PRE-HOSPITAL EMERGENCY SERVICES: PROTRACTED AMBULANCE RESPONSE TIMES TO NON-PRIORITY CALLS AND POTENTIAL IMPACT ON PATIENT MORBIDITIY AND MORTALITY IN AN URBAN ENVIRONMENT

A Thesis

Presented to the Faculty of the Weill Cornell Graduate School of Medical Sciences

Cornell University

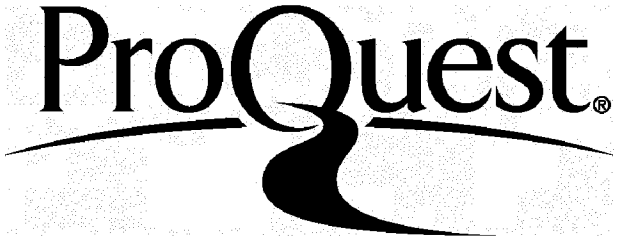
in Partial Fulfillment of the Requirements for the Degree of

Master of Science in Health Science

by

Michael Rachwalski

May 2015



ABSTRACT

Problem: The public's use of Emergency Medical Services (EMS) has been rapidly growing since the inception of modern pre-hospital care, especially in urban environments. The industry adheres to an 8-minute ambulance response time guideline as a basis for evaluating the effectiveness of an EMS agency. Even with the use of "lights and sirens" during a response, it is becoming increasingly burdensome to meet this standard given the increase in demand and high costs associated with ambulance operations. Does current research support current practiceguidelines that patients who receive an ambulance response in less than 8 minutes have better outcomes?
Methods: A systematic literature review was performed by accessing the PubMed and Scopus databases from the Weill Cornell Medical College Library. Original research published within the past 10 years or found to be critically relevant were included for review.**Results:** A focused search found 36 articles for general review, of which a total of 14 articles met inclusion criteria.**Conclusions:**The current 8-minute response guideline is based upon research into patient survival from out of hospital cardiac arrest, which found that rapid administration of defibrillation and CPR had a significant impact on patient outcomes. However, when applied to other patient conditions, both immediately life threatening and of lesser severity, researchers failed to prove that a protracted response time produced higher incidences of morbidity or mortality.

BIOGRAPHICAL SKETCH

Michael Rachwalski, a married father of three, is a lifelong New Yorker born in Brooklyn and raised in Queens. He graduated *cum laude* with a Bachelor of Arts in Labor Studies and Economics from Queens College. His professional career began at age 19 when he started working as a Financial Advisor for a small independent investment advisory firm on Long Island. After an 8-year stent in finance that included stays at some of the leading investment banks on Wall Street, Michael decided to change trajectory and began pursuing an education in the medical field. He completed the Post-Baccalaureate Pre-Health program at Hunter College while simultaneously becoming an Emergency Medical Technician. After gaining several years of patient care experience serving the citizens of the five boroughs as an EMT in the NYC 911 system, he then enrolled in the M.S.H.S. Physician Assistant Program at the Weill Cornell Graduate School of Medical Sciences. He has maintained his status as an EMT throughout his graduate schooling, gaining valuable hours of patient care and emergency medicine experience

To my wife Donna, who has always supported me and sacrificed more than I could ever imagine. To our three children, Nicholas, Sofia and Dominic, who have endured many fatherless days. And to my parents, for instilling their work ethic in me.

ACKNOWLEDGMENTS

I would like to express my sincere gratitude to my thesis advisor Dr. Sam Senturia, for his continued dedication to the advancement of Emergency Medicine and the medical education of Physician Assistant students. A special thanks to my program director Dr. Gerard Marciano, for his guidance and feedback during the literature review process, and to my research professor Dr. Gary Bouchard for providing valuable insight into the world of clinical research.

I would also like to thank my EMS colleagues,especially Mr. Peter Kwiath, EMT-P and Darlene Mercieca, for taking a chance on an unproven technician.

Lastly, to all the men and women who serve their communities as Emergency Medical Technicians and Paramedics, your efforts do not go unrecognized.

TABLE OF CONTENTS

LIST OF FIGURES

REVIEW OF THE LITERATURE

1.1 INTRODUCTION

The development and implementation of pre-hospital Emergency Medical Services (EMS) has evolved rapidly since its inception in the 1960s. An industry that began with only half its members across the country having any formal training now provides access to multiple levels of skilled medical care a mere phone call away.[1] Medical professionals staffing municipal and private ambulances have a diverse array of training, ranging from Basic Life Support (BLS) providers capable of administering first aid, cardiopulmonary resuscitation (CPR) and cardiac defibrillation, to Advanced Life Support (ALS) Paramedics with the additional ability to perform endotracheal intubation, cardiac monitoring and resuscitative medication administration. Despite the field's relatively short existence, since its inception both providers and patients have held one universal truth sacrosanct: the faster the response to a patient's call for help, the better the overall outcome. While this statement evolved from simple logical reasoning, subsequent scientific studies would establish a baseline for what actually met criteria for an adequate rapid response time (RT). Based upon the findings of a study published in 1979 by Eisenberg et al which analyzed the effect rapid defibrillation had on patient survival for out of hospital cardiac arrest (not due to trauma), a set response time of 4 minutes for BLS and 8 minutes for ALS became the standard by which EMS agencies were measured, and in some cases awarded contracts or compensation bonuses.[2] For the purposes of that study, response time was defined as beginning when a call is dispatched to the responding unit and ending upon arrival of that unit at the location of incident. [3]

