and the need for prehospital research. At the same time, in the Vietnam War, the lessons learned from the Korean War were being applied; forward operating medical bases, helicopter medical evacuations, and newly recognized advanced trained medics were attached to military units and squadrons when deployed. This resulted in more saved lives and preventable deaths, as well as reducing deaths from trauma or battlefield injuries (Dowdy & Pait, 2014).

Modern-day EMS systems and system design still hold true to its ancestral DNA. In almost every EMS system, there is a tiered response with different certification-levels of personnel responding, much like a major metropolitan area has tiered hospital systems with some emergency departments providing basic care while others might be designated as a trauma receiving facility. In situations where patients are severely injured this segmentation has proven to save lives (Cudnik, Newgard, Sayre, & Steinberg, 2009; Demetriades et al., 2006). Tiered responses and having tiered receiving facilities do affect patient outcomes, but does having a tiered response affect scene time?

With the Highway Safety Act in 1966, a panel of experts suggested the federal government provide initial funding for the development of programs to reduce deaths from cardiac disease and heart attacks, develop formal EMS systems, and for the training of emergency medical responders (Smeby, 2014). According to Shah (2006), the federal funding is responsible for the formal training and designation of EMTs; without it EMTs would have never occurred, and EMS systems would not have been formed. This funding also led to technological enhancements that would lead to an advanced level of responder, who were later called paramedics.

The government wanted to use a regional concept when creating EMS systems, whether it was the prehospital providers or the development of an area-wide trauma receiving facility. In his 1972 State of the Union address, President Nixon called for more funding to support the continued development of EMS in the United States, which led to the nation's modern EMS system (Rockwood Jr., Mann, Farrington, Hampton Jr., & Motley, 1976). Improvements included a set of standards, which dictated what an ambulance should look like and what it should carry, as well as a standardized training regimen for EMTs and paramedics (Simpson, 2013). The Department of Transportation oversaw this overhaul, and many of those standards still serve as the foundation for today's EMS system design and personnel certification (Shaw, 2006; Simpson, 2013)

The Government's Role in Ambulance and EMS System Design

Civilian ambulances benefited from the invention of the automobile and military vehicle design improvements (Bell, 2009); but, the government also dictated ambulance design and appearance with the publication of their white paper. The transition from the horse-drawn carriage to electric vehicle and then the gas-driven vehicle allowed ambulances to carry more life-saving equipment and for the first time, the ill or injured could summon a vehicle which was specifically designed to transport them (Davison, Karpinski, Levy, & Strobel, 2016). Because of their design to carry litters bearing the dead, morticians began to invest in these vehicles giving way to their dual role as a transporter of the dead and the ill/injured (Scanlon, McMahon, & Van Haastert, 2007). At the time of the of the publication of the government's white paper these hearses transported more than half of the nation's sick and injured (Simpson, 2013; National Academy of Sciences, 1966). The publication of the white paper mandated changes in vehicle design, as well as the standards for first responder training (National Academy of Sciences, 1966).

Today, EMS systems may be governed by state and regional regulations, but most EMS system design is completed on a local level and acknowledge many different resources, including national trends and research, the aggressive or conservative nature of the local medical community, consumer expectations, and the caliber of training available in the region (Kupas, Schenk, Sholl, & Karmin, 2015). For instance, if the key measurement tool is patient outcomes, using survival rates based on EMS system design can help guide decision-makers (Sund, 2013). Sund (2013) found that adding the fire service to the dispatch of reported cardiac arrests, led to an increase in survival rates. How ambulances are located within a community can vary, but through a dynamic deployment model, there is improved efficiency and reduced response times (Bélanger, Kergosien, Ruiz, & Soriano, 2016; Lam et al., 2015). National trends demonstrated more providers are using a dynamic deployment model, with "those using dynamic strategies increasing from 23% to 37%" (Alanis, Ingolfsson, & Kolfal, 2013). EMS systems can be based by city, county, and sometimes by state. However, in California EMS systems are county-based ($n = 33$), and they can cover a larger regional area (California Emergency Medical Services Authority, 2016). North Carolina has 100 county-designed EMS systems (Moss et al., 2015). While education may drive the future of EMS system design, research and technological enhancements in the civilian world drive much of what EMS educators teach. Whether it is driverless ambulances (Davison & Forbes, 2015) or high-fidelity simulation mannequin use in paramedic instruction (McKenna et al., 2015) how EMS systems evolve and improve is in large part due to ongoing research and education. In 2008, Snooks et al. found that of 96 research topics, the main focus was on the identification of new performance measures other than ambulance response times as a way to improve EMS.

There are a variety of delivery models in emergency medical services. These can range from public sector providers (e.g. fire service, public utility model), private providers, and mixed models. In 2012, Govindarajan et al. surveyed participants in a national out-of-hospital cardiac arrest study and found “that nearly 72% of the paid responders came from either the fire service or as a governmental third service (nonfire), with the remainder coming from nonprofit providers and private providers” (p.77). There are mixed models where the fire service and private providers work together to deliver emergency response. Govindarajan et al. found a “majority of the fire department first responders were simply BLS providers (57%) with only 36% of the fire department responders having advanced life support capability” (p. 78). In the latter category, transport services were provided by ALS providers from different services. This study is self-limiting because it only surveyed participants in the cardiac arrest study and does not represent the entire prehospital arena (Govindarajan et al., 2012). Govindarajan et al. also recognized there are differences in patient outcomes based on the delivery model, but were unable to draw conclusions as this was not the basis of the study.

When a fire department is the sole provider of first responder services and the ALS transport service, the department, and therefore the community are getting a greater benefit relative to the number of resources spent (Fogley, 2014). The argument of cross-training fire department personnel means the provider is both a firefighter and a paramedic (Gunderson, 2015) which theoretically creates efficiencies where personnel can respond to fire and rescue responses as well as emergency medical care requests. According to Gunderson (2015), there are potential downsides; this includes not having personnel available for fire and rescue when assigned to a medical emergency and the need to master and maintain skills excellence in multiple disciplines. There is also the question of having too many paramedics on staff which results in fewer opportunities for the individual paramedics to perform skills and maintain their proficiency (Garza, Gratton, Coontz, Noble, & Ma, 2003; Gunderson, 2015; Pepe, Roppolo, & Fowler, 2015).

It makes sense that those who have frequent contact with patients and therefore more opportunities to perform skills will do better than those who do not. Pepe et al. (2015) examined how frequently paramedics performed endotracheal intubation and found those systems with fewer paramedics or a tiered response to emergencies resulted in greater skills performance and fewer complications. Pepe et al. are not the only ones advocating for a system with fewer paramedics with a growing number of researchers questioning their need (Kimmel & Persse, 2015; Ryynanen, Lirola, Reitala, Palive, & Malmivaara, 2010; Woodall, McCarthy, Johnston, Tippett, & Bonham, 2007). Warren et al. (2015) found more rescuers on scene meant a greater likelihood of survival for someone with an out of hospital cardiac arrest, but they make no distinction in the certification level of the rescuers. The American Heart Association found the more often a paramedic tended to cardiac arrest patients the greater likelihood the patient would survive (Dyson et al., 2016). In 2010, researchers attempted to identify variables which improve the rate of out of hospital cardiac arrest survival and found that EMS presence or witnessing a cardiac arrest improved patient. The primary contributor was the rapid administration of CPR, regardless of whether it came from EMS personnel or layperson witnesses (Goto, 2017; Hasselqvist-Ax et al., 2015; Sasson, Rogers, Dahl, & Kellermann, 2010). The impact first responders have on patient survival is still a matter of debate. The question does having first responders get the patient on the road to the hospital sooner, remains unanswered.

Emergency Responders and Transportation Options

In the United States, there are four levels of certification based on the scope of practice (Cone, 2015; Smeby, 2014). This includes emergency medical responder (EMR), emergency medical technician (EMT), advanced emergency medical technician (AEMT), and paramedic. According to the National Association of Emergency Medical Technicians (NAEMT, 2016), the EMR is a responder which possesses basic skills to provide immediate lifesaving care for critical patients. The EMT conducts basic, noninvasive interventions to reduce the morbidity and mortality of acute out-of-hospital emergencies. They have all the EMR's capabilities, plus additional skills associated with patient transport (National Association of Emergency Medical Technicians, 2016; Sasser et al., 2009). Advanced EMTs have the same training and skills as EMRs and EMTs; but, they bring a limited advanced scope of practice, which allows for some medication administration and interventions. Paramedics are considered to have the most advanced scope of practice and can perform invasive and pharmacological interventions (National Association of Emergency Medical Technicians, 2016). The educational requirements range from a single semester for EMR and 2 or more years to become a fully licensed paramedic.

As EMS systems are designed many factors come into play. This includes the certification levels of the first responders or the desired certification level once the system is designed, the financial impact and the community support. The focus of this study is solely on urban EMS, yet acknowledges the distribution of advanced life support decreases dramatically in the rural and mountainous regions of the United States (Govindarajan et al., 2012; Wang et al., 2013).

When a first responder or ambulance crew encounters a patient, they are faced with a number of options for disposition. The patient may not require medical care whatsoever, and the responders are canceled, the patient may elect to refuse care or transportation despite their obvious medical necessity by signing out against medical advice (AMA), or the patient can agree to be transported to a hospital or approved medical receiving facility. Other considerations include the use of aeromedical transportation and the nontransport of those patients deceased or pronounced deceased as the result of a failed resuscitation attempt.

There are times when a person makes a 911 believing a medical emergency is unfolding. This may be a witness to a motor-vehicle crash or someone driving down the road and seeing a person laying on the sidewalk. Other times, well-intentioned family-members call 911 prematurely when in fact the medical emergency is transitory and resolved before the first responders arrive. This ranges from someone witnessing an episode of perceived choking, to a concerned witness that a patient is having an allergic reaction before the patient self-medicating, or a second or third party caller giving/receiving erroneous information.

The next option for a prehospital encounter is for the patient to refuse treatment or transport and seek alternative forms of transport such as with a family member or friend, or stay home and not pursue any additional medical care. In the case where a patient refuses transport or treatment most EMS systems require the patient sign a medical release form, also known as an AMA. According to the 2016 San Diego County Prehospital Treatment Protocols and Guidelines, an AMA is defined as, “The refusal of treatment or transport, by an emergency patient or his/her designated decision maker, against the advice of the medical personnel on scene or the of the base hospital” (p. S-412). The guidelines continue by stating, “adults have the right to accept or refuse any and all prehospital care and transportation provided that the decision to accept or refuse these treatments and/or transportation is made on an informed basis (San Diego County Paramedic Association, 2016, S-412). This definition can be applied to all aspects of medicine. Researchers supported the need for health care practitioners to work hard to convince patients not to terminate their health care or options by opting to AMA yet firmly stating “that a patient has the right to refuse medical care and that treatment without consent may be considered battery” (Levy, Mareiniss, & Iacovelli, 2012, p. 517). Patient refusals are a common occurence, in fact, researchers found an 11.1% patient refusal/AMA disposition in San Francisco (Hodell, Sporer, & Brown, 2014). Refusals in San Diego County for 2015 were at 10.1% which according to the San Diego County Emergency Medical Services Office has been steady for the past several years (San Diego County Emergency Medical Services, 2015).

Another disposition the patient may choose is to be transported to a hospital by ambulance. Often the patient requests a specific hospital; but, in some cases, based upon their need, patients may be transported to specialty facilities such as a trauma center, stroke centers or cardiac treatment centers. Transportation destination decisions are made in accordance with local treatment and transport protocols and are done with the intent of reducing mortality and morbidity in patients suffering from these conditions (Ciesla et al., 2013; Gorelick, 2013; Mumma, Diercks, Wilson, & Holmes, 2015). What happens between the arrival of the first responders and the ambulance and the decision to transport is in part determined by the certification levels of the first responders.

Every emergency response follows a typical sequence (Bledsoe, Porter, & Cherry, 2007). Once an emergency is recognized or suspected someone makes notification to a local 911 center. The 911 center will dispatch resources based on the apparent needs of the incident, and upon arrival the responding personnel assume command of the incident (Carron et al., 2014). This approach holds true regardless of whether the emergency is a bank robbery, a structure fire or a heart attack. There are some guiding principals which all responders follow:

1. Do not become part of the emergency. This is best done by following the mantra “scene survey and scene safety” everytime dispatched to a request for help. In other words, while responding and upon arrival, the responder looks for clues which might indicate an immediate personal threat to the responder, their coworkers or the public (Bledsoe et al., 2007).

2. Perform a scene size-up and determine a need for additional resources. Although most medical emergencies are easily handled with few resources, in cases where there is entrapment, multiple patients or a specialized emergency, it is imperative the responder quickly recognizes this and requests the additional resources necessary to mitigate the situation. The need for responders to identify a shortage of resources or rapid incident escalation can be difficult or chaotic with limited available information or resources initially (Fan, French, Stading, & Bethke, 2015).
3. Establish command of the incident. In every scenario, regardless of its nature or scope, an incident command system is implemented (Carron et al., 2014). Sometimes the incident commander is determined based on responder seniority, local or state statute, certification level or sequence of arrival at the scene of the emergency (Bledsoe, Porter, & Cherry, 2007; Rimstad & Sollid, 2015). It is imperative that one person is identified as the final decision-maker, thereby reducing inefficiency, duplication of resources and establishing a chain-of-command for decision-making and communications (Bledsoe et al., 2007; Carron et al., 2014). Incident command is an important component of the emergency response that "in 2004 when the Department of Homeland Security rolled out NIMS (national incident management system) a mandate to implement the ICS in the on-scene response to all incidents was included" (Jensen & Waugh, 2014, p. 6).

4. Once the incident is established an assessment of the emergency occurs. In the case of a medical emergency, a comprehensive evaluation of the patient occurs. Information is gathered from the patient, family members, witnesses, other healthcare workers and those who might have information which might assist with determining the nature and acuity of the emergency which exists. Responders use a five-step problem-solving model similar to the FEMA model which amounts to an ongoing quality improvement process. According to FEMA's decision-making model (Federal Emergency Management Agency, 2005) the five steps are (a) identify the problem, (b) explore the alternatives, (c) select an alternative, (d) implement the solution, and (e) evaluate the situation. The cycle is continued until the emergency is resolved and FEMA (2005) stated, "each step can be completed quickly but every step must be considered" (p. 2.12). This decision-making process is described as "sequential sampling models" in which "people are assumed to gather information, piece by piece, until they have accrued enough evidence in favor of one or other alternative to justify that decision" (Zhang, Lee, Vandekerckhove, Maris, & Wagenmakers, 2014, p. 1).

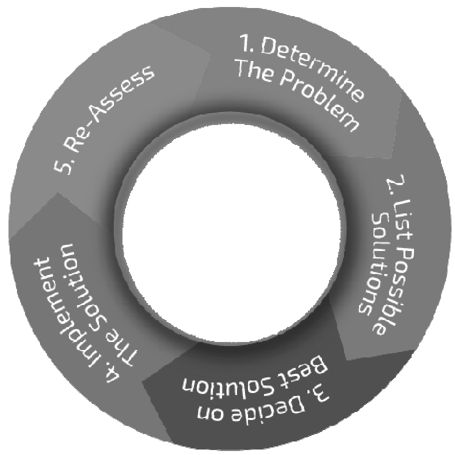

Figure 2. Decision making and problem solving. FEMA (2005). Emergency Management Institute, 2.12. Retrieved from https://training.fema.gov/emiweb/downloads/is241.pdf. Reprinted with permission.

5. In the 911 emergency medical services system, the decision of treatment is an important one. Responders must decide between doing nothing, providing BLS care, ALS care, a combination of both, non-emergent transport or immediate emergent transport. This is sometimes driven by protocol, local standards of care, the types of resources available or the certification levels of the responders on scene. Although infrequent, a danger with prehospital decision-making is making the wrong one, making a premature decision without all the necessary information due to pattern recognition, or making decisions without all the necessary information. In certain cases, once certain protocol criteria are met a decision is made

albeit without all the necessary information. This "diffusion model of sampling" states that once the established parameters of an incident are met the decision is made and no more information is gathered (Zhang et al., 2014). The timeliness and accuracy of decision-making in these situations are critical and the diffusion model of decision making focuses on a binomial approach when only two choices exist (Ratcliff & McKoon, 2008) and as highlighted above typically the decisions made by prehospital responders have many choices yet the timeliness and accuracy must be spot-on each time.

6. Once a treatment plan has been implemented the patient is typically transported to a local hospital for further evaluation and interventions. A substantial population of the patients encountered does not need transport to an emergency department. According to a 2013 study between 12.9% and 16.4% of patients transported by EMS to emergency departments could have had their care managed at an alternative health care facility such as an urgent care center or with their primary physician (Alpert, Morganti, Margolis, Wasserman, & Kellermann, 2013). Another percentage of the population seek no further medical attention at all and sign a medical release form. In a retrospective review of more than 74,000 emergency responses in Nova Scotia over the course of a year revealed 18.9% nontransport rate (Carrigan, Asada, Travers, Goldstein, & Carter, 2016) which includes aid-not-necessary, patient refusals, false alarms, and

patient’s whose medical condition did not warrant further care. In San Diego County, Moss et al. (1998) found a 7% rate of patients signing out AMA; yet, this number does not account for all the other reasons why patient may not be transported to the hospital. A 2003 study of frequency of prehospital AMAs in the State of Utah showed the frequency at 5.1% (Knight et al., 2003). Keene, Davis, and Brook (2015) found an 11.5% rate of non-transport in the Australian EMS system. The determination of whether the transport via a BLS or ALS ambulance is determined based on the resources on scene, the acuity of the patient, the patient complaint, interventions and anticipated needs during transport.

7. The final phase of an emergency medical response occurs at the hospital. This includes the patient turnover to the receiving medical staff and the crew returning the ambulance and its equipment to a state of readiness making the unit available for its next emergency response.

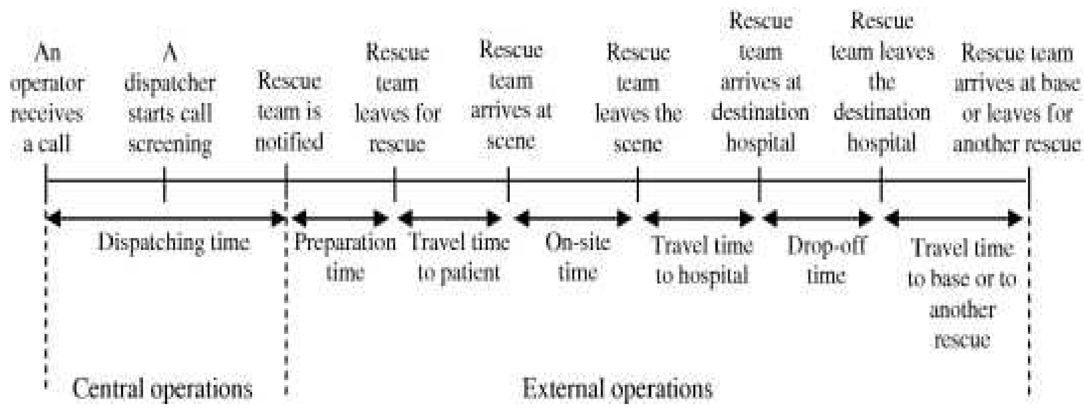

Figure 3. Typical EMS operations. Aboueljinane, L., Sahin, E., & Jemai, Z. (2013). A review on simulation models applied to emergency medical service operations. *Computers and Industrial Engineering, 66*(4), 734-750. doi:10.1016/j.cie.2013.09.017. Reprinted with permission.

Cushman (2016) wrote, “The entry of a patient into the emergency health care system brings with it a complex cascade of events, with a number of possible outcomes” (p. 82). Cushman described the emergency health care system as an input-throughput-output design and acknowledged the EMS system is subject to external variables such as ER over-crowding and a temporary surge in resource demands which can impact this design. There is no one predetermined outcome in an emergency response which confounds EMS managers as they anticipate needs or design EMS systems for the future which is illustrated below (Figure 4).

