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Planning for a Medical Surge Incident: Is Rehabilitation the Missing Link?

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PLANNING FOR A MEDICAL SURGE INCIDENT:

IS REHABILITATION THE MISSING LINK?

A Dissertation Submitted to the
Graduate Faculty
of Jacksonville State University
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for the Degree of Doctorate of Emergency Management

By

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ABSTRACT

This study explores planning considerations for patients needing rehabilitative care in the event of mass casualty incidents, in particular, patient surge. While planning for a patient surge usually considers prehospital and hospital care, the final step for many disaster patients, rehabilitation is often overlooked. Rehabilitative care begins in the hospital, before discharge, with the consultation of a physician specialist. By including early physiatrist care there are documented decreases in hospital length of stay, fewer medical complications and better functional outcomes

Based on past disaster studies, the variables of Simple Triage and Rapid Treatment (START), Injury Severity Score (ISS), and hospital discharge were chosen as benchmarks. The quantitative study research questions are:

1. Can START classifications predict whether a patient will need to be admitted into a rehabilitation facility after a disaster?
2. Can ISS scores predict which patients will need to be admitted into a rehabilitative facility after a disaster?

A secondary disaster dataset was constructed from the 2011 National Trauma Data Bank (NTDB) dataset for patients injured during a disaster. Analysis of this empirical data provided evidence that the selected variables did predict rehabilitation admission, and thus can be used in pre-disaster and operational medical planning.

Qualitative methods were used to investigate how rehabilitation considerations might be incorporated in surge planning. A Haddon matrix for surge planning provided the conceptual framework and aided in the development of interview questions. Six themes were analyzed based on the interview question responses: barriers to planning; multiple surges; planning for

resources; planning to prevent injuries; optimal time to look for rehabilitation beds; and, additional recommendations. The insights of subject matter experts revealed many new strategies to improve surge planning and patient outcomes. This study concludes that a reconceptualization of surge planning to include three phases of field, hospital, and rehabilitation is a needed improvement to medical disaster planning.

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VITA

Mary Kay (nee Butcher) Vonderschmidt was born in Covington, Kentucky on May 26, 1958. She is the daughter of Mr. Eugene and Mrs. Ruth (nee Dressman) Butcher of Covington, Kentucky. Ms. Vonderschmidt received a Bachelor of Science in Public Administration at Northern Kentucky University in 1989, a Master of Science in Public Administration at Northern Kentucky University in 2006 and a Master of Science in Emergency Management at Jacksonville State University in 2008. Kay spent the majority of her first career as a paramedic and educator. Her second career has included education, research, and emergency management. Kay has two children (D. Andrew and Katherine) and resides in Burlington, Kentucky.

DEDICATION

I want to thank my grandmother and my parents for their love, wisdom and the encouragement to follow my dreams. They were the smartest people I have ever known. Their love of always needing to "find out more" continues to inspire me. I also want to thank my children, Drew and Kati, without your love and support I could have not completed this degree. You are the light of my life and have kept me focused during this journey.

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1 Introduction

Each year, the United States experiences many different types and sizes of natural, technical and man-made disasters. In 2016, the United States witnessed federal disaster declarations that included hurricanes, tornadoes, floods, wildfires, and severe weather. (Federal Emergency Management Agency, 2016) Each of these disasters has the ability to cause traumatic injuries and deaths. Because these injuries could turn into lifelong disabilities, it is important to prepare the medical community for a surge of disaster patients who will need rehabilitative care.

Communities plan for disasters based on the hazards that exist within their locality. For example, cities in Kansas may consider tornadoes as their top threat so their plans must include tornado education, warnings, and procedures on what to do when a tornado is near. Each community entity including government, private business, non-government and faith based organizations need an emergency plan for their citizens, employees and students.

Many hospitals plan with regional healthcare coalitions to become better prepared for internal and external disasters. Various types of external disasters that could cause a large amount of patients include a school bus accident or a weather-related incident such as a tornado. Hospitals must also prepare for internal threats such as a fire or active-shooter within their building. Any type of disaster, whether internal or external, has the potential to cause a large number of patients. When this large number of patients overwhelms a field response unit or a hospital it is called a patient surge.

Planning by Emergency Medical Services (EMS) providers for a patient surge includes field care and proper distribution of patients to hospitals. Hospital surge planning includes patient care protocols and procedures that create more space (“open beds”) for patients, such as

cancelling surgeries, facilitating discharges, or moving patients to alternate care centers. (Koenig & Schultz, 2010) Concepts such as surge planning, surge capacity and surge capability have evolved over the last twenty years and with each large disaster experienced, new best practices have emerged.

Disaster planning has received attention by the federal government through healthcare organizations such as the Agency for Healthcare Research and Quality (AHRQ) and the Centers for Disease Control and Prevention (CDC). These agencies have identified medical surge as one of the target capabilities in the National Preparedness Goal. (Federal Emergency Management Agency, 2016) The critical tasks during medical surge planning include having adequate staff, supplies and equipment, and space for each patient. (Reilly & Markenson, 2011) Medical surge incidents are typically considered to be the domain of EMS; hospital emergency departments; hospital in-patient care areas including operating rooms, intensive care and non-critical care beds; and hospital resources such as radiology, lab, medical supplies and personnel.