The general public has shown an inherent tendency to blame poor patient outcomes on a patient's perceived access to an expedient medical response, not accounting for any other confounding factors that may have existed.[4] Variables such as patient age, comorbidities or severity of injury or illness at the time of the event are rarely discussed or their importance diminished. The media fallout from such events when there is in fact a delayed response can be catastrophic for EMS agencies and those charged with governing their operation.[5] The response of policy makers to public outcry against extended response times has generally been to throw more people and more money at the problem by training additional personnel in order to staff more ambulances, with strategic positioning throughout the communities. The biggest inhibitor to this type of crisis management is the staggering costs associated with training, staffing and purchasing additional ambulances which run 24 hours a day, 365 days a year, and can cost upwards of $150,000 per ambulance, not including fuel, insurance and maintenance.[6] These high fixed costs make the role of those responsible for dispatching these limited resources even more vital.

Using standardized triage protocols, 911 call takers must separate priority-1 patients, or those deemed to have immediately life threatening illness or injury, from those with lower priority. When the standard response to a priority-1 call can include dispatching ALS and BLS ambulances, police, fire department and other specialized resources all at once, it is imperative that accurate triage can identify those most in need of such a robust and resource intensive response. Using protocols like the Medical Priority Dispatch System (MDPS), accurate triage can be obtained in over 99% of calls for help.[7] Unfortunately, there exists a culture of abuse of these resources, especially in urban environments where access to a local hospital is more readily attainable by several modes of transportation outside the utilization of an ambulance. When compared with urban residents, patients located in sparsely populated

geographical areas are more often determined to be in a serious condition prior to accessing the 911 system, and receive pre-hospital medications at higher percentage rate than those in more densely populated locations.[8,9] In addition, patient calls to 911 are often over-triaged in order to avoid potential blowback from an underwhelming response, and patient accounts of their illness or injury are sometimes misrepresented in order to receive faster services. This can place a large strain on an EMS agency's ability to adhere to the 8-minute guidelines, and can lead to dangerous conditions for both the ambulance personnel and the community.

An ambulance responding to an emergency makes use of warning lights and sirens in an attempt to cut down on travel time to a patient location. Their use has been statistically shown to significantly cut down ambulance response time in urban environments anywhere from 1minute 46 seconds to 3 minutes on average.[10,11] This time savings does not, however, come without a price as pedestrian, crew, and other motorist safety are all compromised when making use of a "lights and sirens" response. While not life threatening, the noise pollution associated with the constant wailing of ambulance sirens cannot be overlooked. These added risks continue to be assumed and the public subjected to increasingly more ambulances on the streets with sirens blaring, all in an effort to meet this 8-minute deadline.

However, research has placed into question this fundamental guideline and scientific studies have demonstrated that ambulance response times do not necessarily correlate with patient morbidity or mortality. This review is intended to examine what the available current data tells us about the impact, if any, a rapid "lights and sirens" ambulance response has on patient outcomes from immediately life threatening illness or trauma, with specific analysis of patients residing in an urban environment, given their relatively easy access to a local hospital and the perceived misuse of 911 resources.

1.2 METHODS

A systematic literature review was performed using a computerized search of research studies by accessing the PubMed and Scopus databases from the Weill Cornell Medical Library. Original research studies published in English in peer-reviewed journals were found using the following search terms; "ambulance response times", "EMS response time or EMS response", "ambulance response and urban", "geographic ambulance response". The abstracts were scanned to assess for relevance with an in-depth full article review to determine suitability for inclusion. No articles over 10 years old were included unless determined to be foundational in their findings or substantially relevant to the review.

1.3 RESULTS

The database search yielded a total of 36 articles for general review. These results were then filtered to find articles that focused primarily on urban EMS systems and patient populations, or demonstrated a significant finding when comparing rural versus urban EMS response times. As ambulance response time alone is the independent variable of study, articles that focused on or failed to stratify results according to other time intervals such as total pre-hospital time, on-scene time or patient transport time were excluded. An effort was made to find studies on all types of patient medical conditions, both priority-1 (cardiac arrest, trauma, breathing difficulties) as well as non-priority type calls (motor vehicle accidents, minor injuries). Patient access and transport must have been made with an ambulance, not requiring the use of a "fly car", motorcycle or helicopter. Review articles were not included.

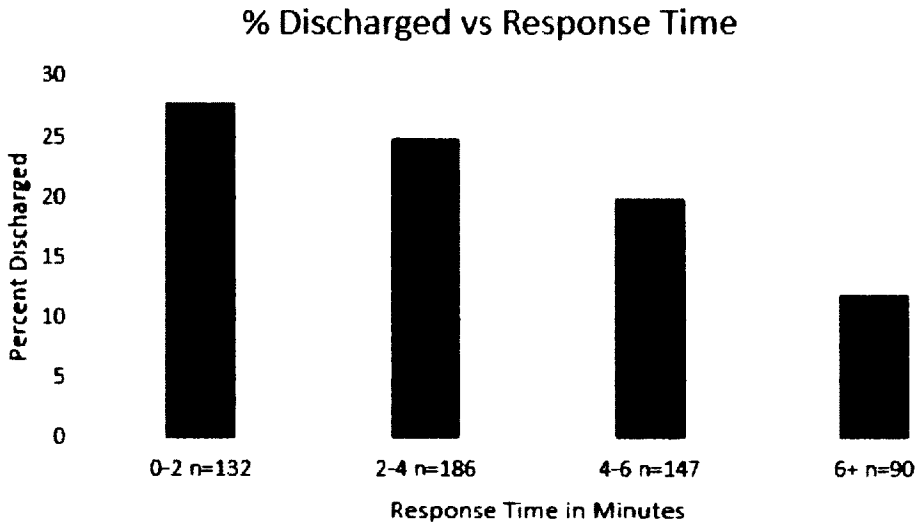
After thorough evaluation, a total of 14 articles met inclusion criteria for in-depth review.