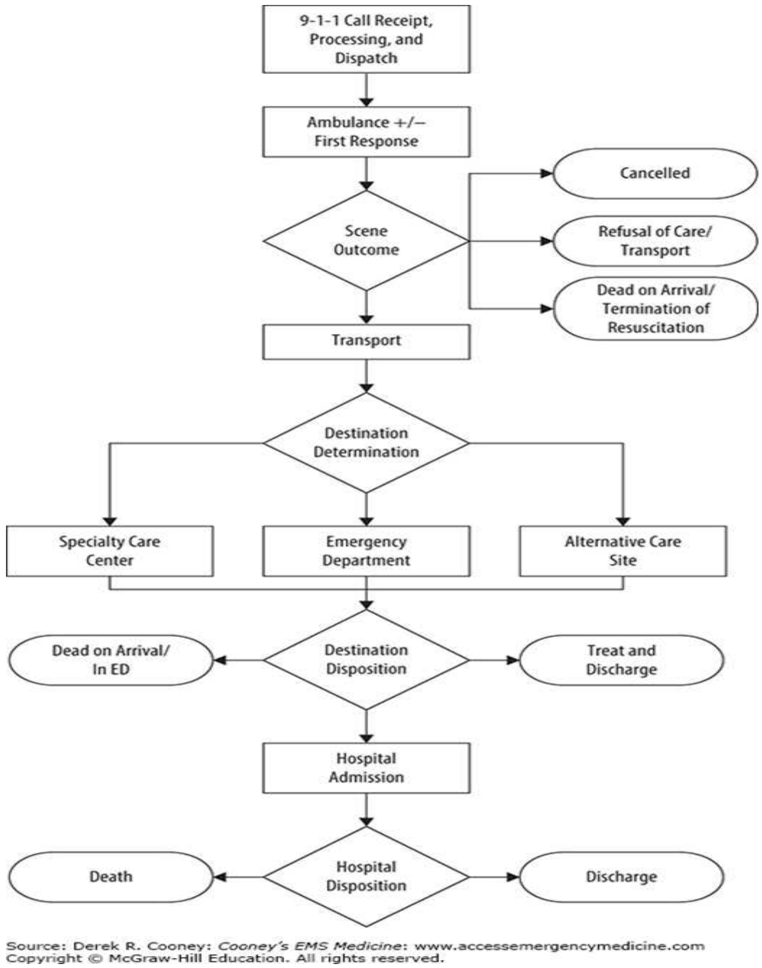

Figure 4. EMS System Design. Cushman, J. T. (2016). EMS system design. In D. Cooney, *EMS medicine* (pp. 81-88). New York, NY: McGraw-Hill Education. Reprinted with permission.

Time Saves Lives

The relationship between the certification level of responders and patient outcome often comes under question and is a part of the discussion when EMS systems are being developed or reviewed (Bakalos, et al., 2011; Morgenstern, Heitz, & Milne, 2017; Sanghavi, Jena, Newhouse, & Zaslavsky, 2015). According to the American Heart Association (as cited in Fonarow et al., 2013), time equals tissue when highlighting heart attacks or strokes. This is referred as the golden hour where the sooner a patient is treated for a suspected heart attack or stroke, the more likely the patient will recover with fewer long-term effects (Ebinger et al., 2014; Fassbender et al., 2013). However, there are some dissidents, suggesting the golden hour, the 60 minutes after a medical emergency or a traumatic injury occurs, are an arbitrary time-frame used as a marketing strategy. In the case of trauma injury, Rogers, Rittenhouse, and Gross (2015) attributed the golden hour to Cowley (1975) who argued that the first hour after an injury is the time that determines the survival chances of a person with a critical injury. The concept of the golden hour is believed to result in improvement of patient survival after suffering injuries on the battlefield (Kotwal et al., 2016; Little, 2010) and the need to facilitate similar results in the civilian world, or whether it was because of the implementation of triage and following Larrey's pursuit of getting the sickest treated sooner (Nestor, 2003), it remains the impetus remains unclear. While the idea of the golden hour is nebulous, Little (2010) instead embraced "the golden opportunity" which he defined as"providing the right care at the right place at the right time" (p. 8). Others postulated rapid recognition and transport of patients only benefits a subset of the population (Harmsen et al., 2015; Little, 2010) and EMS providers along with receiving hospitals should not expect that every patient is well served by a lights and siren approach every time a major trauma patient is encountered (Ross et al., 2015).

In medical emergencies time can matter but arguably, not in the speed in which a patient is transported to hospital but rather the time it takes to recognize an emergency condition exists, and when appropriate, interventions take place. When Cunningham, Mattu, O'Connor, and Brady (2012) examined OHCA cases, they found overwhelming evidence that early recognition and early initiation of CPR were the two most important variables in determining patient outcome. The longer chest compressions are sustained without interruption, the greater the odds of survival and "is associated with greater rates of ROSC" (Cunningham et al., 2012). In a 2015 study, Idris et al. found "the likelihood of survival to hospital discharge from OHCA was significantly greater with chest compression rates between 100 and 120 compressions/min" (p.847) further supporting the need for appropriate and sustained cardiac compressions. Elaborating on this assertion, Cheskes et al. (2015) found a relationship between the duration of a cardiac resuscitation and survival rates and stated:

> Perhaps chest compression fraction (CCF) is a time dependent variable in OHCA with a greater beneficial impact on survival during lengthy resuscitations requiring prolonged CPR to maintain cerebral and coronary perfusion. Shorter resuscitations where providers are performing multiple tasks including early defibrillation may achieve survival with paradoxically lower CCF due to multiple interruptions in CPR which often occur early in resuscitations. (p. 133)

Kimmel and Persse (2015) highlighted the importance of proper ambulance deployment and a tiered response where BLS can be started before ALS arrival (p. 2). An Australian study showed a benefit to patients who were treated by ACLS providers, but not necessarily by advanced interventions (Woodall, McCarthy, Johnston, Tippett, & Bonham, 2007). Kimmel and Persse wondered if this could be due to increased medical knowledge on the part of the advanced providers.

More important than quality cardiac compressions and resuscitative efforts is a layperson's early recognition that an individual is in cardiac arrest and in need of CPR (Koike et al., 2011; Nehme et al., 2013). In a multiyear retrospective study looking at out-of-hospital cardiac arrest patients in the state of North Carolina, researchers found 31.8% of patients who had bystander CPR (and by default, recognition of a cardiac arrest) survived their resuscitation with a good neurological outcome compared to a 15.2% survival for those patients who had not received CPR prior to EMS arrival (Hansen et al., 2015). Japanese researchers had comparable results, discovering bystander CPR more than doubled neurologically intact cardiac arrest survival from 4.1% to 8.4%; but, only 23% of the overall improvement in patient outcomes could be attributed to the bystander interventions (Nakahara et al., 2015). In cardiac arrest, there is convincing evidence of the value of the layperson (Park et al., 2017).

Myers et al. (2008) suggested there has been an over-emphasis on response times associated with paramedic ambulance transport and added:

> Now that basic life support providers and lay rescuers can provide rapid automated defibrillation as well as basic CPR, the relative importance of the ALS response-time interval has been challenged, both for cardiac arrest as well as for other clinical conditions. (p. 142)

Spaite et al. (2008) found no relationship between the transport interval and patient survival for those in cardiac arrest, supporting the argument that early recognition and intervention was more important than an early transport and were advocating that longer transports to specialized postresuscitation facilities improved long-term patient survival.

If there is little evidence to support the impact early ALS intervention has in this critical scenario one could conclude that the certification level of the first responder in an OHCA is not important. Cheskes et al. (2015) further argued that having early ALS intervention in OHCA may, in fact, be detrimental to long-term patient survival.

Minimal research exists on the impact first responders have on major trauma victims (MTV). Although the golden hour has long been touted as the standard for prehospital time with trauma patients (Newgard et al., 2010) most researchers focused on the importance of early recognition of potential serious injuries by patient complaint or obvious injuries, the mechanism of injury or considering special circumstances when assessing a patient (Yang, Kang, & Song, 2016; Schoell et al., 2017). While some would argue the golden hour is irrelevant and prehospital time does not affect outcome (Newgard et al., 2010), there were some serious challenges to this belief. Fleet and Poitras (2011) questioned the results of Newgard et al. (2010), stating that their study was unidimensional and left out a large segment of the patient population. Harmsen et al. (2015) concluded: “that longer on scene times in some trauma patients actually increased a patient’s odds for survival” (p. 608). Allowing first responders and transport crews to initiate certain treatment protocols, in turn, increased the patient’s chances for survival. This did not apply in every case and the authors were not advocating for intentionally delaying transport. Patients with obvious serious injuries do not need much triage; instead, those patients need to be transported to a receiving hospital equipped and staffed to receive MTV’s. The mechanism of injury (MOI) deals with how an injury occurred (Sarmiento, Eckstein, & Zambon, 2013; Sasser et al., 2009). How fast vehicles were traveling, how far did somebody fall, what type of explosion occurred, are all examples of MOI and can be used as determinants for classification as an MTV (Davidson et al., 2014; Patel & Sasser, 2014; San Diego County Paramedic Association, 2016). There are unique situations which might put certain patients at greater risk for more serious injury than the average person. For instance, those patients prescribed blood thinners, the elderly, pregnant women, and language barriers can interfere with a reliable assessment (San Diego County Paramedic Association, 2016). These are patients who meet the criteria for MTV designation (Bouzat et al., 2015; Shawhan et al., 2015); but, there is no clear argument to suggest first responder certification levels affect this decision-making process. Most prehospital trauma triage is intentionally designed for use by responders at any certification level (Nilsson, Åslund, Lampi, Nilsson, & Jonson, 2015; Sasser et al., 2009).

There are mixed opinions on the impact prehospital care has on emergency patients. Universally, it is accepted that bystander recognition of a medical emergency and their participation with rendering aid is key to better outcomes (Hansen et al., 2014; Hansen et al., 2015; Kragholm et al., 2017). However, there remains uncertainty about the efficacy of first responders. In cardiac arrest situations, early recognition of the patient condition, initiation of CPR and access to defibrillators has been shown as the most important criteria for determining patient outcomes (Kragholm et al., 2017). None of these interventions require a first responder, but instead a concerned and engaged layperson. In trauma, while it is universally recognized that the definitive care of a trauma center is what saves patients (Ashley et al., 2015; Ciesla et al., 2013), once again it is the recognition of a significant violent energy transfer, the presence of obvious injuries or the categorization of special patient populations which helps identify those patients most at risk. The evidence remains inconclusive and the questions to be answered by this paper may help demonstrate one point: knowing the certification level of a first responder is based on the level of training they have, and expanded knowledge may result in earlier recognition or heightened awareness of the dangers associated with major trauma victims which in turn can result in shorter scene times and quicker access to definitive care.

EMS System Impact

EMS managers and civic leaders have to be concerned about the medical impact their system has and its efficiency. The system leaders examine many metrics including response times, time on task (TOT), time it takes a unit to return to service, payor mix, reimbursement rates, frequency of skills used and certainly the medical care, and its impact on patient outcomes. In a 2016 study, Danish researchers identified nine different variables which included:

> Time stamps for emergency calls received at one of the five regional emergency medical coordination centers, dispatch of prehospital unit(s), arrival of first prehospital unit, arrival of first supplemental prehospital unit, and mission completion. Finally, professional level and type of the prehospital resource dispatched to an incident and end-of-mission status (mission completed by phone, on scene, or admission to hospital) are registered. (Christensen, Berlac, Nielsen, & Christensen, 2016, p. 669)

Medical Directors attain EMS system improvement through a quality assurance process which is designed to ensure appropriate system performance and to support continuous improvement in patient care (Bass, Lawner, Lee, & Nable, 2015). To maintain sustainability medical directors and clinical practitioners must work hand-in-hand with those involved in financials aspect of the EMS system. Economic challenges, increased demands for service, health-care reform, and patient satisfaction surveys are all variables which stakeholders must consider when examining their EMS system (Seals & Ngugi, 2014). When contemplating options decision-makers should use evidence-based practice (Jensen & Travers, 2016). Seals and Ngugi (2014) suggested a closer look at the 911 logs to see who was calling and why, and then determine what the community needs are.

The prehospital delivery system is dependent on funding from several primary sources. The largest is the federal government through Medicare and Medicaid (Buskirk, 2017), followed by private insurance carriers. According to Haslam (2015), more and more providers are struggling to make ends meet in the face of “steadily increasing business costs of providing emergency medical care, and the declining reimbursement funds from Medicare and Medicaid” (p. 2). According to the Office of the Inspector General of the United States, in 2005, patients and health-care providers spent more than 3 billion dollars on emergency and nonemergency prehospital medical transport (Institute of Medicine Committee on the Future of Emergency Care in the US Health System, 2007, p. 44).

In addition to the financial solvency of an EMS system, managers also focus on response times. First criticized in 2004 as having no clear definition, response time “has no universally accepted definition, and is used to measure an almost endless number of different intervals" (Salvucci, Kuehl, & Clawson, 2004, p. 88). Consider that every aspect of a call to 911 for emergency medical assistance can be evaluated; from the time it takes the 911 operator to answer the phone, to the time it takes the fire department and EMS personnel to be notified an emergency response exists, to how long it takes the responders to get in their vehicles and start driving. More commonly regarded measurement tools are how long it takes an ambulance or responder to arrive on scene from when the 911 call was first made (National Fire Protection Association, 2010), and how long it takes to get a heart attack or major trauma patient to the appropriate facility (Kircher, Kreitzer, & Adeoye, 2016). In one study, researchers found great variability in the amount of time it takes a paramedic to get from their ambulance to the patient's side, with times ranging from 0.67-4.13 minutes (Campbell, Gratton, Salomone III, & Watson, 1993) showing how detailed, while undefined, the term *response time* can be. While the importance of each of these times is subject to debate when taking into consideration other quality indicators Togher et al. (2015) found these items were found to be abstract when compared to concrete variables like response time.

What EMS managers want is a system which meets the needs of its citizens through timely response and quality (health)care. As far back as 1980, EMS managers recognized that measuring the system was important. Stout (1980) identified "response time performance, clinical sophistication, rate structure and per capita local subsidy" (p. 23) as metrics for publicly funded EMS systems. Several years later, Stout introduced his

Standards of Excellence Scoresheet (Figure 5) which is used in some variation to this very day (Stout, 1983; p. 85).

Stouts Standards of Excellence

	Possible Score
1. Clinical Performance	15
2. Medical Accountability	9
3. Dispatching and System Status Management	15
4. Access, First Responder and Citizen CPR	15
5. Disaster Capability	8
6. Personnel Management Practices	10
7. Stability, Reliability and Fail Safes	7
8. Pricing Policies, Billing and Collection Practices	5
9. Response Time Performance	15
10. Public Accountability	4
	Total Score 100

Figure 5. Jack Stout's 10 standards of excellence: Measuring your system. Stout, J. (1983, January). Jack Stout's 10 standards of excellence: Measuring your system. *Journal of Emergency Medical Services*, 84-91. Retrieved from http://www.jems.com/welcome.html?destination=/index.html. Reprinted with permission.

One important variable to meeting these expectations is the amount of time an ambulance is committed to an emergency response. The longer an ambulance is unavailable for a response the increased likelihood someone else in need may not get the services they need on time. Research may answer how first responders can impact the amount of time an ambulance spends on the scene of an emergency. If scene time is shortened, then one would expect the ambulance would arrive at the hospital sooner and in turn available for another emergency response sooner.

Summary

Most researchers recognized first responders come with different levels of certification. Similarly, EMS system managers also recognize and support that with each advancing level of certification comes increased education, scope of practice and ability to practice medicine. Whereas basic life support responders are limited to basic skills as a part of their scope of practice, their ability to positively impact patient outcomes hinges on their ability to focus on two essential tasks: the early identification of who might be critically ill or not, and the early implementation of basic skills, such as CPR and the application of the AED. Beyond this it is uncertain what positive impact they have shortening the scene times of a transporting paramedic unit.

For those first responders who are advanced life support providers, there remain numerous unanswered questions about what impact they have on patient outcomes. When considering the patient in cardiac arrest, early recognition of the patient condition and establishing cardiopulmonary resuscitation quickly along with accessing an automatic external defibrillator are the two universally accepted tasks which most positively affect the patient outcome. Researchers have recommended greater emphasis on quality and sustained CPR in the initial phases of the patient encounter and intentionally delaying advanced life support interventions. For those patients who are major trauma victims it once again falls on the first responder to use established trauma triage criteria to make an early determination of the patient's disposition; yet, there is no evidence to suggest that being an advanced life support provider makes a difference in patient outcomes. There are conflicting studies advocating for BLS responders and others supporting ALS responders (Eckstein, 2011; Eisenberg & Bissell, 2005; Sanghavi, Jena, Newhouse, & Zaslavsky, 2015). If the medical experts cannot agree, then it is incumbent on EMS system designers and administrators to examine other criteria which may impact their decisions when developing or managing an EMS system.

There is peripheral evidence that an emergency response with an ALS transport ambulance, in addition to a paramedic first responder, may lengthen the total patient encounter time. There is no evidence to suggest how long a first responder must be on scene before the arrival of the transport ambulance to shorten the scene time or over-all patient encounter time. While having this information may be reflected in patient outcomes the purpose of this paper is to better understand how the variable of time impacts an EMS system. This includes the certification levels of first responders, the time an ALS ambulance is on scene and possibly identifying whether there is a beneficial relationship in the amount of time a first responder spends with a patient prior to the arrival of the ambulance.

This retrospective study involved comparing an existing EMS system based on secondary data analysis which provided the statistical analysis of numerical data necessary to answer the research questions. Chapter 3 will include a discussion of the research methodology, study population, limitations and ethical concerns associated with examining the questions raised by the gaps in literature identified in this chapter. This study may provide practitioners and EMS leaders with more information as they design and examine their EMS systems. Chapter 3 included details of the steps necessary to obtain valid and reliable information for that purpose.

Chapter 3: Research Method

Introduction

The purpose of this study was to examine the relationship between the certification levels of first responders and how they might impact the amount of time an ambulance remains at the scene of a medical emergency. Currently, there exists very little research on this topic and by adding to this body of knowledge EMS administrators and medical directors might be able to deploy resources that better serve the needs of their citizens in a more efficient manner.

In Chapter 2, the literature search revealed the body of research associated with the impact that time has on emergency medical responses and the care provided by first responders. This included exposing controversies on the role first responders have when caring for patients; but, it also exposed the lack of depth or breadth in researchers understanding of the relationship between first responders and transporting ambulances.

In this chapter, the research design and methodologies will be discussed. The rationale for the research design along with the limitations of using archival data will be discussed. Finally, any potential threats to the research validity will be identified, and all the ethical implications of this research acknowledged. At the conclusion of Chapter 3, a summary will be provided, and introduction to Chapter 4 will be included.

Research Design and Rationale

This quantitative study was designed to answer the following questions:

RQ1. What is the impact of first responder certification level (BLS vs. ALS) on the amount of time the transport ambulance spends on the scene when first responders are on scene before the transport ambulance?

$H_0$1: First responder certification level does not impact scene times of transport ambulances.

H_a1: First responder certification level does impact the scene times of transport ambulances.

RQ2. What is the difference in scene times between when first responders are on scene before the transport ambulance and when they are on scene after the transport ambulance?

$H_0$2: There is no difference in scene times between when first responders are on scene before the transport ambulance and when they are on scene after the transport ambulance.

H_a2: There is a difference in scene times between when first responders are on scene before the transport ambulance and when they on scene after the transport ambulance.

RQ3. What is the relationship between the first responder arrival time in relation to the transport ambulance arrival time and the amount of time the transport ambulance spends on the scene?

$H_0$3: There is no relationship between the first responder arrival time in relation to the transport ambulance arrival time and the amount of time the transport ambulance spends on scene.

H_a3: There is a relationship between the first responder arrival time in relation to the transport ambulance arrival time and the amount of time the transport ambulance spends on the scene.

Through a retrospective analysis of the publicly available data, I examined each of the research questions in detail and then applied the findings to the research questions. The study variables focused on two major components: time and responder certification levels. Conclusions were made based on the data analysis, which resulted in the acceptance or rejection of the study hypotheses.

In EMS, time is a constant measurement, with many variables and some exceptions. According to the National Fire Protection Agency (2010), first responders who are certified as BLS or higher should have a turn-out time of no more than 60 seconds, followed by a response time of no more than 240 seconds (p. 1710-7). In situations where the first responders are BLS certified providers and meet the NFPA standard, the NFPA has determined that an ALS transport ambulance should arrive within 480 seconds from initial dispatch or no more than 240 seconds after the arrival of the first responder (National Fire Protection Association, 2010). There are many other variables which are considered when measuring the times of an emergency medical response. In their breakdown of an emergency response, Aboueljinane et al. (2013) identified six key variables which are standard to all emergency medical responses.