There is an area of medicine, however, that is often overlooked while planning for disaster patients. Medical rehabilitation, that is, patient care that is provided post hospitalization within an in-patient rehabilitation facility, is generally not included in the community disaster planning process. Use of in-patient rehabilitation facilities has been proven to decrease patient hospital stays and increase patient mobility and function after a traumatic injury. (Wade & de Jong, 2000) Such facilities have gained acceptance in the last ten years and currently many patients, including trauma, stroke, and cardiac patients, move from acute care hospitals to in-patient rehabilitation before going home. Research has found that rehabilitative medical care will reduce both mortality and morbidity (Wade & de Jong, 2000). Because of this, it is now common to have a patient discharged from the hospital and admitted into an in-patient

rehabilitative facility. Dr. Rathore and his colleagues noted that several changes need to occur in disaster planning. For example, disaster response plans are lacking for a surge of patients who need to be admitted to a rehabilitative facility:

> Injury patterns, mortality profiles, and the economic impact of natural disasters have been well researched and documented. Regrettably, however, response plans and acute care protocols do not typically include rehabilitative need. Medical complications of disabling injuries, long-term disability, and other significant, negative consequences for the individual and society are the result. (Rathore, et al., 2012, p. 1876)

This study explores several possibilities for surge planning. First, can the standard healthcare tools of Simple Triage and Rapid Treatment (START) and Injury Severity Score (ISS) project demand for patients who require rehabilitative care? Second, can using semi-structured interviews with subject matter experts change the way surge is conceptualized? The answers to these questions will allow emergency planners; healthcare coalitions and hospital incident management teams make appropriate recommendations for rehabilitative patient management. Each disaster patient would then have his/her continuum of care, from field to home, completed, even during surge conditions.

The Problem of Patient Surge

Medical surge has been defined as an "increase in patient flow above the norm and is characterized by an imbalance between resources and needs" (Koenig & Schultz, 2010, p. 35). Medical surge planning for disasters includes patient care, supplies, and resources to manage a

large number of patients. Medical care is begun at the scene of the disaster (field care) and continues until the patient is released from the hospital, rehabilitation facility or expires. For many patients this could take days or months depending on the type and severity of their injuries. Planning for a surge of patients has been well researched in EMS and hospitals, and this research has led to well-defined preparedness recommendations. However, there is a research gap when it comes to planning for a surge of patients who need rehabilitative care. The focus of this research study is to explore strategies that could lead to new recommendations for planning for a surge of patients who need rehabilitative care.

Medical surge planning is an important piece of EMS disaster preparedness and operations. Disaster education on triage, the incident command system, trauma injury care, weapons of mass destruction, and medical countermeasures are incorporated into all levels of EMS certifications. (National Highway Transportation Safety Administration, 2007) In addition, EMS organizations have formal protocols in the event of certain types of disasters that include, for example, specialized medications for nerve agent exposures or as witnessed in the Boston marathon bombings, tourniquets for blast injuries.

EMS manages the *first* phase of patient surge at the scene of the disaster. A large influx of patients will cause the incident commander to request numerous EMS providers to care for these patients. Each patient is triaged into an acuity of care category using a triage algorithm, such as the Simple Triage and Rapid Transport (START) method. (Koenig K. L., 2013) Treatment may include bandaging, splinting and bleeding control.

Hospital surge, which is the *second* phase, includes those transported by EMS as well as those that bring themselves to a hospital after a disaster. (Auf der Heide, 2006; Koenig & Schultz, 2010) Hospital surge planning includes education on triage, the incident command

system, trauma care, and syndromic surveillance. (Koenig & Schultz, 2010) Hospitals should be able to increase their capacity (patient load) by 20% of their licensed beds within four hours of a disaster to meet patient surge demands according to the Department of Health and Human Services. (Department of Health and Human Services, 2016) Each hospital is permitted to have their own individual strategy to meet this 20% of additional capacity. Hospitals must be ready to combat the surge imbalance with disaster plans that include decreasing their patient load. Methods for decreasing the patient load could include, the discharge of patients who are medically stable early, cancel non-emergent outpatient procedures, and, if needed, opening additional temporary beds in alternate care centers. Each hospital should have the ability to accommodate a patient surge incident or have a protocol to transport patients from their emergency department to alternative hospitals if they become saturated.