1.4 DISCUSSION

1.4.1 Response time and cardiac related out of hospital cardiac arrest (OHCA)

As previously noted, Eisenberg et al set the prevailing EMS RT guidelines in 1979 by analyzing outcomes of patients in witnessed versus unwitnessed cardiac arrest secondary exclusively to primary heart diseases as stratified by 4 time variables; (1) access time – from collapse to summoning of aid, (2) response time – from receipt of call for help to arrival of aid on scene, (3) time from collapse to initiation of CPR, and (4) time to definitive care, including intubation or defibrillation. Of a study population consisting of 927 patients, 569 patients had witnessed arrests and 123 (22%) were discharged, compared with only 14 of 358 (4%) unwitnessed arrests. For 160 patients, CPR was initiated within 4 minutes and definitive ALS care provided within 8 minutes, with 43% (69) of those patients being discharged.When looking at response time alone, there was a sharp decline in percent of patients discharged from the hospital post-OHCA when response time was 6 minutes or greater as indicated by Figure 1 below. While the authors' conclusions were actually aimed at increasing community CPR and access to automated external defibrillators, the 8-minute EMS standard for all types and priority levels was established going forward.[2]

Figure 1:Percent Discharged versus Ambulance Response Time



Subsequent studies of out of hospital cardiac arrest (OHCA) found similar results that supported the rapid initiation of CPR and defibrillation. DeMaio et al used a prospective cohort study to analyze the 90th percentile cutoff time, defined as the time when 90 percent of patients should receive defibrillation, currently set at 8 minutes. Looking at 9273 patients who suffered cardiac related OHCA during the 6-year study time period (1991-1997), 392 survivors were identified. The mean defibrillation time was 6.3 minutes with a 90th percentile cutoff of 9.3 minutes. There was a steep decline in the survival curve for defibrillation after 5 minutes which, if that time frame was adopted over the standard 8-minute guideline, would save an additional 12% of patients per year.[12]

RadeVukmir found a secondary endpoint when studying the effects of bicarbonate administration to patients in OHCA by ALS providers. In 874 OHCA patients analyzed, survival improved when time to BLS interventions (eg CPR, defibrillation, ventilation with bag mask) was reduced from 6.81 minutes to 5.52 minutes. A decrease in ALS intervention time from 9.49 minutes to 7.29 minutes also showed a significant improvement in obtaining return of spontaneous circulation

(ROSC). He also noted there were zero survivors when time to ALS interventions exceeded 30 minutes.[13]

A five-year study conducted in England across 4 different EMS agencies showed that out of 1161 OHCA patients, only 2.6% (30) survived to hospital discharge. They noted that, if the patient arrested while paramedics were on scene, 14% of those patients survived. They calculated that a 1-minute decrease in response time would increase the odds of survival by 24%, but at a cost of approximately 54 million British Pounds per year. They found the optimal response time to be less than or equal to 6 minutes.[14]

1.4.2 Response time and survival from traumatic injury or arrest

Pons et al used a retrospective study to see if the 8-minute blanket RT guideline provided any improvement in patient outcomes when hospitalization was due to traumatic injury. Looking at 3576 patients identified at a single Level 1 trauma center in Denver, Colorado, the author took into account several variables including injury severity scoring, patient age, and mechanism of injury (blunt versus penetrating) with an end goal of survival to discharge from hospital. Survival, when separated by response time criteria of less than or greater than 8 minutes, showed no significant difference in the total patient population or when evaluated by subgroups.[15]

In a much larger study that focused on the "golden hour" of trauma patients that looked at 146 EMS agencies transporting to 51 different trauma hospitals in North America over 2 years, the authors broke down several time intervals including response time to analyze for significant associations with survival. Of the 3656 trauma patients, 806 died. After taking into consideration fourteen different out of hospital variables such as field vital sign values, Glasgow Coma Scale (GCS) score, age, sex, mechanism of injury, mode and destination of transport and level of first responding

ambulance (ie, BLS versus ALS), they found no significant association between response time and mortality (OR 1.00, 95% CI 9.97 to 1.04). When categorized into response intervals, there was no association with mortality within the 4-8 minute interval or the greater than 8 or less than four minute interval.[16]