1. Prep Time
2. Travel time to the patient
3. On-site time

4. Transport to hospital time

5. Drop off time

6. Return to base or begin another emergency response time

Cushman (2016) explained the sequencing of an emergency medical response. Cushman took it a step further and introduced the many outcomes which may occur, each which are associated with different amounts of time. For this study the only variables involving time which will be examined are:

1. Time of call (TOC)

2. Arrival time of the first responder

3. Arrival time of the transporting ALS ambulance

4. The time when the ambulance initiates transport to the hospital

Times are measured using a centralized time-clock ensuring accuracy and consistency of the times regardless of the responder or agency. There are several moderating variables involving time which Baron and Kenny (1986) defined as "a quantitative variable that affects the direction and/or strength of the relation between an independent or predictor variable and a dependent or criterion variable" (p. 1174). These would include emergency responses which may have unavoidable delays, directives ordering the responders to not respond completely to the scene or situations involving rescue or multiple patients. These instances would adversely impact the studied times and skew the data. In addition, responses involving multiple patients, delayed transport because of patient access issues or extrication were also eliminated from the dataset. Another set of data points which were eliminated are any responses where the first responders or the transporting ambulance fail to update their unit status via their onboard mobile data terminal or by notifying the emergency dispatch center. This was necessary to ensure that all the unit status times were accurately documented and measured by the same time-clock. Finally, during an emergency response when either the ambulance or the fire department first responders are ordered to cancel prior to their arrival or change their response from Code 3 (lights and siren) to Code 2 (no lights and siren) were eliminated from the study.

The other variable which needed to be monitored was the certification status of the responders. Because I examined the relationship between the certification levels of the first responder and its impact on the scene times of the transporting ambulance, every response needed to have verification of the certification levels of the first responder crew. This was documented by examining the daily crew roster which highlights the crew assignments and their certification levels. The crew rosters of the transporting ambulance were also verified to ensure that every transporting ambulance is staffed by a paramedic. Those ambulances which are staffed by BLS personnel were eliminated from the study, and any instances where the first responder certification levels could not be verified were also documented but eliminated from the study. Because this was an examination of retrospective data over a fixed period, it was not anticipated that there would be any time or resource constraints in this study.

There has been a number of researchers who have measured the impact of time on the different phases of an emergency response (Burke et al., 2013; Carr, Caplan, Pryor, & Branas, 2006; McCoy, Menchine, Sampson, Anderson, & Kahn, 2013; Patel, Waters, Blanchard, Doig, & Ghali, 2012; Takahashi et al., 2011; Weiss, Fullerson, Oglesbee, Duerden, & Froman, 2013) as well as the impact that the level of responder has on patient conditions and outcomes (Bagher et al., 2017; Blackwell & Kaufman, 2002; Blanchard et al., 2012; Cheskes et al., 2015; Kimmel & Persse, 2015; Tsuchida & Meurer, 2017; Rappold et al., 2015). The design choice for this study expands existing knowledge in the subject area by using the same or similar variables found in earlier studies. This ensures a continued conversation by using an "apples to apples" comparison between the studies.

Population

The purpose of this study was to identify whether there is a difference in the time a transporting ambulance must remain on scene when comparing the certification level of the first responders. The study population was emergency responses which occurred from two 30-day periods during March in 2013 and 2014 within the City of Chula Vista. Only the four fire engines assigned to the central core of the city will be studied. This includes Engines 51, 52, 54, and 55. They were selected by the fire department to be the first four engines to become ALS capable, and did so beginning July 1, 2013.

According to the publicly available data provided by the San Diego Association of Governments and the City of Chula Vista, the city currently has a population of approximately 267,000 residents (City of Chula Vista, 2017; Chula Vista Fire Department, 2017). Located between the San Diego Bay to the west and Otay Mountain to the east, it has the City of San Diego bordering its northern and southern regions, and it is just four miles north of the U.S.-Mexican border. While it is primarily a residential community with many of its occupants heading north during the workday, the city has seen tremendous growth making it the second largest city in the county (San Diego Association of Governments, 2011). In its last report, SANDAG (2011) reported the median income was $66, 900 and 65% of the population identified themselves as being Hispanic. It is estimated that by 2050 the city will see an 83% population growth (San Diego Association of Governments, 2011).

The City of Chula Vista is served by the Chula Vista Fire Department which has been existence since 1921 and includes more than 140 paid personnel. In the most recent survey year, 2016, the fire department responded to 19,896 requests for help of which 13,573 were for reported medical emergencies (Chula Vista Fire Department, 2017). During the initial study year (2013), there were 15,742 reported emergencies of which 10, 327 were reported medical emergencies. There are nine fire stations scattered throughout the city, which includes eight fire engines, two truck companies, one Urban Search & Rescue (USAR), and two Battalion Chiefs. In 2013, the fire department did not provide advanced life support first responders and only provided BLS services. Beginning in July, 2013, the Chula Vista Fire Department began the process of adding advanced life support capability to its first responders, and by 2015 all of the fire engines were ALS capable, and as of 2016, every responding vehicle is staffed by a paramedic (Chula Vista Fire Department, 2017).

Every responding vehicle includes a fire captain who is the highest ranking person on the vehicle and when necessary assumes command of an incident where an incident command structure (ICS) must be implemented. In addition to the captain, there is a fire engineer whose primary responsibility is driving the apparatus and operating its pump when attacking a fire. Finally, there is also a fire-fighter who is responsible for basic firefighting duties, patient assessment and following the directions of the fire captain. In the Chula Vista Fire Department, it is typically the firefighter who functions as the paramedic; but, any of the personnel on the fire engine may be the designated paramedic of record on a given shift. If a responder is not a paramedic, they must be a certified EMT-Basic.

AMR-San Diego has been the exclusive contracted provider of paramedic ambulance transport for the City of Chula Vista since 1979. At the beginning of the contract, the ambulances would sometime respond without a first responder and carried extra staff to supplement the paramedic crew. The fire department would only respond to motor vehicle crashes and other rescues; but, once the fire department personnel became certified as EMT-Basics, they began responding to all medical emergencies working in partnership with the ambulance paramedics. As BLS responders, Chula Vista fire-fighters would initiate an assessment, provide basic first aid, begin CPR and take vital signs before the arrival of the ambulance.

Deployed throughout Chula Vista, AMR has five ALS ambulances which respond to emergencies in the city; but, frequently there are more ambulances staged in the city as response volume demands change throughout the day. During the study period, every ALS ambulance was staffed with two fully licensed paramedics who work as partners in caring for patients. They share duties with the assessment, treatment, and transport of all patients and both have the same capabilities as providers.

When an emergency occurs, someone calls 911. In the City of Chula Vista, all 911 calls are initially answered by the Chula Vista Police Department (City of Chula Vista, 2018) who then screens the call to determine the nature of the emergency. When it is determined that a medical emergency exists the call is automatically transferred to the fire department. Information such as the incident location, exact nature of the emergency and any noteworthy information is obtained while simultaneously being input into a computer. When the necessary information is obtained, it is automatically electronically transferred from the fire department to the AMR dispatch center. Both the fire department and AMR simultaneously dispatch their resources (fire engine and ambulance), and an emergency response is generated.

The target population of this study was 911 requests for medical emergencies which occur during the two 30-day study periods and do not meet exclusion criteria. While the volume of requests was expected to exceed those required through the sampling procedures this excess was expected to bring added validity to the study and potentially bring clarity to any differences which may exist between the two study periods.

Sampling and Sampling Procedures

A series of *t* tests were conducted looking for differences between the variables which will help answer the question of whether there is an effect impacting the null hypothesis. Sample size was determined by a priori which considers the power and effect size. Farrokhyer et al. (2013) explained the importance of a priori sample size by stating "sample size calculation can reduce the risk of an underpowered (false-negative) result" (p. 207). They continued by explaining possible untoward outcomes in a study as:

> 1. The study was appropriately powered, but there truly was no significant difference. 2. The study was appropriately powered but owing to chance alone a significant difference was not observed. 3. There truly was an important difference, but the study was underpowered (small sample size) to detect that difference. 4. One or more aspects of the trial was biased in favor of the control group. (Farrokhyar et al., 2013, p. 207)

Using GPower to calculate sample size, a *t* test examining the difference between two independent means was selected. A comparison of the impact that two treatments have on the null hypothesis was done; yet, they were never compared to one another, making them independent variables. When determining sample size, it is necessary to identify the correct statistical power, which according to Anderson, Kelley, and Maxwell (2017) they defined as the "probability of rejecting the null hypothesis of no effect when the true effect is nonnull in the population" (p. 1547). For this study, the power was determined to be 0.8 (1-β err prob) with a calculated sample size of 64 for each group.

Archival Data

Because I used archival data, the required information had already been collected, unbeknownst to the participants in the study. This had the initial benefit of eliminating the risk of altered behavior or subconscious micro changes in the first responders' performance while engaged in a medical emergency. When a participant has an awareness of their participation in an observational study, it can change the way they behave, risking the Hawthorne Effect (Campbell, Maxey, & Watson, 1995). By eliminating the Hawthorne Effect, this adds validity to the study because the entire data analysis is predicated on the normal first responder performance.

Data are stored on a secured central database within the regional 911 dispatch center. A data request was submitted requesting information from Period A and Period B, which provided all the information necessary to examine the relationship between first responder certification levels and the scene times of the transport paramedic ambulance. Conceptual approval has been obtained from the Fire Chief for the Chula Vista Fire Department as well as the Regional Vice-President for AMR to allow access to the data. Confidentiality statements and an agreement to adhere to all relevant HIPAA (Health Insurance Portability and Accountability Act of 1996) were completed before data access.

Previously, representatives from the Chula Vista Fire Department and AMR agreed to provide a report which contains all the data variables. Both agencies signed data use agreements permitting the use of the study data in the research project described in this publication (see Appendices A and B). Because both agencies have linked CADs, a single report provided all the necessary information. The representatives agreed to review and verify the accuracy of the data prior to its release.

Threats to Validity

The greatest risks to the validity of this study was in two areas. The first was the reliability of the response, at scene and transport times of the first responders. The second concern was an insufficient sample size. The TOC is computer generated when a 911 call is received at the regional 911 call center. All subsequent times are manually controlled by the responders. Crews use an MDT which has many status buttons which can indicate when a crew is responding, at scene or available. Ambulances also have additional statuses which reflect the transport of a patient. This includes a status change when enroute to the hospital, arrived at the hospital, and available from their transport.

In some advanced public safety systems, the MDT will automatically change a responder's status from "enroute" to "at scene" based on GPS coordinates and the movement of the apparatus; but, most systems still rely on the responder to manually change their status on the MDT. This creates the first potential threat to the validity of the study; the accuracy of the status change times.

Responders are expected to maintain situational awareness and promptly update their status via their MDT as the situation changes. Responders may become distracted, forget or simply not make their status change promptly which can affect the validity of the data collection in this study. An example would be of an ambulance initiating transport of a patient to the hospital, but the driver is focused on driving Code 3 or the patient care occurring in the back of the ambulance, and they fail to make the appropriate status change on their MDT. Another would be a fire engine arriving on the scene of a traffic accident where there is considerable debris on the roadway requiring the apparatus to slowly work its way to the actual incident. While the apparatus has arrived at the scene, the responder does not press the "at scene" button on their MDT until the wheels come to a stop. This may reflect in what appears to be a shorter at scene time before the arrival of the ambulance and impact the amount of time the ambulance must remain at the scene.

When a responder does not change their status, it becomes incumbent on the dispatchers in the 911 call center to make the necessary changes. All emergency response vehicles in the City of Chula Vista vehicles have vehicle tracking systems embedded with their MDT's allowing the dispatcher to follow the responders on a computer map in real time. The same is true for the AMR ambulances assigned to the city. In addition, there are automated alerts which notify the dispatcher when a unit has been in the "responding" status for too long, on scene for an extended period or if their status is uncertain. Each of these fail-safes allows the dispatcher to change the status of the responders in real-time.

In every incident where the response time exceeds the standards set by NFPA 1710 (National Fire Protection Association, 2010) the response were examined to ensure the validity of the response times. In an incident when there is a failure by the first responders or the ambulance personnel to maintain accurate status changes the incident was removed from the data pool and not included in the study.

The second threat to the validity of the study was insufficient data. Response times, scene times, and the transport times were averaged for the 30-day period. Anomalies, where there is an extraordinarily long response or scene time, can skew the data resulting in an average from one of the sample groups which truly does not reflect the day-to-day performance of the responders. In addition, there was no way to control for extraordinary times between the sample groups if by happenstance one of the sample groups has an anomaly; yet, the other does not. According to Farrokhyar et al. (2013), when one of the factors is biased it can result in an "untoward outcome" (p.207).

In each of the sample groups, a large enough study population helped absorb the impact that any emergency responses where an unusual amount of time was spent either in the response or the scene times. For this study, in each incident when an extraordinary amount of time is spent, the response was examined for inclusion. There are circumstances when a response would need to be excluded from the data set. Examples include responses where the incident location is updated during the response (e.g., the initial response is for 300 West H Street and the crews are updated that the true location is 300 East H Street, the opposite direction), or a large complex where although the crews are on site, they are not with the patient for several more minutes (e.g. a large shopping mall). Both of these examples could result in longer-than-normal responses yet were beyond the control of the responders. If a response was excluded from the sample population, the response was still documented and an explanation for its exclusion was documented.

Ethical Procedures

Representatives from the Chula Vista Fire Department and AMR gave verbal agreement to provide access to the data required for this study. Written agreements were obtained from both participants using the Walden Data Use Agreement as well the Walden Confidentiality Agreement and were included in the IRB application.

Archival data obtained from the two participating agencies included incident location and the nature of the incident. For this study, there was no indication to obtain patient-specific information such as age, gender or medical history. To further sanitize the data, once the incident location had been verified, it was amended to a more generic location. An incident located at 1234 Main Street would be documented as 1200 Main Street, and a dispatch emergency for a reported 65-year-old male with chest pain would be recorded as “chest pain” without any further identifiers.

All the data obtained for this study will be stored on my personal computer. The computer is password-protected, and the archival data obtained will be stored in a password protected file which can be accessed only by me. No other individual or organization will have access to the information. The original unsanitized information will be stored until this dissertation has been accepted and approved for publication. At that time, there will be no further need for the unsanitized information and subsequently will be deleted from my computer. Written documentation was provided to both the CVFD and AMR notifying them that the original archival data had been destroyed and only the generic information previously described will remain.

I would like to disclose that I worked for AMR from 1981-2015 as an ALS paramedic working on an ambulance within the local 911 system. It would be impossible to estimate how many emergency incidents I responded to in the City of Chula Vista; but, it would be fair to say it would number in the thousands. Although still employed by AMR during the proposed study periods, I was assigned to work in another part of the county and did not participate in any of the responses which will be included in the population datasets. At no time was the proposed study disclosed to the first responders working for the Chula Vista Fire Department or those working for AMR thereby eliminating the threat of creating a Hawthorne Effect (Campbell, Maxey, & Watson, 1995).

Although I enjoy a close collegial relationship with representatives from the Chula Vista Fire Department and AMR, neither agency is providing financial support or underwriting this study in any way. Both agencies have asked for a copy of the final work product once approved and accepted; but, no other inducements or conditions have been placed on their participation or expected outcomes. I am not receiving any financial support to produce this research.

Summary

Using archival data two independent data sets were compared to a control group looking for differences in their means. Using the statistical program GPower, a sample size of 64 participants each has been calculated for both sets of data. There was scrutiny of the raw data before the final analysis to ensure its validity and to identify any outliers which may skew the data.

Chapter 4 is a report of the data collected from both participating agencies. The data will be examined for accuracy, completeness, and to identify any information which may threaten the validity of the study. Using statistical analysis, the data will then be evaluated to ascertain how it helps answer the research questions and validate the various hypothesis.

Chapter 4: Results

The purpose of this study was to answer these research questions:

RQ1. What is the impact of first responder certification level (BLS vs. ALS) on the amount of time the transport ambulance spends on the scene when first responders are on scene before the transport ambulance?

$H_0$1: First responder certification level does not impact scene times of transport ambulances.

H_a1: First responder certification level does impact the scene times of transport ambulances.

RQ2. What is the difference in scene times between when first responders are on scene before the transport ambulance and when they are on scene after the transport ambulance?

$H_0$2: There is no difference in scene times between when first responders are on scene before the transport ambulance and when they are on scene after the transport ambulance.

H_a2: There is a difference in scene times between when first responders are on scene before the transport ambulance and when they on scene after the transport ambulance.

RQ3. What is the relationship between the first responder arrival time in relation to the transport ambulance arrival time and the amount of time the transport ambulance spends on the scene?

$H_0$3: There is no relationship between the first responder arrival time in relation to the transport ambulance arrival time and the amount of time the transport ambulance spends on scene.

H_a3: There is a relationship between the first responder arrival time in relation to the transport ambulance arrival time and the amount of time the transport ambulance spends on the scene.

This chapter includes a discussion of the steps taken to secure the data and ensure its accuracy followed by the presentation of the results of the study. A summary will provide answers to the research questions and a transition will introduce the reader to the prescriptive material in Chapter 5.

Data Collection

This was a retrospective study involving emergency medical responses which had been processed by a 911 call center during the years of 2013 and 2014. The data used for this study had been collected several years before the development of this research project and stored in a central database. Using retrospective data helped ensure there would be no effect on the study data due to subconscious changes in behavior on the part of the emergency responders due to their participation in a study (Campbell, Maxey, & Watson, 1995). Obtaining the required data from the 911 center required seeking formal approval from the City of Chula Vista Fire Department (CVFD), and AMR. The data use agreements are in Appendix A and Appendix B.

The data used in this study consisted of all the emergency medical responses during March 2013, and during March 2014, in the City of Chula Vista. The data provided included 100% of the responses, and it was left to the me as the researcher to determine which of these responses met the criteria for inclusion in the study. There were no unexpected discrepancies between the data collected and what had been proposed in Chapter 3. In every scenario, the data collected far exceeded the sample size previously determined through the G*Power program.

The City of Chula Vista Fire Department reported a total of 605 emergency medical responses during March 2013. In the same month of 2014, they reported 613 emergency medical responses. A total of 429 responses for 2013, and 423 responses from 2014, were acceptable for the study.

Table 1

Raw Data and Data Analyzed

Raw Data		Data Analyzed	
3/13	605	3/13	429
3/14	613	3/14	423

There were many reasons why some responses were not included in the study. This included responses when the fire department first responders were recalled before arrival, when they had difficulty locating the emergency scene thus delaying their response, or when the response times could not be verified. A complete list of “run exclusion codes” can be found in Table 2.

AMR reported 562 emergency medical responses during March 2013, and 559 responses during March 2014. Because this study involved only those first responders who were advanced life support trained, responses that did not include the appropriately certified first responder were eliminated from the study.

Table 2

Run Exclusion Codes

1	Cancelled prior to arrival
2	Response downgraded to BLS prior to arrival
3	Cancelled on arrival; no patient contact
4	Pt encountered, non-transport
5	Engine reassignment during initial response
6	Not one of the study engines
8	Unable to locate incident/patient
9	Stage prior to patient contact
10	Patient access delays (e.g. shopping center, large complex medical facility, locked house)
11	Level 4 Response
12	No documented "at scene" either via MDT or verbal communication
13	Any "at scene" which required dispatcher to place unit at scene
14	Any incidents with incomplete or unverifiable data
15	Multiple patients or units
16	Vehicle Rescue

Before July 1, 2013, the Chula Vista Fire Department only provided BLS first responder services, but after that date, they began to integrate ALS personnel onto their first responder vehicles. Being an ALS provider enabled the first responders to conduct full cardiac assessments, apply advanced airway skills, and administer medications (Bledsoe, Porter, & Cherry, 2007). Being one of the last cities to integrate ALS services in San Diego County provided the opportunity to compare and contrast how first responders impacted the transport ambulance scene times as both a BLS provider and as an ALS provider. Selecting the same month in successive years provided a fair comparison of emergency responses in the same district during the same season, with the same fire department and the same transport ambulance service. Although the volume of emergency responses may vary from day to day and sometimes from season to season, this comparison best represents emergency medical responses within the City of Chula Vista in any given month.

Results

Research Question 1

RQ1. What is the impact of first responder certification level (BLS vs. ALS) on the amount of time the transport ambulance spends on the scene when first responders are on scene before the transport ambulance?

$H_0$1: First responder certification level does not impact scene times of transport ambulances.

H_a1: First responder certification level does impact the scene times of transport ambulances.

This question was a comparison of the means between two independent variables. The first variable was those responses with BLS first responders and the second variable was those responses with ALS first responders. This was easily accomplished by comparing the mean transport ambulance scene time (i.e., how long a transport ambulance remained on the scene) in 2013 (had only BLS first responders) to the mean transport ambulance scene time in 2014 (which had only ALS first responders). As shown in Table 3, in 2013 the average scene time for the transport ambulance was 1017.90 seconds (16:58 minutes) with BLS first responders as compared to an average scene time for the transport ambulance of 889.79 seconds (14:50 minutes) in 2014 with ALS first responders.

Table 3

Summary t *Test*

	N	Mean	Std. Deviation	Std. Error of Mean
BLS First Responder (2013)	308	1017.900	422.063	24.049
ALS First Responder (2014)	376	889.795	362.644	18.702

Note: Mean = Average Ambulance Scene Time in seconds

Table 4

Independent Samples Test

	Mean Difference	Std. Error Difference	*t*	*df*	Sig. (2-tailed)
Equal variances not assumed	128.105	30.465	4.205	608.425	.000

In this case, the null hypothesis is rejected because the *p*-value of the two-tailed *t* test of the difference in the two independent sample means (p=.000) is less than the level of significance (.05). Thus, the alternative (H_a1) is accepted, that the "first responder certification level does impact the scene times of transport ambulances." Based on the much lower average scene time in 2014 versus 2013 (i.e., 2.08 minutes), ALS certified first responders have a significant impact on transport ambulance scene times in comparison to BLS certified first responders.

The practical implications of reducing the transport ambulance scene time are positive and could result in reduced mortality or morbidity in patients suffering from heart attacks, strokes or major trauma (DeRuyter et al., 2017; Esmaeiliranjbar, Mayel, Movahedi, Emaeiliranjbar, & Mirafzal, 2016; Martinell et al., 2017; Thompson et al., 2017).

Research Question 2

RQ2. What is the difference in scene times between when first responders are on scene before the transport ambulance and when they are on scene after the transport ambulance?

$H_0$2: There is no difference in scene times between when first responders are on scene before the transport ambulance and when they are on scene after the transport ambulance.

H_a2: There is a difference in scene times between when first responders are on scene before the transport ambulance and when they on scene after the transport ambulance.

This question is also a comparison of the means between two independent variables. The first variable is when the first responders arrive at the scene of a medical emergency before the transport ambulance and the second is those medical emergencies where the first responders arrive at the scene after the transport ambulance. This analysis was done for both 2013 and 2014, which also demonstrated whether a difference in ambulance scene times exists between the two certification levels held by first responders. Research Question 1 included all emergency medical responses where there was a first responder on scene prior to the arrival of the transport ambulance, but in this case, the question was whether there is a difference in the scene times of the transport ambulance if there are no first responders or the transport ambulance does not get the benefit of “first” responders because the first responder arrived simultaneously or after the ambulance.

As shown in Table 5, in 2013 when BLS first responders were at the scene of the medical emergency before the transport ambulance, the average scene time for the ambulance was 1021.86 seconds (17:04 minutes); but, when the first responders arrived after the transport ambulance the average scene time for the ambulance was 1033.74 seconds (17:14 minutes). This represents an additional 10 seconds the ambulance was on scene when the BLS first responders arrived after the ambulance and raises the question whether BLS first responders impact the ambulance scene time. A comparison of the two independent sample means was then conducted.

Table 5

Summary 2013 t *Test*

	N	Mean	Std. Deviation	Std. Error Mean
FR_First_AMB_Scene_Time_2013	310	1021.86	422.495	23.996
AMB_First_AMB_Scene_Time_2013	99	1033.74	356.626	35.842

Note: Ambulance Scene Time in seconds

Table 6

Independent Samples Test

	Mean Difference	Std. Error Difference	*t*	*df*	Sig. (2-tailed)
Equal variances not assumed	-11.880	43.133	-.275	193.228	.783

In this case, the null hypothesis is not rejected because the *p*-value of the two-tailed *t* test of the difference in the two independent sample means (*p*=.783) is greater than the level of significance (.05). Thus, "There is no difference in scene times between when first responders are on scene before the transport ambulance and when they are on scene after the transport ambulance" when the first responders are BLS certified.

The same tests were performed for those incidents comparing when the first responders arrived first to those incidents when the transport ambulance arrived at the scene of the emergency before the first responders during 2014. As shown in Table 7, for responses when the first responders were at the scene of the medical emergency before the transport ambulance the average scene time for the ambulance was 894.24 seconds (14:54 minutes), but when the first responders arrived after the transport ambulance the average scene time for the ambulance was 1112.06 seconds (18:32 minutes).

Table 7

Summary 2014 t *Test*

	N	Mean	Std. Deviation	Std. Error Mean
FR_First_AMB_Scene_Time_2014	376	894.24	376.043	19.393
AMB_First_AMB_Scene_Time_2014	31	1112.06	366.543	65.833

Note: Ambulance Scene Time in seconds

A *t* test which compared the two independent sample means of the data was conducted.

Table 8

Independent Samples Test

	Mean Difference	Std. Error Difference	*t*	*df*	Sig. (2-tailed)
Equal variances not assumed	-217.820	68.630	-3.174	35.411	.003

In this case, the null hypothesis is rejected because the *p*-value of the two-tailed *t* test of the difference in the two independent sample means (p=.003) is less than the level of significance (.05). Thus, the alternative (H_a1) is accepted, that "there is a difference in scene times between when first responders are on scene before the transport ambulance and when they on scene after the transport ambulance" of 3:38 minutes on average when the first responders are ALS certified.

Research Question 3

RQ3. What is the relationship between the first responder arrival time in relation to the transport ambulance arrival time and the amount of time the transport ambulance spends on the scene?

$H_0$3: There is no relationship between the first responder arrival time in relation to the transport ambulance arrival time and the amount of time the transport ambulance spends on scene.

H_a3: There is a relationship between the first responder arrival time in relation to the transport ambulance arrival time and the amount of time the transport ambulance spends on the scene.

To answer this final question involved an examination of the relationship between the amount of time the first responder is on scene and how it impacts the transport ambulance scene time. A linear regression analysis was conducted for this purpose. A straight line corresponding to the regression model was superimposed on a scatter plot of the data to show the relationship between the arrival time of the first responder and the scene time of the transport ambulance. The analysis for 2013 (BLS certified) begins with Table 9, and the analysis for 2014 responses (with the first responders being only ALS certified) begins with Table 12. Table 9 contains the descriptive statistics for the 2013 (BLS certified first responder) linear regression model.

Table 9

Descriptive Statistics-2013 (BLS)

	N	Minimum	Maximum	Mean	Std. Deviation
AMB Scene Time	411	58.00	2242.00	1025.8054	407.87588
AMB ATS-FR ATS	411	-640.00	747.00	97.1241	188.24517
Valid N (listwise)	411				

Table 10 contains the model coefficients for the 2013 (BLS certified first responder) linear regression model.

Table 10

2013 Model Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	*t*	Sig.
	B	Std. Error	Beta		
(Constant)	1038.142	22.634		45.867	.000
AMB ATS-FR ATS	-.127	.107	-.059	-1.188	.236

a. Dependent Variable: AMB Scene Time

Because the *p*-value (*p*=.236) of the two-tailed *t* test of the regression model coefficient shown in Table 11 is greater than the level of significance (.05), the null hypothesis is not rejected. Hence, there is no relationship between the first responder arrival time in relation to the transport ambulance arrival time and the amount of time the transport ambulance spends on scene when the first responders are BLS certified.

Table 11 contains the model summary for the 2013 (BLS certified first responder) linear regression model, which shows that the model explains less than 1% of the variation in the transport ambulance scene time (*R* Square = .003). Figure 6 provides visual confirmation of this fact.

Table 11

2013 Model Summary

Model	*R*	*R* Square	Adjusted R Square	Std. Error of the Estimate
1	.059[a]	.003	.001	407.67189

Predictors: (Constant), AMB ATS-FR ATS
Note: Times in seconds

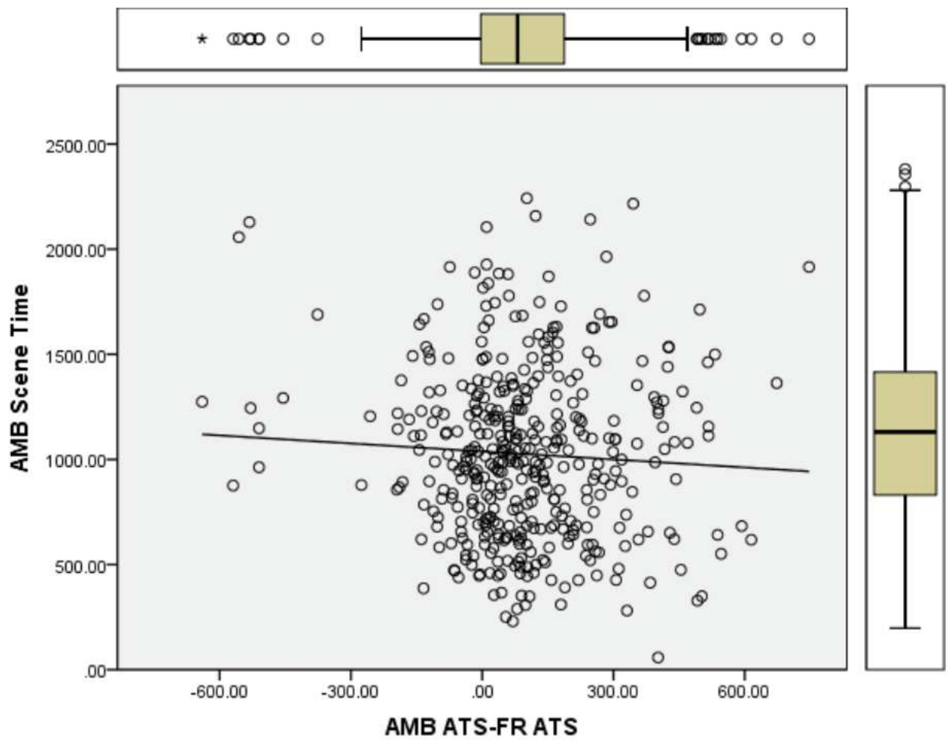

Figure 6. G Graph - 2013 data analysis.

The second half of this research question involved examining the relationship between ALS first responder arrival time in relation to the transport ambulance arrival time and the amount of time the transport ambulance spent on the scene during 2014. A linear regression analysis was conducted followed by fitting a straight-line based on regression model for the 2014 data and displayed in a scatter plot showing the relationship between first responder arrival time in relation to the transport ambulance arrival time and the amount of time the transport ambulance spent on the scene during emergency responses in 2014. The data are provided in the following tables and figure.

Table 12 contains the descriptive statistics for the 2014 (ALS certified first responder) linear regression model.

Table 12

Descriptive Statistics – 2014 (ALS)

	N	Minimum	Maximum	Mean	Std. Deviation
AMB Scene Time	407	139.00	2301.00	905.7985	366.97577
AMB ATS-FR ATS	407	-491.00	1013.00	251.3833	189.70922
Valid N (listwise)	407				

Note: Times in seconds

Table 13 contains the model coefficients for the 2014 (ALS certified first responder) linear regression model.

Table 13

2014 Model Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	*t*	Sig.
	B	Std. Error	Beta		
(Constant)	1008.931	29.570		34.120	.000
AMB ATS-FR ATS	-.410	.094	-.212	-4.367	.000

a. Dependent Variable: AMB Scene Time

Because the *p*-value of the two-tailed *t* test ($p < 0.001$) is less than the level of significance (.05), the null hypothesis is rejected. Thus, the alternative is accepted (H_a1):

"There is a relationship between the first responder arrival time in relation to the transport ambulance arrival time and the amount of time the transport ambulance spends on the scene" when the first responders are ALS certified.

Table 14 contains the model summary for the 2014 (ALS certified first responder) linear regression model, which shows that the model explains about 5% of the variation in the transport ambulance scene time (*R* Square = .045). Figure 7 provides visual confirmation of this fact.

Table 14

Model Summary

Model	*R*	*R* Square	Adjusted *R* Square	Std. Error of the Estimate
1	.212[a]	.045	.043	359.06996

Predictors: (Constant), AMB ATS-FR ATS

The average transport ambulance scene time was 905.7985 seconds (15:06 minutes) representing a 2-minute reduction in scene time when the ambulance was responding with ALS first responders. It is important to note that the data includes responses where the first responders arrived after the transport ambulance, further confirming the positive impact that first responders with advanced certification reduced the ambulance scene time, regardless of the first responder arrival scene time. While it is not entirely clear why having ALS certified first responders reduces the scene time of the transport ambulance, one explanation is that by having the same advanced training as the ambulance personnel the first responders are able to assist more with the patient care and better anticipate the needs of the ambulance personnel. Further research would be necessary to verify this idea.

In this scenario the *R* Square value was .045, which, although statistically significant as shown in Table 15, is nonetheless indicative of a poor fit between the linear regression model and the data. Alternative explanations must be considered to help explain the relationship. Just as in the responses with BLS first responders there can be many uncontollable factors which can impact the transport ambulance scene time. Additional causes include inclement weather, number of patients, time of day, or difficulty communicating with a patient can all affect how quickly an ambulance is able to transport a patient, and may explain the poor level of fit.

Table 15

Model Summary

Model	*R*	*R* Square	Adjusted *R* Square	Std. Error of the Estimate
1	.212[a]	.045	.043	359.06996

Predictors: (Constant), AMB ATS-FR ATS

While the scatter plot involving the 2014 data showed a stronger linear relationship between the first responder arrival time in relation to the transport ambulance arrival time (dependent variable) and the amount of time the transport ambulance remained on scene prior to transport (independent variable), the overall fit to the data, while statistically significant, is poor.

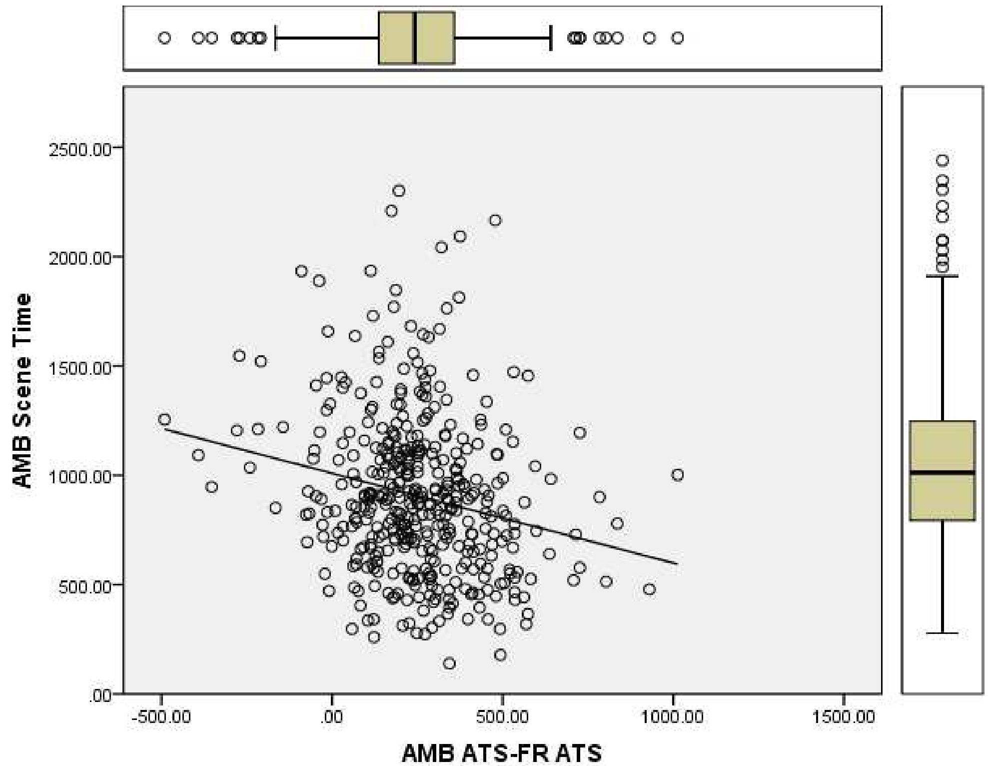

Figure 7. G Graph - 2014 data analysis (ALS)

To reiterate, in this case the null hypothesis is rejected because the *p*-value of the two-tailed *t* test ($p < 0.001$) is less than the level of significance (.05). Thus, the alternative is accepted (H_a1): “There is a relationship between the first responder arrival time in relation to the transport ambulance arrival time and the amount of time the transport ambulance spends on the scene” when the first responders are ALS certified.

Summary

I designed the three research questions to explore whether a relationship existed between the amount of time a first responder was at the scene of a medical emergency and how it impacted the amount of time a transport ambulance would remain on scene with their patient. In addition, the three questions were broken into two subsets to determine if the certification level of the first responders had a separate impact on the scene time of the transport ambulance.

The focus for Research Question 1 was specifically on the impact that first responder certification (BLS v. ALS) had on the total amount of time a transport ambulance would remain on scene before transporting their patient. In this case, it was demonstrated that having ALS first responders shortened the scene time of the transport ambulance by 2:08 minutes. A two-tailed *t* test of the difference in the two independent sample means has a p value ($p < 0.001$) less than the required level of significance (.05). Thus, the alternative hypothesis was accepted: “First responder certification level does impact the scene times of transport ambulances.”

For research Question 2, I compared the data to determine whether there was any difference in having the first responders at the scene of the emergency before the transport ambulance versus arriving simultaneously or after the ambulance. Secondarily, the question helped answer whether certification level (BLS v. ALS) made a difference when the first responders did arrive. The data were a side-by-side comparison by year; those emergencies when the first responder arrived first compared to those emergencies where the first responders arrived at the same time as the transport ambulance or afterward.

In 2013, (BLS first responders) the difference in the scene time of the transport ambulance was 10 seconds longer when the first responders arrived simultaneously or after the transport ambulance, which was not statistically different from arriving at the same time. However, for 2014, with ALS first responders, the difference in scene times was 3:38 minutes longer when the first responders arrived after the transport ambulance, which was a statistically difference.

The findings for Research Question 2 also helped validate the conclusions found in Research Question 1, and further demonstrated that having ALS certified first responders does have a statistically significant impact on the scene times of a transport ambulance. While there still is considerable controversy on whether certification levels affect long-term patient survival (Kurz et al., 2018; Sanghavi, Jena, Newhouse, & Zaslavsky, 2015), there is no question that time saves lives (DeRuyter et al., 2017; Esmaeiliranjbar et al., 2016; Martinell et al., 2017; Thompson et al., 2017). Although there are many variables that can impact how much time is spent on the scene of a medical emergency the conclusions in this second research question demonstrated that first responders do make a difference in the total time.

I asked the final research question to determine whether the amount of time a first responder was on the scene before the transport ambulance impacted the ambulance scene time. In other words, does having the first responder on scene sooner make a difference in the amount of time an ambulance spent on the scene? With the BLS first responders (2013 data) there was no demonstrable difference in the scene time of the transport ambulance, and the null hypothesis was accepted. The 2014 data (ALS first responders) indicated there was a positive impact on the ambulance scene time and the null hypothesis was rejected; but, the low R Square for the linear regression model raises questions about what other variables may have had an impact on the transport ambulance scene time. In short, while there appears to be some correlation on how first responder scene time impacts the transport ambulance scene time as well as the certification of the first responders (BLS vs. ALS), there are additional variables which need to be explored. In Chapter 5, I will not only discuss the impact of my research findings, but also identify its social and practical impact and suggest additional research which may help clarify the conclusions found in this study.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

The purpose of this study was to determine whether a relationship existed between the amount of time a first responder was on the scene before the arrival of a transport ambulance and how much time was spent on scene by the ambulance. This study was also an exploration of whether the certification level of a first responder had any impact on the transport ambulance scene time. The analysis of the data showed that having first ALS certified responders tended to shorten the scene time of the transport ambulance. There was a significant reduction in the transport ambulance scene time when they responded with ALS first responders.

Interpretation of the Findings

Much of the current debate involving prehospital emergency medical services swirls around the efficacy of the care provided and whether time makes a difference. The knowledge gained through the research conducted for this paper does not speak directly to patient treatment or modalities, but it explores how the relationship between 911 first responders and transport ambulances impacts the amount of time a patient remains on the scene of a medical emergency. There is no question that how long it takes a patient to receive definitive medical care can impact patient outcomes in situations such as heart attacks, stroke, or instances of major trauma (DeRuyter et al., 2017; Esmaeiliranjbar et al., 2016; Martinell et al., 2017; Thompson et al., 2017).