1.4.3 Response time to Motor Vehicle Accidents and mortality

Motor vehicle collisions (MVC) represent a large portion of EMS responses and are associated with a high degree of morbidity and mortality. Gonzalez et al analyzed urban versus rural EMS responses to MVCs across Alabama using a linked EMS and police database. Over 2 years, 45,763 crash reports were linked to corresponding EMS agency records, 75% occurring in rural setting and 25 % in urban counties. A total 714 mortalities occurred, 611 of which were in rural locations and 103 in urban. The average response time to urban crashes involving a fatality was 6.50 minutes, while non-fatal crashes had a response time of 6.01 minutes, producing a t-test *p*value of .3034. This indicates that there was no association between mortality and RT in urban crashes in that study. However, the average response time to fatal rural crashes was 10.67 minutes, and non-fatal crashes had mean RT of 8.54 minutes. In a rural setting, response times were significantly longer in crashes involving a fatality ($p = <.0001$).[17]

In another study conducted in Spain, Sanchez et al attempted to determine if lowering ambulance response times to the scene of motor vehicle accidents would create a lower probability of patient death. Using probit regressions on the outcome measure of fatality versus non-fatality, analysis was done on a total of 1463 crashes on both major roadways and conventional roads. When the response time was 25 minutes, the estimated probability of death was 7.2%. The researchers found that a 10-minute reduction in medical response times from 25 to 15 minutes would result in

decreasing the probability of a fatal outcome by 33%(90%CI, p = 0.024).While this represents a significant improvement in patient mortality, a 15 minute response is still nearly double the current 8-minute guidelines. The study also found that after 30 minutes there is no significant improvement in patient outcomes at any greater time interval.[18]

1.4.4 All-cause mortality in priority-1 patients and response time intervals

Blanchard and Doiganalyzed a total of 7760 advanced life support responses in an urban community, with 1865 (24%) of the responses taking over 8 minutes from call receipt to arrival on scene. Retrospective analysis of patient data showed 7.1% of patients with response times greater than 8 minutes died in the ER or during hospital admission, versus 6.4% of those in the control group with response less than 8 minutes (risk difference 0.7%,95% CI -0.5,2.0%). When taking into account other confounding variables selected a priori, the adjusted odds ratioof mortality for those in the cohort was 1.19 (95% CI, 0.7, 1.47). Therefore when separating high priority patients by this dichotomous 8-minute cutoff, these results show no benefit in patient mortality for responses less than 8 minutes, as well as no significant increase in all-cause mortality for patients whose response time exceeded the 8-minute threshold.[19]

During the retrospective study performed by Blackwell and Kline there existed a mandate by the governing body of the EMS agency in Mecklenburg, NC , that all priority 1 calls have a response time less than 10:59 for advanced life support units. These priority calls included such things as breathing problems, unconsciousness, chest pain, motor vehicle crashes, strokes and gunshot wounds. In total, the study included 3270 priority-1 type patients, of which 373 had response times greater than 10:59 while the remaining 2897 met the benchmark time. To match the study cohort, 373 control patients were chosen at random from the 2897. The main outcomes

measured were in-hospital death and the types of interventions performed on scene. The researchers used Mann-Whitney U testing and then constructed an ROC curve to see if response times could be used to predict patient in-hospital mortality. They found that the ROC curve was no better a predictor than random assignment (the diagonal of the curve). There was an 80% survival rate for those in the study cohort, versus a 82% survival in the control, with a 95% CI for a difference of -6% to +4% change in mortality. All statistical testing performed supported the idea that there was no significant correlation between this 10:59 response time and patient mortality or the frequency of ALS interventions.[20]In a separate study, Blackwellproduced another telling graphplotting the log mortality odds of 71 deaths that occurred in 5424 patient transports versus the respond time in minutes. The graph illustrated that the mortality odds curve significantly flattened at responses over 5 minutes, indicating the inadequacy of the 10:59 minute guideline that existed in the study county. Therefore, lowering response times from 10:59 to 9 or 8-minutes would not improve patient outcomes.He showed that priority 1 patients had a mortality risk of 1.58 % if response times exceeded 5 minutes, while they experienced a 0.51% risk if RT was below 5 minutes.[21]

When performing analysis of patient outcomes other than just mortality, Weiss et al sampled 2164 cases of priority 1 patients being brought to a trauma center, with average response to trauma patients of 4.5 minutes and mean response to medical cases of 5.9 minutes. In a sampling of 559 total patients, they found no association between response time and total hospital days, admissions, ICU admissions or deaths.[22]

1.4.5 Three-tiered analysis of various patient conditions

Pons et al produced another study that separated patients into 3 risk categories: low, medium and high, using the EMS dispatch priority code and ED diagnosis codes. The retrospective study used multivariate regression analysis to see if patients in any of the three categories would have better outcomes as measured strictly by hospital discharge percentage if they received an ambulance response in less than 8 minutes. Over a period of one year they had 9559 patients that met inclusion criteria and found that patients across all categories saw no change in percentage discharged (ie, in-hospital mortality), even after controlling for factors such as age, gender, injury severity scoring and on-scene time. They did find that patients with a response time less than 4 minutes saw a small but significant improvement in outcomes, but these results were seen largely in the high risk group and in patients experiencing out of hospital cardiac arrest.[23]

1.4.6 Qualitative analysis of 8-minute response guideline

In the only relevant qualitative study found during the literature review, a population of 20 paramedics with a mean length of service of 19 years were interviewed using the constant comparative method. Questions regarding the use of an 8-minute response standard evoked feedback that illustrated the burden placed on meeting the guideline and its inadequacy as a performance indictor. The respondents noted the detrimental effects it has had on patient care due to the use of undertrained providers and understaffed response vehicles necessary to ensure adherence to the guideline. There also existed a systematic "tinkering" with times to produce the desired outcome. The use of rapid response vehicles that are able to be on-scene quickly but not capable of transporting patients was seen as delaying patient care.