The data analysis conducted and reported in Chapter 4 is an explanation of how first responders impacted the scene time of paramedics. It appears that ALS certified first responders arriving first shortened the scene times of the transport ambulance by more than 2 minutes; but, when they arrived after the ambulance, it extended the scene time by more than 3 minutes. Having a BLS first responder did not statistically affect the scene time of an ambulance. The impact of ALS first responders was much greater and statistically significant. This is an argument that appears to validate the need for ALS first responders; but, there are opinions on whether time is an important variable in prehospital EMS. As an example, current researchers supported early layperson recognition of out-of-hospital-cardiac-arrest (OHCA) patients and the layperson's subsequent initiation of CPR and use of a defibrillator. Although cardiac arrest patient survival decreases for each minute it takes the first responders to arrive at the scene of the emergency, this adverse impact is offset by the layperson initiation of CPR (Cunningham et al., 2012; Park et al., 2017). In a retrospective analysis, researchers found OHCA patient survival was 60.8% higher for patients who had received layperson CPR before the arrival of first responders or transport ambulances than those who had not (Geri et al., p. 131, 2017).

Another controversial area where time is disputed is when encountering major trauma victims. The term, golden hour, was coined by Cowley, which he explained as, "If you are critically injured you have less than 60 minutes to survive. You might not die right then; it may be three days or two weeks later -- but something has happened in your body that is irreparable" (University of Maryland Medical Center, 2018, p. 2). The idea that someone with serious injuries should be assessed and treated first goes back to the Napoleonic Wars (Nestor, 2003); but, the notion that every major trauma victim is rushed to the closest trauma center does not necessarily result in more lives saved (Ross et al., 2016). Experts have argued over whether prehospital EMS changes the outcome in major trauma victims through their treatments (Fleet & Poitras, 2011; Harmsen et al., 2015). Authors of a recent South African study concluded there was no change in patient mortality whether a patient arrived at a hospital via private transport or through an organized EMS system (Möller, Hunter, Kurland, Lahri, & van Hoving, 2018). This challenges the concept of time and calls into question the importance of trained responders.

If transport time has a questionable impact on patient outcomes, what component of time measurement does? As in OHCA, researchers believe the most significant impact which first responders can have on patient outcomes is the early recognition of serious injuries, and appreciation for the mechanism of injury, and patient-specific risk factors (Newgard et al., 2010; Sarmiento, Eckstein, & Zambon, 2013; Yang, Kang, & Song, 2016). Not to be over-looked is the EMS provider's judgment as a value-added tool for determining trauma triage criteria (Rein et al., 2018).

The research questions in this study were tailored to look at how transport scene times were affected by first responder arrival times. If a first responder can recognize the acuity of the emergency, or through published criteria determine a patient meets major trauma criteria they can communicate this information to the responding transport ambulance or tell the ambulance crew upon their arrival which should in most cases get the responders working quickly towards transporting the patient as soon as possible. Prehospital trauma triage criteria have been developed so that any certification level of first responder can utilize them (Newgard et al., 2010; San Diego County Paramedic

Association, 2016) but Nordberg, Castrén, and Lindström (2016) found that if using a pre-established set of triage criteria, the average layperson could reasonably accurately identify major trauma patients. This raises the question of first responder certification.

The golden hour of trauma has been applied to stroke care as well as heart attack victims. Both require early recognition and rapid transport to hospitals which can significantly impact the patient's outcome (Ebinger et al., 2015; Fassbender et al., 2013). First responders can help make this a reality.

First responders who are BLS certified are unable to provide invasive medical care but regardless, their presence is essential in the early recognition of a patient's condition, and they provide additional personnel which can assist the transport ambulance with expediting the patient transport when necessary. For all three research questions, it was demonstrated that having ALS certified first responders on the scene before the transport ambulance shortened ambulance scene times. In OHCA, strokes, heart attacks, and trauma, all of the experts agree on one thing: early recognition and when necessary, early initiation of life-saving procedures saves lives (Cunningham et al., 2012; Ebinger et al., 2014; Fassbender et al., 2013; Newgard, et al., 2010; Sarmiento et al., 2013; Yang et al., 2016) and this is one critical task that can be emphasized to BLS first responders and their earlier arrival time at the scene of a medical emergency. The first responders typically arrived approximately 2 minutes earlier than the transport ambulance in this study, which alone can be a factor in positively impacting patient outcomes. In a typical medical emergency, in addition to their gurney, there is a lot of equipment which the transport ambulance personnel will bring to the patient's side. The additional personnel from the first responder crew provides valuable assistance in facilitating this task, and their help shortens the amount of time the transport ambulance needs to remain at the scene.

ALS first responders not only help with the early recognition of an emergency; but, they also bring with them the same life-saving equipment that the transport ambulance carries. This enables them to begin the advanced medical care that would otherwise have to wait until the transport ambulance arrives. Once the ambulance does arrive, some of the tasks they usually would have done are already completed, and this too has demonstrated to shorten the time the transport ambulance remains on scene. Through the research conducted for this paper, it was clear that having first responders of any type can shorten the scene time of the transport ambulance but it was demonstrated that having ALS first responders had a meaningful and practical impact on reducing scene times regardless of whether they arrived before or after the transport ambulance. Although the intepretations cannot be fully explained by the data, one explanation of the reduced scene time is the ALS first responder's familiarity with the needs and anticipated needs of the ambulance personnel.

One of the principal foundations of this paper centered around the need for prehospital emergency medical services to sustain itself through evidence-based research. The inception of modern EMS began with the publication of the National Academy of Sciences (1966) white paper which served as the theoretical foundation for this study. Nearly 20 years, later EMS professionals began to question whether the treatments and system designs being implemented were indeed the best and started the cry for evidence-based research (Glind et al., 2016; Maguire et al., 2016; Stewart, 2005). The term has since been updated to "evidence-based guidelines" (Fishe et al., 2018) which is more reflective of how new and old treatments along with protocols are vetted before their implementation.

Prehospital emergency medical services have seen an increase in relevant research, and as an example, a number of major studies have been generated through the Ontario Prehospital Advanced Life Support (OPALS) Study. This was both a prospective and retrospective evaluation of prehospital trauma care and in its subsequent phases, advanced cardiac care. Studies in 17 major cities located in both Canada and the United States were conducted (Stiell et al., 2008). Many studies were generated using the data from researchers in the OPALS Study, focusing on those conditions which resulted in the highest morbidity and mortality. This includes Safdar et al. (2014) looking at OHCA survival rates by gender. Sasson and Haukoos (2015) went so far as to question the efficacy of prehospital EMS, while internationally the OPALS study has been a foundational study from which nonparticipant EMS systems have measured their performance (Kim, Shin, Kim, Kim, & Kim, 2015). Prehospital emergency medical providers are in the business of trying to improve patient outcomes, and perhaps the explanation for the need for ongoing research came from O'Meara et al. (2015), who stated that "research is essential to ensure that the best possible patient care is provided in the out-of-hospital setting and to facilitate the continued development of paramedicine as a health profession (p. 2)." The outcomes highlighted in this study adds another thin slice of information to the body of scholarly research which is reviewing current EMS practices and investigating strategies on how to improve upon the care and services provided by first responders and transport ambulances systemwide.

Limitations of the Study

There were no practical limitations to this study. Areas of concern discussed in Chapter 2 revolved around the accuracy of the data which was entirely human dependent. During the research, the statistical analysis highlighted the potential of some alternative explanations based on the poor fits of the linear regression models to the study data.

The primary data used in this retrospective study involved time, measured in minutes and seconds. The amount of time a first responder was at the scene of a medical emergency before the arrival of the transport ambulance was measured, as was the amount of time the transport ambulance remained on a scene before initiating transport of a patient to the hospital. The times were generated in real-time, as a first responder or an ambulance responded and arrived at the scene of an emergency, with responders reporting their status to a 911 dispatcher or self-reporting through an onboard mobile data terminal. This required the responders to be prompt and accurate in their reporting. There are also some variables which are beyond the responder's control which could impact time. This could include incomplete or inaccurate dispatch information, difficulties with access and egress of a location or an incident which involved multiple patients. In each of these scenarios the time would be impacted and as a result, potentially provide misleading data or outliers which could skew the results.

For the two study periods, the CVFD and AMR provided unfiltered incident times for all responses within the City of Chula Vista. The data provided by each agency included incidents which were not medical aids (e.g., fires, HazMat), incidents which fell outside of the study area and incidents which did not have a complete or a verifiable set of times. In each of these cases, the data were removed from the study set. The data were cross-checked between the CVFD and AMR to ensure the accuracy of incident location, times and resources. Any incident where this information could not be confirmed was also removed from the study set. Through this process, the data which were analyzed were felt to be accurate and met the criteria for inclusion in the study.

What could not be anticipated were variables unique to each emergency incident. This could be an incident where a patient had to be stabilized with pain medication before movement, a patient which needed to be carried down a flight of stairs or perhaps a patient who was initially refusing transportation to the hospital necessitating the responders to spend extra time explaining the need and importance of additional medical care. In each of these cases, the scene time of the transporting ambulance could potentially have been impacted, yet the scope and nature of this study did not allow for these variables to be considered.

The data analysis found in Chapter 4 showed that in incidents where ALS first responders were at the scene it tended to shorten the scene time of the transport ambulance by slightly more than 2 minutes. The statistical analysis explained very little of the variation in the ambulance scene time further supporting the belief that other factors were in play when trying to explain the reduction in scene time. It was evident in Research Question 1 that there is a difference in the transport ambulance scene time based on the certification level of the first responders with ALS first responders reducing the ambulance time by 2:08 and this was confirmed in Research Question 3 which asked whether it made a difference whether the first responders arrived before or after the transport ambulance. Once again, the data showed that ALS first responders reduced the scene time of the transport ambulance; yet, it did not matter whether they arrived before or after the ambulance.

Recommendations

The role of the first responder in medical emergencies has not been sufficiently validated when compared to the impact that laypersons can have in a medical emergency. There is consensus that early recognition of a medical emergency, initiation of the 911 system, and beginning rudimentary resuscitative measures will have the most significant impact on patients suffering from heart attacks or in cases of major trauma (Cunningham et al., 2012; Ebinger et al., 2014; Fassbender et al., 2013; Newgard et al., 2010; Sarmiento et al., 2013; Yang et al., 2016). But this speaks to the value of the layperson and does not specifically address the impact that first responders can have on patient outcomes. It is clear from existing literature that researchers have considered the effect that both BLS and ALS first responders can have on specific medical conditions; but, there is limited research which looks at how first responders interact with transport ambulances or impact EMS system design. If existing EMS systems want to demonstrate the positive impact that their first responders have on the system metrics or patient outcomes it will be necessary for researchers to build upon current literature and focus more on the role of the first responder.

Difficult questions will need to be asked about the value and impact that first responders have on an EMS system. While some of the answers about whether every community needs ALS first responders, does every firetruck need to be staffed with ALS first responders, and would the system be better served with BLS first responders may be intuitive, it is only with evidence-based guidelines that the efficacy of system design will be demonstrated, and each of these questions currently remains unanswered by scholarly research.

EMS managers and medical directors will not be making radical changes to their systems based on the information developed in this paper, but it can generate discussion or serve as an impetus for additional research on the importance of time as a system metric. It can also stimulate researchers to demonstrate the importance and impact that first responders have on patient outcomes. In my community, of greater importance is the social impact of having a local provider/student-scholar conduct original research using data from within our EMS system to better explain the relationship between the different certification levels of providers found within the local system. Locally, to have a provider level researcher is a rarity. There is no doubt some will see the interpretations of the data as fodder to question the current EMS system design while others may see it as validation for the advanced scope of the first responders. All of this will result in a conversation, and with any hope generate new research as providers of all level certifications better appreciate the need for scholarly research to not only help validate current practices, but also explore new ways which the EMS system can enhance the patient care experience.

Although not discussed in this paper, there could also be a positive financial effect based on the information gathered in this paper. To staff and equip an advanced life support ambulance is not an inexpensive venture. A staffed and fully equipped ambulance on the road costs the provider agency money, regardless of whether the ambulance is sitting in their station or transporting a patient. According to a local EMS manager, the unit hour cost can range from $115-150 per hour based upon the unit staffing. If one were to expand this cost over an entire system which is staffing 30 ambulances for 24 hours, it costs the EMS system $95,400 per day to staff and thoroughly equip the resources necessary to meet their needs.

Each minute costs an EMS provider $2.21 ($132.50/60 min), and if each emergency ambulance response were quantified and had their total time on task reduced by an average of two minutes, this would result in savings of $4.42 ($2.21 x 2) per transport. If an ambulance transports an average of nine patients in a 24-hour shift, this will result in 18 minutes of savings or $19.89 per ambulance. If an entire EMS system averaged nine transports per ambulance (30 ambulances x 9 transports x $2.21), there would be a potential savings of $597 per day or $218,000 per year. It is important to note that not every emergency medical transport would realize the two-minute savings, and the data analysis in this study demonstrated there were many unexplained variables which impacted times and the relationship between the first responders and the transport ambulance scene time.

Regardless, reducing minutes on an emergency can save lives, and it can also save money which can be reinvested back into the EMS system with additional staffing, to purchase equipment, or as revenue. This potential impact is not trivial, and if EMS managers were to identify additional steps which would reduce the total time the transport ambulance is assigned an emergency it could result in significant savings for the system, and potentially for the patient's themselves.

Implications

There are many implications for positive social change based on the results of this study and the recommendations found in this chapter. The role of the emergency medical responder is to impact positively the outcome of an individual who is suffering from a medical emergency or a major trauma. While not every patient will be saved, having increased information on how to better develop an EMS system may result in first responders and transport ambulances arriving sooner at the scene of an emergency, thereby increasing the odds for a favorable outcome. It is important to note that the emergency is not limited to just the patient, but may involve their family, coworkers, or other witnesses to the event. The coordinated response of the first responders and ambulance also provides reassurance to this group of participants in the emergency and can have a tremendous impact on how they view emergency services as well as the trauma of witnessing a medical emergency. Since they are the true first responders at an emergency, this group provides a critical link in the chain of survival which is necessary for the first responders or transport ambulance to do their job.

In Chapter 1, I highlighted the lack of scholarly research on the relationship between first responders, their certification levels, and the amount of time a transport ambulance remains on the scene of an emergency. As communities and provider agencies evaluate their emergency medical services, knowing that such a relationship exists and shows a positive impact on the scene times, patient outcomes, and system management, gives them another piece of information they can use to make better decisions about their EMS system.

Perhaps the most benefit this study can have is by demonstrating the value of scholarly research to the providers who respond to the emergencies. As a group, they have just begun to appreciate the need for evidence-based research along with evidence-based treatment guidelines. Seeing the results of a credible research project conducted by one of their peers which demonstrates the importance of research and has positive outcomes will hopefully further persuade this group to become involved in scholarly studies. In the end, this may be the best social change that could happen.

Conclusion

At the outset of this study, the purpose was to find a relationship between certification levels of first responders and the time spent on scene by a transport ambulance as well as determine whether first responder arrival time impacted the scene time of the ambulance. The results show that a relationship exists, but the data does not provide a clear explanation of why. In Chapter 2, the literature search revealed that very little research had been done exploring the impact of first responders or their relationship with a transport ambulance. Of greater significance was the clear message that the value of the current practices in the prehospital emergency medical services arena is highly suspect and not fully supported. It is imperative that current providers take responsibility for the future of their profession, and this can only be done by asking questions and conducting research. To do something just because of historical legacy is not enough to sustain the EMS profession; instead, it will be necessary to understand why a particular treatment or system design exists and then question it. Through scholarly research conducted by EMS personnel will the role of a first responder or ambulance crew-member evolve from that of a technician to one of a professional.

References

Aboueljinane, L., Sahin, E., & Jemai, Z. (2013). A review on simulation models applied to emergency medical service operations. *Computers and Industrial Engineering, 66*(4), 734-750. doi:10.1016/j.cie.2013.09.017

Aczel, A. D., & Sounderpandian, J. (2006). *Complete business statistics* (6th ed.). New York, NY: McGraw-Hill/Irwin.

Alanis, R., Ingolfsson, A., & Kolfal, B. (2013). A Markov chain model for an EMS system with repositioning. *Production and Operations Management, 22*(1), 216-231. doi:10.1111/j.1937-5956.2012.01362.x

Alpert, A., Morganti, K. G., Margolis, G., Wasserman, J., & Kellermann, A. L. (2013). Giving EMS flexibility in transporting low-acuity patients could generate substantial medicare savings. *Health Affairs, 32*(12), 2142-2148. doi:10.1377/hlthaff.2013.0741

American Heart Association. (2017). *What is an automated external defibrillator?* Retrieved from http://www.heart.org/idc/groups/heart-public/@wcm/@hcm/documents/downloadable/ucm_300340.pdf

Anderson, S. F., Kelley, K., & Maxwell, S. E. (2017). Sample-size planning for more accurate statistical power: A method adjusting sample effect sizes for publication bias and uncertainty. *Psychological Science, 28*(11), 1547-1562. doi:10.1177/0956797617723724

Ashley, D., Pracht, E. E., Medeiros, R. S., Atkins, E. V., NeSmith, E. G., Johns, T. J., & Nicholas , J. (2015). An analysis of the effectiveness of a state trauma system:

Treatment at designated trauma centers is associated with an increased probability of survival. *Journal of Trauma and Acute Care Surgery, 78*(4), 706-714. doi:10.1097/TA.0000000000000585

Bagher, A., Todorova, L., Andersson, L., Wingren, C., Ottosson, A., Wangefjord, S., & Acosta, S. (2017). Analysis of pre-hospital rescue times on mortality in trauma patients in a Scandinavian urban setting. *Trauma, 19*(1), 28-34. doi:10.1177/1460408616649217

Bakalos, G., Mamali, M., Komninos, C., Koukou, E., Tsantilas, A., Tzima, S., & Rosenberg, T. (2011). Advanced life support versus basic life support in the pre-hospital setting: A meta-analysis. *Resuscitation, 82*(9), 1130-1137. doi:10.1016/j.resuscitation.2011.04.006

Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51*(6), 1173-1182. Retrieved from http://www.apa.org/pubs/journals/psp/

Bass, R. R. (2015). History of EMS. In D. C. Cone, J. H. Brice, T. L. Delbridge, & J. B. Myers (Eds.), *Emergency medical services: Clinical practice and systems oversight* (2nd ed., Vol. 1, pp. 1-16). West Sussex: John Wiley & Sons.

Bass, R. R., Lawner, B., Lee, D., & Nable, J. V. (2015). Medical oversight of EMS systems. In *Emergency medical services: Clinical practice and systems oversight* (pp. 71-84). West Sussex: John Wiley & Sons.

Beam, T. E. (2003). Medical ethics in the military. In Office of the Surgeon General, *Textbook of military medicine* (pp. 369-402). Falls Church, VA: Office of the Surgeon General, Department of the Army.

Bélanger, V., Kergosien, Y., Ruiz, A., & Soriano , P. (2016). An empirical comparison of relocation strategies in real-time ambulance fleet management. *Computers & Industrial Engineering, 94*, 219-229. doi:10.1016/j.cie.2016.01.023

Bell, R. C. (2009). *A history: The ambulance.* Jefferson, NC: McFarland & Company.

Banharak, S., Zahrli, T., & Matsuo, H. (2018). Public knowledge about risk factors, symptoms, and first decision-making in response to symptoms of heart attack among lay people. *Pacific Rim International Journal of Nursing Research, 22*(1), 18-29. Retrieved from https://www.tci-thaijo.org/index.php/PRIJNR

Berk, K. N., & Carey, P. (2004). *Data analysis with Microsoft Excel.* Belmont.

Blackwell, T. H., & Kaufman, J. S. (2002). Response time effectiveness: Comparison of response time and survival in an urban emergency medical services system. *Academic Emergency Medicine, 9*(4), 288-295. doi:10.1197/aemj.9.4.288

Blackwell, T. H., Kline, J. A., Willis, J. E., & Hicks, G. M. (2009). Lack of association between prehospital response times and patient outcomes. *133*(4), 444-450. doi:10.1080/10903120902935363

Blanchard, I. E., Doig, C. J., Hagel, B. E., Anton, A. R., Zygun, D. A., Kortbeek, J. B.,…Innes, G. D. (2012). Emergency medical services response time and mortality in an urban setting. *Prehospital Emergency Care, 16*(1), 152-151. doi:10.3109/10903127.2011.614046

Bledsoe, B. E., Porter, R. S., & Cherry, R. A. (2007a). *Essentials of paramedic care* (2nd ed.). Upper Saddle River, NJ: Pearson Education.