Once a vehicle was on scene and the time target met, transport units responding would no longer deem a rapid response a priority and long wait times were common. One study participant indicated that:

> With this eight minutes, if you arrive in seven minutes and the patientdies it's a success. If you arrive in nine minutes and the patient lives and it's a good outcome, you've failed.And we are now treating the clock and not the patient[24].

The respondents noted that being required to sit strategically placed inside vehicles for entire 12-hour tours of duty without access to facilities and in sometimes dangerous conditions has caused multiple health and safety issues, including lower back pain and exposure to noxious diesel exhaust emitted from the constantly idling engine. Psychologically the isolation forced upon crew members by standby positioning has lowered morale and made it difficult to cope with the unique stressors the job places on the individual. The study participants stated that there are multiple factors that contribute to patient outcomes, with response times being just one.

1.5 CONCLUSION

The 8-minute response time guideline established early on in the history of modern EMS was based upon sound scientific evidence that those patients suffering cardiac arrest due to a cardiac related issue (ie, arrhythmia-inducing event) benefited by rapid administration of defibrillation and other advanced life support interventions. However, the broad application and adherence to this guideline when responding to both high and low priority calls has stretched the capabilities of municipal and private ambulance companies to their limits, and in some cases been detrimental to patient care and provider well-being.

After thorough review of studies encompassing a variety of patient conditions, current data fails to support a correlation between priority-1 patient outcomes and ambulance response times. High priority patients, or those identified as being most in need of expedient intervention, see no added improvement in morbidity or mortality when measured against this guideline. In fact, the standard would appear to be grossly inadequate as studies demonstrated that patients benefit when response times were less than 5 to 6 minutes. Given the already high demand on EMS resources and public use of emergency services continuing to rise, any additional reduction in response time standards would push ambulance companies past a breaking point.

A rapid medical response to emergency situations is a multifactorial issue that includes political, public perception and medical scientific components. Given the existing research, it appears the public and political factors currently outweigh what medical science tells us is an adequate response time. What remains to be addressed is how to best meet the needs of a community while making the most efficient use of resources.

After review of the existing literature, it was found that high acuity patients have been the major focus of previous research on the topic, even though they comprise only a small percentage of the overall call volume handled by EMS services. However, the low acuity patient receives the same "lights and sirens" ambulance response and calls are held to the same 8-minute standard as their high priority counterpart. The question remains if these low priority patients can be safely managed with protracted response times in light of the fact that even the "sickest of the sick" patients garner little to no benefit from current response guidelines. If data supports the theory that the low priority patient does not mandate a "lights and sirens" response, the answer to EMS resource management could come in more efficient use of existing resources, rather than the addition of new units on the street.

RESEARCH PROPOSAL

2.1 ABSTRACT

Problem: Emergency Medical Service agencies are adherent to an 8-minute ambulance response time guideline that research has shown does not correlate with improved patient outcomes, with the possible exception of patients experiencing out of hospital cardiac arrest. High acuity patient conditions represent a small percentage of calls to 911, yet they represent the focus of the majority of prior research. Non-priority patients receive the same emergent response, making use of "lights and sirens" during ambulance travel and placing the public and ambulance personnel at increased safety risks. Existing research fails to examine if there is any increase in patient morbidity or mortality when they experience an ambulance response exceeding 8 minutes, specifically in patients deemed to have non-life threatening conditions at the time of dispatch. **Purpose**: To improve the management of existing ambulance resources, and to ensure the safe operation of ambulance units when responding to patient locations. **Research questions:**Can non-priority patients who request ambulance response via a 911 system in an urban setting be safely managed with protracted response times in excess of the 8-minute response time guidelines currently in place with no adverse effect in outcomes?**Methods:** This is a retrospective cohort study analyzing data from 6 months of emergency calls and associated patient medical records. Statistical analysis of data will includelogistic regression and stratified analysis. Odds ratio and correlation coefficients will be used to evaluate interactions between the dependent and independent variables.**Outcomes:**The study will determine if non-priority patients who receive an ambulance response in excess of 8 minutes are more likely to be admitted to the hospital through the Emergency Department, or have a longer overall duration of hospitalization, or experience higher in-hospital mortality rates.**Benefit:** If exceeding the current 8-minute guidelines for ambulance scene response is not shown

to increase any of the selected determinants of patient outcomes, then EMS agencies can use this data to support changes in current protocols that enhance the safety and efficacy of existing units.

2.2 AIMS

2.2.1 Project Overview

Emergency Medical Service (EMS) agencies are often evaluated based upon their adherence to a previously established 8-minute response time guideline. Both high-priority patient conditions and non-priority calls receive the same "lights and sirens" ambulance response to the scene in order to comply with the guidelines. Subsequent research into high priority patient outcomes has failed to prove an association with an ambulance response time less than 8 minutes.

This study sets out to determine if an association exists between non-priority patient outcomes as measured by a specific set of variables, and ambulance response times. Recommendations on alterations to current protocols will be made based upon the findings of the study

2.2.2 Research Question

Can non-priority patients who request ambulance response via a 911 system in an urban setting be safely managed with protracted response times in excess of the 8-minute response time guidelines currently in place with no adverse effect in outcomes?

2.2.3 Specific Aims

AIM 1: Create a retrospective cohort study within an urban environment to determine if ambulance response times to non-priority patients in excess of 8 minutes are correlated with an increase in patient morbidity or mortality.

AIM 2: Cull data from the New York City (NYC) 911 EMS system to recruit patients with appropriate inclusion criteria and link them with corresponding medical records at receiving hospitals.

AIM 3: Analyze the data using appropriate statistical methods to determine correlation coefficients and adjusted odds ratios.

AIM 4: Identify if a statistically significant difference exists between patients exposed to a protracted ambulance response time and those who received an ambulance response in less than 8 minutes.

2.2.4 Hypothesis

Null Hypothesis: Non-priority patients who have ambulance response times in excess of 8 minutes will see no significant differences in morbidity as measured by admission rate, total duration of hospital course,or in their overallmortality rate.

Alternative: Those non-priority patients who have ambulance response times in excess of 8 minutes will have a higher rate of admission through the emergency department, and/or a longer total duration of hospital stay, and/or a higher in-hospital mortality rate versus those who meet the 8-minute guideline.

2.3 BACKGROUND AND SIGNIFICANCE

2.3.1 Background

Emergency Medical Services in urban environments are often overwhelmed by the high volume of requests for medical aid.Efficient management of limited resources is essential to providing effective, timely interventions to those most in need of pre-hospital care. Prior research into one highly focused patient condition, out of hospital cardiac arrest, has established a sweeping 8-minute ambulance response time guideline.[2]Non-adherence to the guideline can result in negative consequences for the EMS agency, including loss of contract, negative public opinion and political blowback[4,5]. Subsequent research has questioned the impact this 8-minute guideline has on high priority patients suffering from a number of different conditions. Despite

this apparent lack of association, the application of the same 8-minute standard and other response protocols including the use of lights and sirens to the scene is standard practice. This places an additional burden on EMS systems and contributes to added safety risks for patients and care providers[24]. Little emphasis in existing research has focused on non-priority patient calls to 911 systems, despite their disproportionate percent of overall call volume.

2.3.2 Project Significance

This study will be the first to look specifically at non-priority patients in relation to ambulance response time as prior studies have focused on more highly acute patient conditions. Recommendations based upon the results could greatly affect the management of limited EMS resources in urban environments.The safety implications for both patients and EMS providers based upon the findings of this study are a secondary gain. While it might prove to be a the largest hurdle to overcome, this study could support a campaign to change the culture of EMS in such a way that educates the public on the proper intended use of 911 resources and resets public expectations regarding "fast" responses.

2.4 PRELIMINARY STUDIES

Not Applicable

2.5 RESEARCH DESIGN AND METHODS

2.5.1 Design

A retrospective cohort study will be performed to enable a quantitative analysis of data. Study subjects will be selected from the New York City 911 system. Subjects will then be split according to exposure to an ambulance response time under or over 8

minutes as documented on ambulance generated Patient Care Reports (PCRs).Data from subject PCRs will be linked to Electronic Medical Records (EMRs) at the receiving 911 hospital, specifically looking at ED admission data, hospital length of stay and discharge disposition. The data from PCRs and EMRs will be culled to account for any confounding variables.Statistical analysis will be performed using SPSS software to determine correlations and significance.

2.5.2 Methods

Only emergency calls placed in the NYC 911 system taken by trained dispatch personnel will be screened for inclusion. The call type at time of dispatch to the responding ambulance as detailed in Figure 2 must be between priority levels 4-6. Those call types represent non-priority calls that make use of a "lights and siren" response. The call must have generated a PCR with an actual patient encounter.The PCR must clearly document response time as measured by time interval from dispatch of ambulance to the scene to arrival of first responding unit.The patient must have been transported to a 911 receiving emergency department. The PCR must be linked to a patient medical record at the receiving hospital.The medical record must give complete information regarding patient disposition from Emergency Room, overall length of hospital course and discharge status or the occurrence of in hospital mortality.Prior to commencing the chart review, Institutional Review Board (IRB) approval will be obtained.

Figure 2: Call Types and Assigned Triage Priority[27]