Bledsoe, B., Porter, R. S., & Cherry, R. A. (2007b). *Essentials of paramedic care*. Upper Saddle River, NJ: Pearson.

Boland, L. L., Satterlee, P. A., Fernstrom, K. M., Hanson, K. G., Desikan, P., & LaCroix, B. K. (2015). Advanced clinical interventions performed by emergency medical responder firefighters prior to ambulance arrival. *Prehospital Emergency Care, 19*(1), 96-102. doi:10.3109/10903127.2014.942477

Bosse, H. M., Mohr, J., Buss, B., Krautter, M., Weyrich, P., Herzog, W., & Jünger, J. (2015, February 19). The benefit of repetitive skills training and frequency of expert feedback in the early acquisition of procedural skills. *BMC Medical Education, 15*(22). doi:10.1186/s12909-015-0286-5

Bouzat, P., Ageron, F.-X., Brun, J., Levrat, A., Berthet, M., Rancurel, E., …Payen, J.F. (2015). A regional trauma system to optimize the pre-hospital triage of trauma patients. *Critical Care*, 1-9. doi:10.1186/s13054-015-0835-7

Bradley, E. H., Roumanis, S. A., Radford, M. J., Webster, T. R., MnNamara, R. L., Mattera, J. A., … Krumholz, H. M. (2005). Achieving door-to-balloon times that meet quality guidelines. *Journal of the American College of Cardiology, 46*(7), 1236-1241. doi:10.1016/j.jacc.2005.07.009

Brown, K. M., Macias, C. G., Dayan, P. S., Shaw, M. I., Weik, T. S., Wright, J. L., & Lang, E. S. (2014). The development of evidence-based prehospital guidelines using a GRADE-based methodology. *Prehospital Emergency Care, 18*(Sup 1), 3-14. doi:10.3109/10903127.2013.844871

Burke, A. G., Joyce, N., Baker, W. E., Biddinger, P. D., Dyer, S., Friedman, F. D.,…Epstein, S. K. (2013). The effect of an ambulance diversion ban on emergency department length of stay and ambulance turnaround time. *Annals of Emergency Medicine, 61*(3), 303-312. doi:10.1016/j.annemergmed.2012.09.009

California Emergency Medical Services Authority. (2016). *Local EMS Agency/County Information*. Retrieved from http://www.emsa.ca.gov/Local_EMS_Agencies

Callaham, M., & Madsen, C. D. (1996). Relationship of timeliness of paramedic advanced life support interventions to outcome in out-of-hospital cardiac arrest treated by first responders with defibrillators. *Annals of Emergency Medicine, 27*(5), 638-648. doi:10.1016/0300-9572(96)89055-1

Callaway, C. W., Donnino, M. W., Fink, E. L., Geocadin, R. G., Golan, E., Kern, K. B.,…Zimmerman, J. L. (2015). Post–cardiac arrest care. *Circulation, 132*(2), S465-S482. doi:10.1161/CIR.0000000000000262

Campbell, J. P., Gratton, M. C., Salomone III, J. A., & Watson, W. A. (1993). Ambulance arrival to patient contact: The hidden component of prehospital response time intervals. *Annals of Emergency Medicine, 22*(8), 1254-1257. doi:10.1016/S0196-0644(05)80102-7

Campbell, J. P., Maxey, V. A., & Watson, W. A. (1995). Hawthorne effect: Implications for prehospital research. *Annals of Emergency Medicine, 26*(5), 590-594. doi:10.1016/S0196-0644(95)70009-9

Campeau, A. (2008). Why paramedics require “Theories-of-Practice”. *Journal of Emergency Primary Health Care, 6*(2), 1-7. Retrieved from https://ajp.paramedics.org/index.php/ajp/article/view/451

Carlson, J. N., Karns, C., Mann, N. C., Jacobson, K. E., Dai, M., Colleran, C., & Wang, H. E. (2016). Procedures performed by emergency medical services in the United States. *Prehospital Emergency Care, 20*(1), 15-21. doi:10.3109/10903127.2015.1051682

Carr, B. G., Caplan, J. M., Pryor, J. P., & Branas, C. C. (2006). A meta-analysis of prehospital care times for trauma. *Prehospital Emergency Care, 10*(2), 198-206. doi:10.1080/10903120500541324

Carrigan, S. A., Asada, Y., Travers, A., Goldstein, J., & Carter, A. (2016). The prevalence and characteristics of non-transported EMS patients in Nova Scotia. *Canadian Journal of Emergency Medicine, 18*(S1), 536-537. doi:10.1017/cem.2016.56

Carron, P.-N., Reigner, P., Vallotton, L., Clouet, J.-G., Danzeisen, C., Zürcher, M., & Bertrand, Y. (2014). Implementation of a medical command and control team in Switzerland. *Disasters, 38*(2), 434-450. doi:10.1111/disa.12043

Cheskes, S., Schmicker, R. H., Rea, T., Powell, J., Drennan, I. R., Kudenchuk, P., … Christenson, J. (2015). Chest compression fraction: A time dependent variable of survival in shockable out-of-hospital cardiac arrest. *Circulation, 97*, 129-135. doi:10.1016/j.resuscitation.2015.07.003

Christensen, E. F., Berlac, P. A., Nielsen, H., & Christensen, C. F. (2016). The Danish quality database for prehospital emergency medical services. *Clinical Epidemiology, 8*, 667-671. doi:10.2147/CLEP.S100919

Chroust, G., Ossimitz, G., Roth, M., Sturm, N., & Ziehesberger, P. (2015). First responders in regional disasters: A case of social responsibility. In *Social responsiblity beyond neoliberalism and charity* (Vol. 4, pp. 77-104). Sharjah: Bentham Science Publishers.

Chula Vista Fire Department. (2017). *Firehouse 2016 national run survey.* Annual Report , City of Chula Vista. Retrieved from file:///C:/Users/Devin/Downloads/FH%20Mag%202016%20National%20Run%20Survey.pdf

Chula Vista Fire Department. (2017,). *About us*. Retrieved from Chula Vista Fire Department: http://www.chulavistaca.gov/departments/fire-department/about-us

Ciesla, D. J., Tepas III, J. J., Pracht, E. E., Langland-Orban, B., Cha, J. Y., & Flint, L. M. (2013). Fifteen-year trauma system performance analysis demonstrates optimal coverage for most severely injured patients and identifies a vulnerable population. *Journal of the American College of Surgeons, 216*(5), 687-695. doi:10.1016/j.jamcollsurg.2012.12.033

City of Chula Vista. (2018). *Chula Vista Police Department* . Retrieved from http://www.chulavistaca.gov/departments/police-department/about-us/support-operations

Cone, D. C. (2015). EMS Personnel. In D. C. Cone, J. H. Brice, T. R. Delbridge, & B. Myers, *Emergency medical services: Clinical practice and systems oversight* (pp. 51-59). Somerset, NJ: John Wiley & Sons.

Corbin, J., & Strauss, A. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (2nd ed.). Thousand Oaks: Sage.

Costantini, T. W., Kobayashi, L., & Coimbra, R. (2015). Dedicated Resuscitation Operating Room for Trauma. In *Technological advances in surgery, trauma and critical Care* (pp. 97-102). New York, NY: Springer-Verlag.

Coster, J. E., Irving, A. D., Turner, J. K., Phung, V.-H., & Siriwardena, A. N. (2018). Prioritizing novel and existing ambulance performance measures through expert and lay consensus: A three-stage multimethod consensus study. *Health Expectations, 21*(1), 249-260. doi:10.1111/hex.12610

Cowley, R. A. (1975). A total emergency medical system for the State of Maryland. *Maryland Medical Journal, 24*(7), 37-45. Retrieved from http://www.medchi.org/News-and-Publications/Maryland-Medicine-Journal

Cox, H., Albarran, J. W., Quinn, T., & Shears, K. (2006). Paramedics' perceptions of their role in providing pre-hospital thrombolytic treatment: Qualitative study. *Accident and Emergency Nursing, 14*(4), 237-244. doi:10.1016/j.aaen.2006.08.002

Cudnik, M., Newgard, C. D., Sayre, M. R., & Steinberg, S. (2009). Level I versus level II trauma centers: An outcomes-based assessment. *Journal of Trauma-Injury*

Infection & Critical Care:, 66(5), 1321-1326. doi:10.1097/TA.0b013e3181929e2b

Cunningham, L. M., Mattu, A., O'Connor, R. E., & Brady, W. J. (2012). Cardiopulmonary resuscitation for cardiac arrest: The importance of uninterrupted chest compressions in cardiac arrest resuscitation. *American Journal of Emergency Medicine, 30*(8), 1630-1638. doi:10.1016/j.ajem.2012.02.015

Cushman, J. T. (2016). EMS system design. In D. Cooney, *EMS medicine* (pp. 81-88). New York, NY: McGraw-Hill Education.

Davidson, G. H., Rivara , F. P., Mack, C. D., Kaufman , R., Jurkovich , G., & Bulger, E. M. (2014). Validation of prehospital trauma triage criteria for motor vehicle collisions. *Journal of Trauma and Acute Care Surgery, 76*(3), 755-761. doi:10.1097/TA.0000000000000091

Davis, R. (2003). Many lives are lost across USA because emergency services fail. *USA TODAY*, p. 1A.

Davis, R. (2003). Only strong leaders can overhaul EMS. *USA Today*, p. 20.

Davison, K., & Forbes, M. P. (2015). Pre-hospital medicine: A glimpse of the future. *Australasian Journal of Paramedicine, 12*(5), 1-3. Retrieved from https://ajp.paramedics.org/index.php/ajp

Davison, S., Karpinski , E., Levy, M., & Strobel, C. (2016). *A modified EMS system: transport ambulance.* Worcester: Worcester Polytechnic Institute. Retrieved from https://web.wpi.edu/Pubs/E-project/Available/E-project-050316-182351/unrestricted/A_Modified_EMS_System_-_Transport_Ambulance.pdf

Demetriades, D., Martin, M., Salim, A., Rhee, P., Brown, C., Doucet, J., & Chan, L. (2006). Relationship between American College of Surgeons trauma center designation and mortality in patients with severe trauma (Injury Severity Score > 15). *Journal of the American College of Surgeons, 202*(2), 212-215. doi:10.1016/j.jamcollsurg.2005.09.027

DeRuyter, N. P., Husain, S., Yin, L., Olsufka, M., McCoy, A. M., …Sayre, M. R. (2017). The impact of first responder turnout and curb-to-care intervals on survival from out-of-hospital cardiac arrest. *Resuscitation, 113*, 51-55. doi:10.1016/j.resuscitation.2017.01.015

Dowdy, J., & Pait, T. G. (2014). The influence of war on the development of neurosurgery. *Journal of Neurosurgery, 120*(1), 237-243. doi:10.3171/2013.8.JNS122369

Driscoll, C. R. (2001). U.S. Army medical helicopters in the Korean War. *Military Medicine, 166*(4), 290-296. Retrieved from https://academic.oup.com/milmed

Dyson, K., Bray, J. B., Smith, K., Bernard, S., Straney, L., & Finn, J. (2016). Paramedic exposure to out-of-hospital cardiac arrest resuscitation is associated with patient survival. *Circulation: Cardiovascular Outcomes and Quality*, 154-160. doi:10.1161/CIRCOUTCOMES.115.002317

Ebinger, M., Kunz, A., Wendt, M., Rozanski, M., Winter, B., Waldschmidt, C., … Audebert, H. J. (2015). Effects of golden hour thrombolysis a prehospital acute neurological treatment and optimization of medical care in stroke (PHANTOM-S) substudy. *Journal of the American Medical Association, 72*(1), 25-30. doi:10.1001/jamaneurol.2014.3188

Eckstein, M. (2011). Basic and advanced life support considerations (BLS vs ALS-what does it mean for system design?). In T. H. Blackwell, J. J. Clawson, M. K. Eckstein, C. Miramonti, & H. E. Wang, *Emergency medical services evidence-based system design white paper for EMSA* (pp. 30-39). Tulsa: Emergency Medical Services Authority. Retrieved from http://www.cafsti.org/wp-content/uploads/LM10-OUDEM-EMS-System-Design-White-Paper-FINAL-for-July-2011-Release.pdf#page=30

Eid, S. M., Abougergi, M. S., Albaeni, A., & Chandra-Strobos, N. (2017). Survival, expenditure and disposition in patients following out-of-hospital cardiac arrest: 1995–2013. *Resuscitation, 113*, 13-20. doi:10.1016/j.resuscitation.2016.12.027

Eisenberg, D. L., & Bissell, R. (2005). Does advanced life support provide benefits to patients?: A literature review. *Prehospital Disaster Medicine*, *20*(4), 265-270. doi:10.1017/S10492023X0000165X

Eschmann, N. M., Pirrallo, R. G., Aufderheide, T. P., & Lerner, E. B. (2010). The association between emergency medical services staffing patterns and out-of-hospital cardiac arrest survival. *Prehospital Emergency Care, 14*(1), 71-77. doi:10.3109/10903120903349820

Esmaeiliranjbar, A., Mayel, M., Movahedi, M., Emaeiliranjbar, F., & Mirafzal, A. (2016). Pre-hospital time intervals in trauma patient transportation by emergency medical service: Association with the first 24-hour mortality. *Journal of Emergency Practice and Trauma, 2*(2), 37-41. doi:10.15171/jept.2015.15

Fan, Y., French, M. L., Stading, G. L., & Bethke, S. (2015). Disaster response: An examination of resource management in the early hours. *Journal of Applied Business and Economics, 17*(2), 22-41. Retrieved from http://www.na-businesspress.com/jabeopen.html

Farrokhyar, F., Reddy, D., Poolman, R. W., & Bhandari, M. (2013). Why perform a priori sample size calculation? *Canadian Journal of Surgery, 56*, 207-213. doi:10.1503/cjs.018012

Fassbender, K., Balucani, C., Walte, S., Levin, S. R., Haass, A., & Grotta, J. (2013). Streamlining of prehospital stroke management: The golden hour. *Lancet, 12*(6), 585-596. doi:10.1016/S1474-4422(13)70100-5

Fayrer, J. (1888). *The natural history and epidemiology of cholera .* London, England: J. & A. Churchill .

Federal Emergency Management Agency. (2005). The decision-making process. In *Decision Making and Problem Solving* (pp. 2.13 - 2.30). Emmitsburg, MD: Emergency Management Institute.

Fessler, S. J., Simpson, H. K., Yancey II, A. H., Colman, M., & Hirsh, D. A. (2014). How well do general EMS 911 dispatch protocols predict ED resource utilization for pediatric patients? *American Journal of Emergency Medicine, 32*(3), 199-202. doi:10.1016/j.ajem.2013.09.018

Fishe, J. N., Crowe, R. P., Cash, R. E., Nudell , N. G., Martin-Gill, C., & Richards, C. T. (2018). Implementing prehospital evidence-based guidelines: A systematic literature review. *Journal of Prehospital Emergency Care, 22*(4), 511-519. doi:10.1080/10903127.2017.1413466

Fleet, R., & Poitras, J. (2011). Have we killed the golden hour of trauma? *Annals of Emergency Medicine, 57*(1), 74. doi:10.1016/j.annemergmed.2010.08.003

Fogley, D. (2014). *The alarm has aounded: A descriptive study of performance measures of fire department ESDs in Travis County.* San Marcos: Texas State University - San Marcos. Retrieved from https://digital.library.txstate.edu/handle/10877/5374

Fonarow, G. C., Smith, E. E., Zhao, X., Peterson, E. D., Xian, Y., Olson, D. M., ... Schwarmm, L. H. (2013). Use of strategies to improve door-to-needle times with tissue plasminogen activator in acute ischemic stroke by US Hospitals: Findings from the target: Stroke survey. *Stroke, 44*(2). Retrieved from http://www.heart.org/idc/groups/heart-public/@wcm/@maa/documents/downloadable/ucm_453098.pdf

Fujii, T., Kitamura, T., Kajino, K., Kiyohara, K., Nishiyama, C., Nishiuchi, T., … Iwami, T. (2017). Prehospital intravenous access for survival from out-of-hospital cardiac arrest: propensity score matched analyses from a population-based cohort study in Osaka, Japan. *BMJ Open, 12*, 1-12. doi:10.1136/bmjopen-2016-015055

Garrison, F. H. (1921). *Notes on the history of military medicine* (Vol. 1). New York, NY: Georg Olms Verlag Hildesheim.

Garza, A. G., Gratton, M. C., Coontz, D., Noble, E., & Ma, O. J. (2003). Effect of paramedic experience on orotracheal intubation success rates. *The Journal of Emergency Medicine, 25*(3), 251-256. doi:10.1016/S0736-4679(03)00198-7

Geri, G., Fahrenbruch, C., Meischke, H., Painter, I., White, L., Rea, T. D., & Weaver, M. R. (2017). Effects of bystander CPR following out-of-hospital cardiac arrest on hospital costs and long-term survival. *Resuscitation, 115*, 129-134. doi:10.1016/j.resuscitation.2017.04.016

Ginchereau, E. (2016). The american ambulance in Paris, 1914–1917; Part III: The american ambulance field service. *Military Medicine, 181*(2), 100-101. Retrieved from https://academic.oup.com/milmed

Glind, I. v., Berben, S., Zeegers, F., Poppen, H., Hoogeveen, M., Bolt, I., … Vloet, L. (2016). A national research agenda for pre-hospital emergency medical services in the Netherlands: A Delphi-study. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine, 24*(2), 1-9. doi:10.1186/s13049-015-0195-y

Gorelick, P. B. (2013). Primary and comprehensive stroke centers: History, value and certification criteria. *Journal of Stroke, 15*(2), 78-89. doi:10.5853/jos.2013.15.2.78

Goto, Y. (2017). Bystander interventions for out-of-hospital cardiac arrests: Substantiated critical components of the chain of survival. *Journal of Emergency and Critical Care Medicine, 1*(12), 1-5. doi:10.21037/jeccm.2017.06.01

Govindarajan, P., Lin, L., Lineman, A., McMullan, J. T., McNally, B. F., Crouch, A. J., & Sasson, C. (2012). Practice variability among the EMS systems participating in cardiac arrest registry to enhance survival (CARES). *Resuscitation, 83*(1), 76-80. doi:10.1016/j.resuscitation.2011.06.026

Graham, I. D., Logan, J., Harrison, M. B., Straus, S. E., Tetroe, J., Caswell, W., & Robinson, N. (2006). Lost in knowledge translation: Time for a map? *Journal of Continuing Education in the Health Professions, 26*(1), 13-24. doi:10.1002/chp.47

Gunderson, M. (2015). Principles of EMS System Design. In D. C. Cone, J. H. Brice, T. R. Delbridge, & J. B. Myers, *Emergency Medical Services: Clinical Practice and Systems Oversight* (pp. 1-14). New York, NY: John Wiley & Sons.

Hansen, A. J. (1996). *Gentlemen volunteers.* New York,NY: Arcade Publishing.

Hansen, C. M., Jollis, J. G., Dupre, M., McNally, B., Monk, L., Tyson, C., … Granger, C. B. (2014). *Early defibrillation, mainly by bystanders and first responders, associated with higher survival in statewide data.* Dallas: American Heart Association. Retrieved from http://circ.ahajournals.org/content/130/Suppl_2/A225.short

Hansen, C. M., Kragholm, K., Pearson, D., Tyson, C., Monk, L., Myers, B., … Granger, C. B. (2015). Association of bystander and first-responder intervention with survival after out-of-hospital cardiac arrest in North Carolina, 2010-2013. *JAMA, 314*(3), 255-264. doi:10.1001/jama.2015.7938

Harmsen, A., Giannakopoulos, G. F., Moerbeek, P. R., Jansma, E. P., Bonjer, H. J., & Bloemers, F. W. (2015). The influence of prehospital time on trauma patients outcome: A systematic review. *Injury, 46*(4), 602-609. doi:10.1016/j.injury.2015.01.008

Haslam, J. (2015). Emergency medical services: Decreasing revenue and the regulated healthcare environment. *Journal of Health Care Finance, 46*(4), 1-16. doi:10.1016/j.injury.2015.01.008

Hasselqvist-Ax, I., Riva, G., Herlitz, J., Rosenqvist, M., Hollenberg, J., Nordberg, P., … Svensson, L. (2015). Early cardiopulmonary resuscitation in out-of-hospital cardiac arrest. *New England Journal of Medicine, 372*(24), 2307-2315. doi:10.1056/NEJMoa1405796

Ho, J., & Casey, B. (1998). Time saved with use of emergency warning lights and sirens during response to requests for emergency medical aid in an urban environment. *Annals of Emergency Medicine, 32*(5), 585-588. doi:10.1016/S0196-0644(98)70037-X

Ho, Y.-C., Tsai, T.-H., Sung, P.-H., Chen, Y.-L., Chung, S.-Y., Yang, C.-H., … Yip, H.-K. (2014). Minimizing door-to-balloon time is not the most critical factor in improving clinical outcome of ST-elevation myocardial infarction patients undergoing primary percutaneous coronary intervention. *Critical Care Medicine, 42*(8), 1788-1796. doi:10.1097/CCM.0000000000000329

Hodell, E. M., Sporer, K. A., & Brown, J. F. (2014). Which emergency medical dispatch codes predict high prehospital nontransport rates in an urban environment? *Prehospital Emergency Care, 18*(1), 28-34. doi:10.3109/10903127.2013.825349

Holcomb, J. B., Stansbury, L. G., Champion, H. R., Wade, C., & Bellamy, R. F. (2006). Understanding combat casualty care statistics. *Journal of Trauma Injury, Infection, and Critical Care, 60*(2), 397-401. doi:10.1097/01.ta.0000203581.75241.f1

Howard, I., Cameron, P., Wallis, L., Castren, M., & Lindstrom, V. (2017). Quality ndicators for evaluating prehospital emergency care: A scoping review. *Prehospital and Disaster Medicine*, 1-10. doi:10.1017/S1049023X17007014

FEMA (2005). Emergency Management Institute, 2.12. Retrieved from https://training.fema.gov/emiweb/downloads/is241.pdf

Frenz, H. (1969). *Nobel Lectures, Literature 1901-1967.* Amsterdam, Holland: Elsevier. Retrieved from http://www.nobelprize.org/nobel_prizes/literature/laureates/1954/hemingway-bio.html

Hoyer, C., & Christensen, E. (2009). Firefighters as basic life support responders: A study of successful implementation. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine, 17*(16), 16-23. doi:10.1186/1757-7241-17-16

Huber, S., Crönlein, M., von Matthey, F., Hanschen, M., Seidl, F., Kirchhoff, C., Biberthaler, P., Lefering, R., Huber-Wagner, S. (2016). Effect of private versus emergency medical systems transportation in trauma patients in a mostly physician based system- a retrospective multicenter study based on the TraumaRegister DGU®. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine, 24*(1), 60-68. doi:10.1186/s13049-016-0252-1

Idris, A. H., Guffey, D., Pepe, P. E., Brown, S. P., Brooks, S. C., Callaway, C. W., …Aufderheide, T. P. (2015). Chest compression rates and survival following out-of-hospital cardiac arrest. *Critical Care Medicine, 43*(4), 840-848. doi:10.1097/CCM.0000000000000824

Institute of Medicine Committee on the Future of Emergency Care in the US Health System. (2007). *Emergency medical services: At the crossroads.* Washington, DC: National Academies Press.

Isenberg, D. L., & Bissell, R. (2005). Does advanced life support provide benefits to patients?: A literature review. *Prehospital and Disaster Medicine, 20*(4), 265-270. doi:10.1017/S1049023X0000265X

Iserson, K. V., & Moskop, J. C. (2007). Triage in Medicine, Part I: Concept, history, and types. *Annals of Emergency Medicine, 49*(3), 275-281. doi:10.1016/j.annemergmed.2006.05.019

Jensen, J. L., & Travers, A. H. (2016). Contemporary evidence-based practice in Canadian emergency medical services: A vision for integrating evidence into clinical and policy decision-making. *Canadian Journal of Emergency Medicine*, 1-10. doi:10.1017/cem.2016.364

Jensen, J., & Waugh, W. L. (2014). The United States' experience with the incident command system: What we think we know and what we need to know more about. *Journal of Contingencies & Crisis Management, 22*(1), 5-17. doi:10.1111/1468-5973.12034

Keene, T., Davis, M., & Brook, C. (2015). Characteristics and outcomes of patients assessed by paramedics and not transported to hospital: A pilot study. *Australasian Journal of Paramedicine, 12*(2), 1-7. Retrieved from https://ajp.paramedics.org/index.php/ajp

Kidane, B., Gupta, V., El-Beheiry, M., Vogt, K., Parry, N. G., Malthaner, R., & Forbes, R. L. (2016). Association between prehospital time and mortality following blunt thoracic aortic injuries. *Annals of Vascular Surgery* doi:10.1016/j.avsg.2016.07.081

Kim, T. H., Shin, S. D., Kim, Y. J., Kim, C. H., & Kim, J. E. (2015). The scene time interval and basic life support termination of resuscitation rule in adult out-of-hospital cardiac arrest. *Journal of Korean Medical Science*, 30(1), 104-109. doi:10.3346/jkms.2015.30.1.104

Kimmel, K., & Persse, D. (2015). Background and advantages of a tiered EMS response in a large, fire-based EMS model. *Health Care: Current Reviews*, 1-3. doi:10.4172/2375-4273.1000138

King, M. B., & Jatoi, C. (2005). The Mobile Army Surgical Hospital (MASH): A military and surgical legacy. *Journal of the National Medical Association, 97*(05), 648-656. Retrieved from https://www.journals.elsevier.com/journal-of-the-national-medical-association

Kircher, C., Kreitzer, N., & Adeoye, O. (2016). Pre and intrahospital workflow for acute stroke treatment. *Current Opinion in Neurology, 29*(1), 14-19. doi:10.1097/WCO.0000000000000281

Knight, S., Olson, L. M., Cook, L. J., Mann, N. C., Corneli, H. M., & Dean, J. M. (2003). Against all advice: An analysis of out-of-hospital refusals of care. *Annals of Emergency Medicine, 42*(5), 689-696. doi:10.1016/S0196-0644(03)00524-9

Koike, S., Ogawa, T., Tanabe, S., Matsumoto, S., Akahane, M., Yasunaga, H., … Imamura, T. (2011). Collapse-to-emergency medical service cardiopulmonary resuscitation interval and outcomes of out-of-hospital cardiopulmonary arrest: A nationwide observational study. *Critical Care*, 1-9. doi:10.1186/cc1021

Kotwal, R. S., Howard, J. T., Orman, J. A., Tarpey, B. W., Bailey, J. A., Champion, H. … Gross, K. R. (2016). The effect of a golden hour policy on the morbidity and mortality of combat casualties. *Journal of the American Medical Association - Surgical, 151*(1), 15-24. doi:10.1001/jamasurg.2015.3104

Kragholm, K., Wissenberg, M., Mortensen, R. N., Hansen, S., Hansen, C. M., Thorsteinsson, K., … Rasmussen, B. S. (2017). Bystander efforts and 1-year outcomes in out-of-hospital cardiac arrest. *New England Journal of Medicine, 376*(18), 1737-1747. doi:10.1056/NEJMoa1601891

Kupas, D. F., Schenk, E., Sholl, M., & Karmin, R. (2015). Characteristics of statewide protocols for emergency medical services in the United States. *Prehospital Emergency Care, 19*(2), 292-301. doi:10.3109/10903127.2014.964891

Kurz, M. C., Schmicker, R. H., Leroux, B., Nichol, G., Aufderheide, T. P., Cheskes, S., … Wang, H. E. (2018). Advanced vs. basic life support in the treatment of out-of-hospital cardiopulmonary arrest in the resuscitation outcomes consortium. *Resuscitation, 128*, 132-137. doi:10.1016/j.resuscitation.2018.04.031

Lam, S. S., Zhang, J., Zhang, Z. C., Choon, H., Overton, J., Ng, Y. Y., & Ong, M. E. (2015). Dynamic ambulance reallocation for the reduction of ambulance response times using system status management. *American Journal of Emergency Medicine, 33*, 159-166. doi:10.1016/j.ajem.2014.10.044

Lang, E. S., Spaite, D. W., Oliver, Z. J., Gotschall, C. S., Swor, R. A., Dawson, D. E., & Hunt, R. C. (2012). A national model for developing, implementing, and evaluating evidence-based guidelines for prehospital care. *Academic Emergency Medicine, 19*(2), 201-209. doi:10.1111/j.1553-2712.2011.01281.x

Larsen, M. P., Eisenberg, M. S., Cummins, R. O., & Hallstrom, A. P. (1993). Predicting survival from out-of-hospital cardiac arrest: A graphic model. *Annals of Emergency Medicine, 22*(11), 1652-1658. doi:10.1016/S0196-0644(05)81302-2

Lee, A., Sim, F., & Mackie, P. (2016). Changing times, changing challenges: Lessons for public health from history. *Public Health, 138*, 1-3. doi:10.1016/j.puhe.2016.07.020

Lee, C. H., Van Gelder, C. M., & Cone, D. C. (2010). Early cardiac catheterization laboratory activation by paramedics for patients with ST-segment elevation myocardial infaraction on prehosital 12-lead electrocardiograms. *Prehospital Emergency Care, 14*(2), 153-158. doi:10.3109/10903120903537213

Levin, W. R. (2004). *The Allegory of Mercy at the misericordia in Florence: Historiography, context, iconography, and the documentation of confraternal charity in the Trecento.* Lanham, MD: University Press of America.

Levine, D. M., Berenson, M. L., & Stephan, D. (1999). *Statistics for Managers* (2nd ed.). Upper Saddle River, NJ: Prentice-Hall.

Levy, F., Mareiniss, D. P., & Iacovelli, C. (2012). The importance of a proper against-medical advice (AMA) discharge: How signing out AMA may create significant liability protection for providers. *Journal of Emergency Medicine, 43*(3), 516-520. doi:10.1016/j.jemermed.2011.05.030

Little, W. K. (2010). Golden hour or golden opportunity: Early management of pediatric trauma. *Clinical Pediatric Emergency Medicine, 11*(1), 4-9. doi:10.1016/j.cpem.2009.12.005

Lu, T.-C., Chen, Y.-T., Patrick, C.-I., Chih-Hao, L., Shih, F.-Y., Yen, Z.-S., …Lin, F.-Y. (2006). The demand for prehospital advanced life support and the appropriateness of dispatch in Taipei. *Resuscitation, 71*(2), 171-179. doi:10.1016/j.resuscitation.2006.03.016

MacFarlane, C., & Benn, C. A. (2003). Evaluation of emergency medical services systems: A classification to assist in determination of indicators. *Journal of Emergency Medicine, 20*(2), 188-191. doi:10.1136/emj.20.2.188

Maguire, B., O'Meara, P., & Newton, A. (2016). Toward an international paramedic research agenda. *Irish Journal of Paramedicine, 1*(2), 1-5. Retrieved from http://irishparamedicine.com/index.php/ijp/

Martinell, L., Nielsen, N., Herlitz, J., Karlsson, T., Horn, J., Wise, M. P., Undén, J., Rylander, C. (2017). Early predictors of poor outcome after out-of-hospital cardiac arrest. *Critical Care, 21*(96), 1-10. doi:10.1186/s13054-017-1677-2

Masterson, S., Wright, P., O'Donnell, C., Vellinga, A., Murphy, A. W., Hennelly, D.,…. Deasy, C. (2015). Urban and rural differences in out-of-hospital cardiac arrest in Ireland. *Resuscitation, 91*, 42-47. doi:10.1016/j.resuscitation.2015.03.012

May, M. R., Dionne, R., Maloney, J., & Poirier, P. (2010). The role of paramedics in a primary PCI program for ST-elevation myocardial infarction. *Progress in Cardiovascular Diseases, 53*(3), 183-187. doi:10.1016/j.pcad.2010.08.003

McCoy, C. E., Menchine, M., Sampson, S., Anderson, C., & Kahn, C. (2013). Emergency medical services out-of-hospital scene and transport times and their association with mortality in trauma patients presenting to an Urban Level 1 Trauma Center. *Annals of Emergency Medicine, 61*(2), 167-174. doi:10.1016/j.annemergmed.2012.08.026

McKenna, K. D., Carhart, E., Bercher, D., Spain, A., Todaro, J., & Freel, J. (2015). Simulation use in paramedic education research (SUPER): A descriptive study. *Prehospital Emergency Care, 19*(3), 432-440. doi:10.3109/10903127.2014.995845

McManamny, T., Sheen, J., Boyd, L., & Jennings, P. A. (2014). Mixed methods and Its application in prehospital research. *Journal of Mixed Methods Research, 9*(3), 214-231. doi:10.1177/1558689813520408

Metropolitan Fire Chiefs Association. (2009). *Fire service deployment: Assessing community vulnerability.* Quincy, MA: National Fire Protection Association.

Mitchell, G. W. (2013). A brief history of triage. *Disaster Medicine and Public Health Preparedness*, S1-S4. Retrieved from https://www.cambridge.org/core/journals/disaster-medicine-and-public-health-preparedness

Möller, A., Hunter, L., Kurland, L., Lahri, S., & van Hoving, D. J. (2018). The association between hospital arrival time, transport method, prehospital time intervals, and in-hospital mortality in trauma patients presenting to Khayelitsha Hospital, Cape Town. doi:10.1016/j.afjem.2018.01.001

Morgenstern, J., Heitz, C., & Milne, W. K. (2017). Hot off the press: Prehospital advanced cardiac life support for out-of-hospital cardiac arrest. *Academic Emergency Medicine, 24*, 1100-1109. doi:10.1111/acem.13334

Moskop, J. C., & Iserson, K. V. (2007). Triage in medicine, part II: Underlying values and principles. *Annals of Emergency Medicine, 49*(3), 282-287. doi:10.1016/j.annemergmed.2006.07.012

Moss, C., Cowden, C. S., Atterton, L., Arasaratnam, M. H., Fernandez, A. R., Evarts, J. S., … J. H. (2015). Accuracy of EMS trauma transport destination plans in North Carolina. *Prehospital Emergency Care, 19*(1), 53-60. doi:10.3109/10903127.2014.916021

Moss, S. T., Chan, T. C., Dunford, J. V., & Vilke, G. M. (1998). Outcome study of prehospital patients signed out against medical advice by field paramedics. *Annals of Emergency Medicine, 31*(2), 247-250. doi:10.1016/S0196-0644(98)70315-4

Mumma, B. E., Diercks, D. B., Wilson, M. D., & Holmes, J. F. (2015). Association between treatment at an ST-segment elevation myocardial infarction center and neurologic recovery after out-of-hospital cardiac arrest. *American Heart Journal, 170*(3), 516-523. doi:10.1016/j.ahj.2015.05.020

Myers, J. B., Slovis, C. M., Eckstein, M., Goodloe, J. M., Isaacs, S. M., Loflin, J. R., … Pepe, P. E. (2008). Evidence-based performance measures for emergency medical services systems: A model for expanded EMS benchmarking. *Prehospital Emergency Care, 12*(2), 141-151. doi:10.1080/10903120801903793

Nakahara, S., Tomio, J., Ichikawa, M., Nakamura, F., Nishida, M., Takahashi, H., … Sakamoto, T. (2015). Association of bystander interventions with neurologically intact survival among patients with bystander-witnessed out-of-hospital cardiac arrest in Japan. *JAMA, 314*(3), 247-254. doi:10.1001/jama.2015.8068

Nakao, H., Ukai, I., & Kotani, J. (2017). A review of the history of the origin of triage from a disaster medicine perspective. *Acute Medicine & Surgery, 4*(4), 379-384. doi:10.1002/ams2.293

National Academy of Sciences (US) and National Research Council (US) Committee on Trauma; National Academy of Sciences (US) and National Research Council (US) Committee on Shock. (1966). *Accidental death and disability: The neglected disease of modern society.* Washington, DC: National Academy of Sciences. Retrieved from https://www.ncbi.nlm.nih.gov/books/NBK222962/

Nakao, H., Ukai, I., & Kotani, J. (2017). A review of the history of the origin of triage from a disaster medicine perspective. *Acute Medicine & Surgery, 4*(4), 379-384. doi:10.1002/ams2.293

National Association of Emergency Medical Technicians. (2016). *EMS Careers.* Retrieved May 1, 2016, from NAEMT: http://www.naemt.org/about_ems/emsCareers.aspx

National Association of EMT's. (2015). PHTLS: Prehospital Trauma Life Support. In *PHTLS* (pp. 50-69). Burlington: Jones & Bartlett Learning.

National Fire Protection Association. (2010). *NFPA 1710.* Retrieved from: http://www.whitfieldems.com/nfpa1710.htm

National Highway Traffic Safety Administration. (2001). *National EMS research agenda.* Washington, DC: National Highway Traffic Safety Administration.

Nehme, Z., Andrew, E., Cameron, P., Bray, J. E., Meredith, I. T., Bernard, S., & Smith, K. (2013). Direction of first bystander call for help is associated with outcome from out-of-hospital cardiac arrest. *Resuscitation, 85*(1), 42-48. doi:10.1016/j.resuscitation.2013.08.258

Nehme, Z., Andrews, E., Bernard, S., & Smith, K. (2015). Comparison of out-of-hospital cardiac arrest occurring before and after paramedic arrival: Epidemiology, survival to hospital discharge and 12-month functional recovery. *Resuscitation, 89*, 50-57. doi:10.1016/j.resuscitation.2015.01.012

Nestor, P. (2003). Baron Dominique Jean Larrey 1766-1842. *Journal of Emergency Primary Health Care, 1*(3). Retrieved from https://ajp.paramedics.org/index.php/ajp/article/view/196/214

Newgard, C. D., Meier, E. N., Bulger, E. M., Buick, J., Sheehan, K., Lin, S., …Brasel, K. (2015). Revisiting the “Golden Hour”: An evaluation of out-of-hospital time in shock and traumatic brain injury. *Annals of Emergency Medicine, 66*(1), 30-41. http://dx.doi.org/10.1016/j.annemergmed.2014.12.004

Newgard, C. D., Schmicker, R. H., Hedges, J. R., Trickett, J. P., Davis, D. P., Bulger, E. M., …Nichol, G. (2010). Emergency Medical Services intervals and survival in trauma: Assessment of the "Golden Hour" in a North American prospective cohort. *Annals of Emergency Medicine, 55*(3), 235-246. doi:10.1016/j.annemergmed.2009.07.024

Nilsson, A., Åslund, K., Lampi, M., Nilsson, H., & Jonson, C.-O. (2015). Improved and sustained triage skills in firemen after a short training intervention. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine, 23*(81), 1-6. doi:10.1186/s13049-015-0162-7

Nordberg, M., Castrén, M., & Lindström, V. (2016). Primary trauma triage performed by bystanders: An observation study. *Prehospital and Disaster Medicine, 31*(4), 353-357. doi:10.1017/S1049023X1600039X

Office for Civil Rights Headquarters. (2017). *HIPAA for professionals*. Retrieved from HHS.gov: Health information privacy: https://www.hhs.gov/hipaa/for-individuals/guidance-materials-for-consumers/index.html

O'Meara, P., Maguire, B., Jennings, P., & Simpson, P. (2015). Building an Australasian paramedicine research agenda: A narrative review. *Health Research Policy and Systems*, 1-5. doi:10.1186/s12961-015-0065-0

Okoli, C., & Pawlowski, S. D. (2004). The Delphi method as a research tool: An example,design considerations and applications. *Information & Management, 42*(1), 15-29. doi:10.1016/j.im.2003.11.002

Park, Y. M., Shin, S. D., Lee, Y. J., Song, K. J., Ro, Y. S., & Ahnf, K. O. (2017). Cardiopulmonary resuscitation by trained responders versus lay persons and outcomes of out-of-hospital cardiac arrest: A community observational study. *Resuscitation, 118*, 55-62. doi:10.1016/j.resuscitation.2017.06.024

Park, Y. M., Do Shin, S., Lee, Y. J., Song, K. J., Ro, Y. S., & Ahn, K. O. (2017). Timely bystander CPR improves outcomes despite longer EMS times. *American Journal of Emergency Medicine, 35*(8), 1049-1055. doi:10.1016/j.ajem.2017.02.033

Patel, A. B., Waters, N. M., Blanchard, I. E., Doig, C. J., & Ghali, W. A. (2012). A validation of ground ambulance pre-hospital times modeled using geographic information systems. *International Journal of Health Geographics, 11*(1), 42-52. doi:10.1186/1476-072X-11-42

Patel, H., & Sasser, S. M. (2014). Field trauma triage. In D. Cone, J. H. Brice, T. R. Delbridge, & J. B. Myers, *Emergency Medical Services: clinical practice and systems oversight* (pp. 289-296). Hoboken, NJ: John Wiley & Sons.