Call Type	Priority	Response	Call Type	Priority	Response
ARREST	1	DUAL CFR	[illegible]	4	BLS
CHOKE	1	DUAL CFR	[illegible]	4	BLS
DROWN	1	DUAL CFR	[illegible]	4	BLS
ANAPH	2	ALS CFR	[illegible]	4	BLS
STATEP	2	ALS CFR	[illegible]	4	BLS
UNC	2	ALS CFR	[illegible]	4	BLS
UNCRF	2	ALS CFR	[illegible]	4	BLS
ASTHMA	2	ALS H/CFR	[illegible]	5	BLS
DIFFBR	2	ALS	[illegible]	5	BLS
DIFFRF	2	ALS	[illegible]	5	BLS
MEDVAC	2	ALS	[illegible]	5	BLS
TRAUMA	2	BLS Rescue	[illegible]	5	BLS
JUMPDN	2	BLS CFR	[illegible]	5	BLS
VENOM	2	BLS CFR	[illegible]	5	BLS
CVAC	2	BLS	[illegible]	5	BLS
OBCOMP	2	BLS	[illegible]	5	BLS
ALTMEN	3	ALS	[illegible]	5	BLS
BURNMA	3	ALS CFR	[illegible]	6	BLS
CARD	3	ALS CFR	[illegible]	6	BLS
ELECT	3	ALS CFR	[illegible]	6	BLS
INBLED	3	ALS CFR	[illegible]	6	BLS
AMPMAJ	3	BLS CFR	[illegible]	6	BLS
INJMAJ	3	BLS CFR	[illegible]	6	BLS
OBOUT	3	BLS CFR	BURNMI	7	BLS
PEDSTR	3	BLS Rescue	DOA	7	BLS
GYNMAJ	3	BLS	EDP	7	BLS
PD13C	3	BLS	INJMIN	7	BLS
SHOT	3	BLS	JUMPUP	7	BLS
STAB	3	BLS	PD13	7	BLS
UNKNOWN	3	BLS	SICMIN	7	BLS
[illegible]	4	BLS	SPEVNT	8	BLS
[illegible]	4	BLS	STNDBY	8	BLS
[illegible]	4	BLS	STRANS	8	BLS
[illegible]	4	BLS	DDOA	9	BLS
[illegible]	4	BLS			

All calls with an initial triage level 1-3 will not be selected, as those calls represent high priority patients. Calls with an initial triage level of 7-9 will also be excluded as those do not require the use of "lights and sirens" to the scene.Any calls designated as type "Other" or "Unknown" will be excluded as they represent an incomplete triage by the dispatcher.PCRs must have complete time interval data clearly documented. A link between the ambulance-generated PCR and the patient medical recordat the receiving hospitalmust be established. If the dispatched ambulance was not the first unit on scene (ie, fly car, fire apparatus, other BLS or ALS unit), the PCR will be excluded. EMRs without a complete hospital course and/or discharge disposition will be excluded.

As dependent variables, this research study will focus specifically on the rate of admission to hospital through the ED, the total length of hospital stay in days, and the percentage discharged from the hospital. The statistical significance of each dependent variable will be analyzed separately. Exposure to an ambulance scene response time in excess of an 8-minute cutoff will be the independent variable.Confounding variables could include the accuracy of the initial triage level at time of dispatch, as measured by the need to upgrade the call to a higher priority after the first responding unit makes patient contact. This data can be readily obtained from PCRs.

2.5.3 Statistical Analysis

An *a priori* power analysis performed to a 0.99 power produced a minimum sample size of 1149 patients. Logistic regression and stratified analysis will be used to measure associations between ambulance response time and likelihood of admission through the ED, total duration of hospital stay and overall percentage discharged.Odds ratio and correlation coefficients will be used to evaluate interactions between the

dependent and independent variables.Additional stratified analysis separating patients into groups by their initial call triage level (4,5,6) will be performed to see if differences exist between the subset groups. Confidence level will be set at 95%, significance will be a p value <0.05.

2.5.4 Limitations

This study is limited by several factors. A retrospective study is dependent upon the accuracy of data documented at the time of occurrence, without any ability of the researcher to definitively prove accuracy. The study relies on the initial triage of the medical condition by EMS dispatchers. There may be iatrogenic complications or other causes of morbidity or mortality during the patient's hospital course unrelated to the initial presenting complaint. The ability to manually link Patient Care Reports with Electronic Medical Record data could prove to be a difficult process. The study will use only 3 variables as a measure of patient outcomes, which may underestimate long term patient morbidity related to one particular hospitalization.

In addition, the model and modalities of pre-hospital care vary between geographic regions and between countries, making it difficult to broadly apply the findings of this study.

2.5.5 Timeline

Chart review will begin in January 2016. The total time period covered by retrospective analysis based upon power analysis will be from January 2015 through June 2015, considering an average total daily call volume of approximately 3000 per day.[28]An additional 3 months will be required for data analysis and publishing of data.

2.5.5 Conclusion

Utilizing carefully selected ambulance PCRs and patient EMRs, retrospective statistical analysis of any existing relationship between non-priority patient outcomes and ambulance response times will be performed over the course of 6 months. Data will be used to support or refute the established industry standard response time guidelines.

2.6 SUMMARY

This retrospective study, conducted in a major urban EMS setting over the course of 6 months, sets forth to analyze the pre-hospital and electronic medical record data of1149 patients, to determine if patient outcomes are predicated on receiving an ambulance response in 8-minutes or less. It will be the first to look specifically at the patient population which comprises the majority of calls to 911: conditions deemed by EMS dispatchers as not immediately life threatening. The study will use three separate variables; admission rate, hospital length of stay, and discharge percentage as indicators of patient outcomes. If there is determined to be no significant difference in patient outcomes with a protracted ambulance response, recommendations will be made to help EMS agencies test more appropriate response guidelines in an effort to maximize resources and improve patient and provider safety.

REFERENCES

1. Shah MN. The formation of the emergency medical services system. Am J Public Health. 2006;96(3):414-23.

2. Eisenberg MS, Bergner L, Hallstrom A. Cardiac resuscitation in the community. Importance of rapid provision and implications for program planning. JAMA. 1979;241(18):1905-7.