Patel, M. D., Brice, J. H., Moss, C., Suchindran, C. M., Evenson, K. R., Rose, K. M., & Rosamond, W. D. (2014). An evaluation of emergency medical services stroke protocols and scene times. *Prehospital Emergency Care, 18*(1), 15-21. doi:10.3109/10903127.2013.825354

Patel, M., Dunford, J. V., Aguilar, S., Castillo, E., Patel, E., Fisher, R., … Mahmud, E. (2012). Pre-hospital electrocardiography by emergency medical personnel. *Journal of the American College of Cardiology, 60*(9), 806-811. doi:10.1016/j.jacc.2012.03.071

Pepe, P. E., Roppolo, L. P., & Fowler, R. L. (2015). Prehospital endotracheal intubation: Elemental or detrimental? *Critical Care, 19*, 121-128. doi:10.1186/s13054-015-0808-x

Peterson, M., Syndergaard, T., Bowler, J., & Doxey, R. (2011). A systematic review of factors predicting door to balloon time in ST-segment elevation mycardial infarction treated with percutaneous intervention. *International Journal of Cardiology, 157*(1), 8-23. doi:10.1016/j.ijcard.2011.06.042

Pittenger, J., Fuhrman, S., Hansen, A., Etter, C., Pollum, K., Watkins, K., & Gardner, M. (2014). Evaluating pre-hospital response shen stroke symptoms are present though hospital arrival mode and last known well to arrival times. *Circulation: Cardiovascular Quality and Outcomes, 7*(Supp 1), A268. Retrieved from http://circoutcomes.ahajournals.org/content/7/Suppl_1/A268.short

Pollock, A. (2013). Ambulance services in London and Great Britain from 1860 until today: A glimpse of history gleaned mainly from the pages of contemporary journals. *Emergency Medical Journal, 30*(3), 218-222. doi:10.1136/emermed-2011-200086

Pons, P. T., Haukoos, J. S., Bludworth, W., Cribley, T., Pons, K. A., & Markovchick, V. J. (2005). Paramedic response time: Does it affect patient survival? *Academic Emergency Medicine, 12*(7), 594-601. doi:10.1197/j.aem.2005.02.013

Rajabali, N. A., Tsuyuki, R. T., Sookram, S., Simpson, S. H., & Welsh, R. C. (2009). Evaluating the views of paramedics, cardiologists, emergency department physicians and nurses on advanced prehospital management of acute ST elevation myocardial infarction. *Canadian Journal of Cardiology, 25*(9), 323-328. doi:10.1016/S0828-282X(09)70146-1

Rappold, J., Hollenbach , K. A., Santora, T. A., Beadle , D., Dauer, E., Sjoholm , L. O., … Goldberg, A. J. (2015). The evil of good is better: Making the case for basic life support transport for penetrating trauma victims in an urban environment. *Journal of Trauma and Acute Care Surgery, 78*(3), 343-348. doi:10.1097/TA.0000000000000078

Ratcliff, R., & McKoon, G. (2008). The diffusion decision model: Theory and data. *Neural Computation, 20*(4), 873-922. doi:10.1162/neco.2008.12-06-420

Rea, T. D., & Page, R. L. (2010). Community approaches to improve resuscitation after out-of-hospital sudden cardiac arrest. *Circulation, 121*, 1134-1140. doi:10.1161/CIRCULATIONAHA.109.899799

Rein, E. A., van der Sluijs, R., Houwert, R. M., Gunning, A. C., Lichtveld, R. A., Leenen, L. P., & van Heijl, M. (2018). Effectiveness of prehospital trauma triage systems in selecting severely injured patients: Is comparative analysis possible? *The American Journal of Emergency Medicine, 36*(3), 1060-1069. doi:10.1016/j.ajem.2018.01.055

Remba, S. J., Varon, J., Rivera, A., & Sternbach, G. L. (2010). Dominique-Jean Larrey: The effects of therapeutic hypothermia and the first ambulance. *Journal of Resuscitation, 81*(3), 268-271. doi:10.1016/j.resuscitation.2009.11.010

Rewegan, A., Bogaert, K., Yan, M., Gagnon, A., & Herring, D. A. (2015). The first wave of the 1918 influenza pandemic among soldiers of the Canadian Expeditionary Force. *American Journal of Human Biology, 27*(5), 638-645. doi:10.1002/ajhb.22713

Rimstad, R., & Sollid, S. (2015). A retrospective observational study of medical incident command and decision-making in the 2011 Oslo bombing. *International Journal of Emergency Medicine, 8*(1), 4-14. doi:10.1186/s12245-015-0052-9

Rockwood Jr., C. A., Mann, C. M., Farrington, J. D., Hampton Jr., O. P., & Motley, R. E. (1976). History of emergency medical services in the United States. *Journal of Trauma, 16*(4), 299-308. Retrieved from https://journals.lww.com/jtrauma/pages/default.aspx

Rogers, F. B., Rittenhouse, K. J., & Gross, B. W. (2015). The golden hour in trauma: Dogma or medical folklore? *Injury, 46*(4), 525-527. doi:10.1016/j.injury.2014.08.043

Rohlfs, C., Sullivan, R., Treistman, J., & Deng, Y. (2015). Using combat losses of medical personnel to estimate the impact of trauma care in battle: Evidence from World War II, Korea, Vietnam, Iraq and Afghanistan. *Defence and Peace Economics, 26*(5), 465-490. doi:10.1080/10242694.2015.1005897

Ross, D. W., Caputo, L. M., Salottolo, K. M., Coniglio, R., Mayfield, R., Mains, C. W., … Bar-Or, D. (2016). Lights and siren transport and the need for hospital intervention in trauma patients. *Prehospital Emergency Care, 20*(2), 260-265. doi:10.3109/10903127.2015.1076094

Ryynanen, O., Lirola, T., Reitala, J., Palive, H., & Malmivaara, A. (2010). Is advanced life support better than basic life support in prehospital care? A systematic review. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine, 18*(1), 62-76. doi:10.1186/1757-7241-18-62

Sackett, D. L., Rosenberg, W. M., Gray, J. M., Haynes, B. R., & Richardson, S. W. (1996). Evidence based medicine: What it is and what it isn't. *The BMJ*, 312(7023) 71-72. doi:10.1136/bmj.312.7023.71

Salvucci, A., Kuehl, A., & Clawson, J. J. (2004). The response time myth: Does time matter in responding to emergencies? *Topics in Emergency Medicine, 26*(2), 86-92. Retrieved from http://journals.lww.com/aenjournal

San Diego Association of Governments. (2011, October). *Fast facts: Chula Vista*. Retrieved from SANDAG: http://www.sandag.org/resources/demographics_and_other_data/demographics/fastfacts/chul.htm

San Diego County Emergency Medical Services. (2015). *2015 Emergency Medical Services System Report.* San Diego: County of San Diego. Retrieved from: http://www.sandiegocounty.gov/content/dam/sdc/hhsa/programs/phs/EMS/Reports/2015%20EMS%20Annual%20Report_FINAL.pdf

San Diego County Paramedic Association. (2016). *2016/2017 San Diego County Protocol & Medications Handbook.* San Diego, CA: San Diego County Paramedic Association.

Sanders, M. J. (1994). *Mosby's paramedic textbook.* St. Louis, MO: Mosby-Year Book, Inc.

Sanghavi, P., Jena, A. B., Newhouse, J. P., & Zaslavsky, A. M. (2015). Outcomes after out-of-hospital cardiac arrest treated by basic vs advanced life support. *JAMA Internal Medicine, 175*(2), 196-204. doi:10.1001/jamainternmed.2014.5420

Sanghavi, P., Jena, A. B., Newhouse, J. P., & Zaslavsky, A. M. (2015). Outcomes of basic versus advanced life support for out-of-hospital medical emergencies. *Annals of Internal Medicine, 163*(9), 681-690. doi:10.7326/M15-0557

Sarmiento, K., Eckstein, D., & Zambon, A. (2013). Evaluation of field triage decision scheme educational resources: Audience research with emergency medical service personnel. *Health Promotion Practice, 14*(2), 174-180. doi:10.1177/1524839912437788

Sasser, S. M., Hunt, R. C., Sullivent, E. E., Wald, M. M., Mitchko, J., Jurkovich, G. J., … Sattin, R. W. (2009). *Guidelines for field triage of injured patients recommendations of the national expert panel on field triage.* Atlanta, GA: Centers for Disease Control and Prevention. Retrieved from https://www.cdc.gov/mmwr/preview/mmwrhtml/rr5801a1.htm?ref=driverlayer.com

Sasson, C., Rogers, M. A., Dahl, J., & Kellermann, A. L. (2010). Predictors of survival from out-of-hospital cardiac arrest: A systematic review and meta-analysis. *Circulation: Cardiovascular Quality and Outcomes, 3*(1), 63-81. doi:10.1161/CIRCOUTCOMES.109.889576

Scanlon, J., McMahon , T., & Van Haastert, C. (2007). Handling mass death by integrating the management of disasters and pandemics: Lessons from the Indian Ocean Tsunami, the Spanish Flu and Other Incidents. *Journal of Contingencies and Crisis Management, 15*(2), 80-94. doi:10.1111/j.1468-5973.2007.00511.x

Schoell, S. L., Doud, A. N., Weaver, A. A., Talton, J. A., Barnard, R. T., Winslow, J. E., & Stitzel, J. D. (2017). Characterization of the occult nature of injury for frequently occurring motor vehicle crash injuries. *Accident Analysis & Prevention, 98*, 149-156. doi:10.1016/j.aap.2016.10.001

Seals, N., & Ngugi, R. (2014). City of Dallas creative improvement on EMS and revenue development. *Government Finance Review*, 45-48. Retrieved from http://www.gfoa.org/GFR

Seamon, M. J., Doaneb, S. M., Gaughanc, J. P., Kulp, H., D'Andrea, A. P., Pathak, A. S., … Wydrod, G. C. (2013). Prehospital interventions for penetrating trauma victims: A prospective comparison between advanced life support and basic life support. *Injury, 44*(5), 634-638. doi:10.1016/j.injury.2012.12.020

Shaw, M. N. (2006). The formation of the emergency medical services system. *American Journal of Public Health, 96*(3), 414-423. doi:10.2105/AJPH.2004.048793

Shawhan, R. R., McVay, D. P., Casey, L., Spears, T., Steele, S. R., & Martin, M. J. (2015). A simplified trauma triage system safely reduces overtriage and improves provider satisfaction: A prospective study. *American Journal of Surgery, 209*(5), 856-863. doi:10.1016/j.amjsurg.2015.01.008

Shuja, A. (2017). History of ambulance. *Indepreview, 19*(7-9), 5-77. Retrieved from http://admin.indepreview.com/article/VOL.%2019%20No.%2003/001%20History%20of%20Ambulance.pdf

Simpson, A. T. (2013). Transporting Lazarus: Physicians, the state, and the creation of the modern paramedic and ambulance, 1955-73. *Journal of the History of Medicine and Allied Sciences, 68*(2), 163-197. doi:10.1093/jhmas/jrr053

Smeby, C. L. (2013). Historical foundations of fire and emergency services. In L. C. Jr., *Fire and emergency services administration: management and leadership practices* (pp. 1-11). Burlington, VT: Jones & Bartlett.

Snooks, H., Evans, A., Wells, B., Peconi, J., & Thomas, M. (2009). What are the highest priorities for research in pre-hospital care? Results of a review and Delphi consultation exercise. *Emergency Medicine Journal , 26*, 549-550. doi:10.1136/emj.2008.065862

Spaite, D. W., Bobrow, B. J., Vadeboncoeur, T. F., Chikani, V., Clark, L., Mullins, T., & Sanders, A. B. (2008). The impact of prehospital transport interval on survivial in out-of-hospital cardiac arrest: Implicatons for regionalization of post-resuscitation care. *Resuscitation, 79*(1), 61-66. doi:10.1016/j.resuscitation.2008.05.006

Squire, B. T., Tamayo-Sarver, J. H., Rashi, P., Koenig , W., & Niemann, J. T. (2013). Effect of prehospital cardiac catheterization lab activation on door-to-balloon time, mortality, and false-positive activation. *Prehospital Emergency Care, 18*(1), 1-8. doi:10.3109/10903127.2013.836263

Stecker, E. C., Reinier, K., Marijon, E., Narayanan, K., Teodorescu, C., Uy-Evanado, A., ... Chugh, S. S. (2014). Public health burden of sudden cardiac death in the United States. *Circulation: Arrhythmia and Electrophysiology, 10*(3), 212-217. http://dx.doi.org/10.1161/CIRCEP.113.001034

Stewart, R. D. (2005). History of EMS: Foundation of an EMS System. In J. A. Brennan, & J. R. Krohmer, *Principles of EMS Systems* (pp. 2-18). Sudbury, MA: Jones and Bartlett.

Stiell, I. G., Nesbitt, L. P., Pickett, W., Munkley, D., Spaite, D. W., Banek, J., …Wells, G. A. (2008). The OPALS major trauma study: Impact of advanced life-support on survivial and morbidity. *Canadian Medical Association Journal, 178*(9), 1141-1152. doi:10.1503/cmaj.071154

Stout, J. (1980). The public utility model: Part I Measuring your system. *Journal of Emergency Medical Services*, 5(3), 22-25. Retrieved from https://medlineplus.gov/emergencymedicalservices.html

Stout, J. (1983). Jack Stout's 10 standards of excellence: Measuring your system. *Journal of Emergency Medical Services*, *1*(2), 84-91. Retrieved from https://medlineplus.gov/emergencymedicalservices.html

Strauss, D. G., Sprague, P. Q., Underhill, K., Maynard, C., Adams, G. L., Kessenich, A., … Wagner, G. S. (2007). Paramedic transtelephonic communication to cardiologist of clinical and elctrocardiograph assessment for rapid reperfusion of ST-elevation myocardial infarction. *Journal of Electrocardiology, 40*(3), 265-270. doi:10.1016/j.jelectrocard.2006.11.006

Stroshine, M. S. (2015). Technological innovations in policing. In R. G. Dunham, & G. P. Albert, *Critical Issues in policing* (7th ed., pp. 229-243). Long Grove, IL: Waveland Press.

Sund, B. (2013). Developing an analytical tool for evaluating EMS system design changes and their impact on cardiac arrest outcomes: Combining geographic information systems with register data on survival rates. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine, 21*(1), 8-16. doi:10.1186/1757-7241-21-8

Sutter, J. H., Panczyk, M., Spaite, D. W., Ferrer, J. M., Roosa, J., Dameff , C., ...Bobrow , B. J. (2015). Telephone CPR instructions in emergency dispatch systems: Qualitative survey of 911 call centers. *Western Journal of Emergency Medicine, 16*(5), 736-742. doi:10.5811/westjem.2015.6.26058

Takahashi, M., Kohsaka, S., Miyata, H., Yoshikawa, T., Takagi, A., Harada, K., ... Takayama, M. (2011). Association between prehospital time interval and short-term outcome in acute heart failure patients. *Journal of Cardiac Failure, 17*(9), 742-747. doi:10.1016/j.cardfail.2011.05.005

Thompson, L., Hill, M., Davies, C., Shaw, G., & Kiernan, M. D. (2017). Identifying pre-hospital factors associated with outcome for major trauma patients in a regional trauma network: an exploratory study. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine, 25*(83), 1-8. doi:10.1186/s13049-017-0419-4

Togher, F., Turner, J., Siriwardena , A. N., & O'Cathain, A. (2015). What do users value about the emergency ambulance service? *Emergency Medicine Journal, 28*(Supp 1), S-53. doi:10.1017/S1049023X13004998

Trivedi, K., Schuur, J. D., & Cone, D. C. (2009). Can paramedics read ST-segment elevation myocardial infarction on prehospital 12-lead electrocardiograms? *Prehospital Emergency Care, 13*(2), 207-214. doi:10.1080/10903120802706153

University of Maryland Medical Center. (2018). *History of the shock trauma center: Tribute to R Adams Cowley, MD*. Retrieved from University of Maryland Medical

Center Shock Trauma: https://www.umms.org/ummc/hea, lth-services/shock-trauma/about/history

Vandeventer, S., Studneck, J. R., Garrett, J. S., Ward, S. R., Staley, K., & Blackwell, T. (2011). The association between ambulance hospital turnaround times and patient acuity, destination hospital, and time of day. *Prehospital Emergency Care, 15*(3), 366-370. doi:10.3109/10903127.2011.561412

Vopelius-Feldt, J., Branding, J., & Bender, J. (2017). Review article: Systematic review of the effectiveness of prehospital critical care following out-of-hospital cardiac arrest. *Resuscitation, 114*, 40-46. doi:10.1016/j.resuscitation.2017.02.018.

Vopelius-Feldt, J., Coulter, A., & Benger, J. (2015). The impact of a pre-hospital critical care team on survival from out-of-hospital cardiac arrest. *Resuscitation, 96*, 290-295. doi:10.1016/j.resuscitation.2015.08.020

Vrotsos, K. M., Pirrallo, R. G., Guse, C. E., & Aufderheide, T. P. (2008). Does the number of system paramedics affect clinical benchmark thresholds? *Prehospital Emergency Care, 12*(3), 302-306. doi:10.1080/10903120802101355

Waalewijn, R. A., de Vos, R., Tijssen, J. G., & Koster, R. W. (2001). Survival models for out-of-hospital cardiopulmonary resuscitation from the perspectives of the bystander, the first responder, and the paramedic. *Resuscitation, 113*(2), 113-122. doi:10.1016/S0300-9572(01)00407-5

Wang, H. E., Mann, N. C., Jacobson, K. E., Dai, M., Mears, G., Smyrski, K., & Yearly, D. M. (2013). National characteristics of emergency medical services responses in the United States. *Prehospital Emergency Care, 17*(1), 8-14. doi:10.3109/10903127.2012.722178

Warren, S. A., Prince, K. D., Huszti, E., Rea, T. D., Fitzpatrick, A. L., Andrusiek, D. L., ... Nichol, G. (2015). Volume versus outcome: More emergency medical services personnel on-scene and increased survival after out of hospital cardiac arrest. *Resuscitation, 94*, 40-48. doi:10.1016/j.resuscitation.2015.02.019

Weiss, S., Fullerson, L., Oglesbee, S., Duerden, B., & Froman, P. (2013). Does ambulance response time influence patient condition among patients with specific medical and trauma injuries? *Southern Medical Journal, 106*(3), 230-235. doi:10.1097/SMJ.0b013e3182882c70

Wilson, B. (2016). EMS denied 15 minutes of fame: Newspaper coverage of pre-hospital healthcare related to policy change. In R. Gholipour, & K. Rouzbehani, *Social, Economic, and Political Perspectives on Public Health Policy-Making* (pp. 20-41). Hershey, PA: IGI Global.

Winship, C., Boyle, M., & Williams, B. (2014). Out-of-hospital cardiac arrest management by first responders: Retrospective review of a fire fighter first responder program. *Australasian Journal of Paramedicine, 11*(5), 1-7.

Woodall, J., McCarthy, M., Johnston, T., Tippett, V., & Bonham, R. (2007). Impact of advanced cardiac life supportskilled paramedics on survival from out-ofhospital cardiac arrest in a statewide emergency medical service. *Journal of Emergency Medicine, 24*(2), 134-138. doi:10.1136/emj.2005.033365

Yager, C., Dinakar, S., Sanagaram, M., & Ferris, T. K. (2015). *Emergency vehicle operator on-board device distractions.* College Station: Texas A&M Transportation Institute. Retrieved June 26, 2017, from http://www.tsag-its.org/media/emergency-vehicle-operator-on-board-device-distractions-revised-report-2-19-15.pdf

Yang, L., Yang, S. H., & Plotnick, L. (2012). How the internet of things technology enhances emergency response operations. *Technological Forecasting & Social Change, 80*(9), 1854-1867. doi:10.1016/j.techfore.2012.07.011

Yang, Y., Kang, J., & Song, S. (2016). Validation of applying the field triage guideline recommendations at the emergency department. *Applied Science and Engineering for Better Human Life, 2*, 113-118. doi:10.21742/asehl.2016.2.26

Young, D., Murinson, M., Wioson, C., Hammond, B., Welch, M., Block, V., …Wagner, G. S. (2011). Paramedics as decision makers on the activation of the cathereizatin laboratory in the presence of acute ST-elevation myocardial infarction. *Journal of Electrocardiology, 44*(1), 18-22. doi:10.1016/j.jelectrocard.2010.06.010

Zhang, S., Lee, M. D., Vandekerckhove, J., Maris, G., & Wagenmakers, E.-J. (2014). Time-varying boundaries for diffusion models of decision making and response time. *Frontiers in Psychology, 5*, 1364-1375. doi:10.3389/fpsyg.2014.01364