3. Spaite D, Benoit R, Brown D, et al. Uniform prehospital data elements and definitions: a report from the uniform prehospital emergency medical services data conference. Ann Emerg Med. 1995;25(4):525-34.

4. Gonzalez, Juan. Mistake delayed ambulance to girl, 4, struck by SUV on Upper East Side. Available at: http://www.nydailynews.com/opinion/gonzalez-delay-911-system-claimed-life-article-1.1365678. Accessed August 11, 2014.

5. Bankoff, Caroline. 911 Dispatchers Suspended over delayed response to deadly fire. Available at: http://nymag.com/daily/intelligencer/2014/04/911-dispatchers-suspended-over-delayed-response.html. Accessed August 11, 2014.

6. McIntire, Mike. Anatomy of a $133,000 ambulance; city pays premium but its tough specs draw few bidders. Available at: http://www.nytimes.com/2003/10/21/nyregion/anatomy-133000-ambulance-city-pays-premium-but-its-tough-specs-draw-few-bidders.html. Accessed August 11, 2014.

7. Hinchey P, Myers B, Zalkin J, Lewis R, Garner D. Low acuity EMS dispatch criteria can reliably identify patients without high-acuity illness or injury. PrehospEmerg Care. 2007;11(1):42-8.

8. Beillon LM, Suserud BO, Karlberg I, Herlitz J. Does ambulance use differ between geographic areas? A survey of ambulance use in sparsely and densely populated areas. Am J Emerg Med. 2009;27(2):202-11.

9. Sporer KA, Wilson KG. How well do emergency medical dispatch codes predict prehospital medication administration in a diverse urban community?. J Emerg Med. 2013;44(2):413-422.e3.

10. Ho J, Casey B. Time saved with use of emergency warning lights and sirens during response to requests for emergency medical aid in an urban environment. Ann Emerg Med. 1998;32(5):585-8.

11. Brown LH, Whitney CL, Hunt RC, Addario M, Hogue T. Do warning lights and sirens reduce ambulance response times?.PrehospEmerg Care. 2000;4(1):70-4.

12. DeMaio VJ, Stiell IG, Wells GA, Spaite DW. Optimal defibrillation response intervals for maximum out-of-hospital cardiac arrest survival rates. Ann Emerg Med. 2003;42(2):242-50.

13. Vukmir RB. Survival from prehospital cardiac arrest is critically dependent upon response time. Resuscitation. 2006;69(2):229-34.

14. O'Keeffe C, Nicholl J, Turner J, Goodacre S. Role of ambulance response times in the survival of patients with out-of-hospital cardiac arrest. Emerg Med J. 2011;28(8):703-6.

15. Pons PT, Markovchick VJ. Eight minutes or less: does the ambulance response time guideline impact trauma patient outcome?. J Emerg Med. 2002;23(1):43-8.

16. Newgard CD, Schmicker RH, Hedges JR, et al. Emergency medical services intervals and survival in trauma: assessment of the "golden hour" in a North American prospective cohort. Ann Emerg Med. 2010;55(3):235-246.e4.

17. Gonzalez RP, Cummings GR, Phelan HA, Mulekar MS, Rodning CB. Does increased emergency medical services prehospital time affect patient mortality in rural motor vehicle crashes? A statewide analysis. Am J Surg. 2009;197(1):30-4.

18. Sánchez-Mangas R, García-Ferrrer A, De Juan A, Arroyo AM. The probability of death in road traffic accidents. How important is a quick medical response?.Accid Anal Prev. 2010;42(4):1048-56.

19. Blanchard IE, Doig CJ, Hagel BE, et al. Emergency medical services response time and mortality in an urban setting. PrehospEmerg Care. 2012;16(1):142-51.

20. Blackwell TH, Kline JA, Willis JJ, Hicks GM. Lack of association between prehospital response times and scenepatient outcomes. PrehospEmerg Care. 2009;13(4):444-50.

21. Blackwell TH, Kaufman JS. Response time effectiveness: comparison of response time and survival in an urban emergency medical services system. AcadEmerg Med. 2002;9(4):288-95.

22. Weiss S, Fullerton L, Oglesbee S, Duerden B, Froman P. Does ambulance response time influence patient condition among patients with specific medical and trauma emergencies?. South Med J. 2013;106(3):230-5.

23. Pons PT, Haukoos JS, Bludworth W, Cribley T, Pons KA, Markovchick VJ. Paramedic response time: does it affect patient survival?.AcadEmerg Med. 2005;12(7):594-600.

24. Price L. Treating the clock and not the patient: ambulance response times and risk. QualSaf Health Care. 2006;15(2):127-30.

25. FDNY EMS Citywide Summary Statistics. Available at: http://www.nyc.gov/html/fdny/pdf/stats/2014/ems/cw/ems_cwsum_cy14. Accessed February 12, 2015.

26. Silverman RA, Galea S, Blaney S, et al. The "vertical response time": barriers to ambulance response in an urban area. AcadEmerg Med. 2007;14(9):772-8.

27. Freese, John. What happens when you queue less urgent 911 calls. Available at: http://gatheringofeagles.us/ACEPDenver/ThankYouForHolding. Accessed March 18, 2015.

28. FDNY EMS Response Times. Available at: http://www.nyc.gov/html/fdny/html/stats/graph_ems_resp_times.shtml. Accessed August 11, 2014.