Recently the Department of Health and Human Services (DHHS), Centers for Medicare and Medicaid Services (CMS) published new emergency preparedness requirements for Medicare- and Medicaid-participating healthcare organizations. (Department of Health and Human Services, Centers for Medicare and Medicaid Services, 2016) This new standard includes changes in disaster planning, education, operations, and business continuity. These new requirements are based on past nation-wide disaster experiences and will assist healthcare facilities to become more disaster resistant and resilient. (Department of Health and Human Services, Centers for Medicare and Medicaid Services, 2016)

This document proposes that an additional surge of patients should be considered during disaster planning. A *third* surge of patients may occur at the time of hospital discharge for those patients that need additional medical care at an in-patient rehabilitative facility. Considerable evidence exists about how physical, occupational and speech therapies are critical to a patient's

health. By increasing a patient's functional outcome, the patient will be more productive when returning to the community. (Rathore, et al., 2012)

Rehabilitation facilities have a limited number of licensed beds available, a typically high census, and often a waiting list for admittance. (Sirois, Lavoie, & Dionne, 2004) In many instances, hospitals may have an agreement with local skilled nursing and rehabilitation facilities to move hospitalized patients to these care centers in the event of a disaster to gain more beds for use at the hospital, as previously discussed. Such agreements have the unintended consequence of exacerbating the problem of limited rehabilitation beds. The resulting delay in rehabilitative care will likely cause a reduction in functional outcome for the patient. (Reinhardt, et al., 2011) "With an increasing frequency of natural disasters, there is a greater focus on the role of rehabilitation in disaster management" (Khan, Amatya, Gosney, Rathore, & Burkle, 2015, p. 1710).

Despite this increased focus, community disaster planners typically do not include rehabilitative care during the recovery phase so there could be a significant delay from in-hospital care to in-patient rehabilitative facility care post disaster for many patients. (Reinhardt, et al., 2011) Benchmarks are needed to determine which patients may need rehabilitative care after a disaster. (Aylwin, et al., 2006; Bayrum, Zuabi, & Subbarao, 2011) One way to begin to establish such benchmarks would be to find a reliable way to project demand for rehabilitative care based on the injuries sustained or on past usage of rehabilitative care after a disaster. Use of these benchmarks could aid healthcare leaders in planning when to open additional rehabilitative care locations, and add medical personnel after a disaster.

The EMS and Hospital Roles

Preparedness for patient surge management was an area of concern for EMS and hospitals before 1983; however, it was not until 1983 that the staff from Hoag Hospital and Newport Beach Fire Department developed the Simple Triage and Rapid Treatment (START) triage method. (Jenkins, et al., 2008) Triage, from the French verb that means, "to sort," was reportedly first used by Surgeon Jean Larrey during the Napoleonic Wars (Koenig & Schultz, 2010, p. 174). "Dr. Larrey developed a new system for sorting battle casualties into categories" (Koenig & Schultz, 2010, p. 174) based on how critically the soldier was injured. Some form of triage has been used subsequently during many wars and conflicts. The goal of patient triage today for EMS providers is to place patients into categories based on their injuries and vital signs, and also to ensure that the most critically injured are transported to designated trauma hospitals. "START triage is the most commonly used method in the United States. It is also used in Canada, Saudi Arabia, and parts of Australia and Israel" (Koenig & Schultz, 2010, p. 175).

Medical surge research has revealed that most "disaster planners assume that the flow of casualties in a disaster will be under the control of the EMS system, however, it has been found that many disaster casualties are transported by private vehicle" (Auf der Heide, 2006, p. 42). Because of the large number of patients that self-transport to the hospital, plans at each hospital have to include a quick triage upon patient arrival by hospital personnel, similar to that used by EMS, to sort out the large number of people arriving at the hospital emergency department doors. Eventually, ambulances will also be bringing in patients from the field to the emergency department. These patients will have their first triage in the field and will then need to be re-triaged for changes in their medical condition upon arrival at the hospital. Many hospitals now

have plans to hold open empty beds in the emergency department for potential incoming ambulances. (Auf der Heide, 2006)

The Rehabilitation Role

Rehabilitative medicine has been in existence at least since Franklin D. Roosevelt (1921) used warm waters for therapy for his polio in Warm Springs, Georgia. The first university Department of Rehabilitation was founded at Temple University Medical School in 1929. (Atanelov, Stiens, & Young, 2015) The first textbook was published in 1941, *Physical Medicine*, where the term "physiatrist" was coined. (Atanelov, Stiens, & Young, 2015, p. 569) Physiatrists customize treatment plans for each patient that often include, "medications, therapeutic exercise, injections, physical modalities and education" (Atanelov, Stiens, & Young, 2015, p. 570).

Over the last thirty years, the medical specialty of rehabilitation medicine has grown tremendously and it is now common for a patient with a traumatic injury from a fall or motor vehicle crash to be treated by trauma *and* rehabilitation physicians. (Wade & de Jong, 2000) This is also true for patients who have suffered a stroke, cardiac event or even a hip or knee replacement. "The primary goals of medical rehabilitation are to improve activity and participation within contextual factors (personal, environmental). This includes functional capabilities and social reintegration" (Khan, Amatya, Gosney, Rathore, & Burkle, 2015, p. 1710).

> Wade and de Jong write: The demand for rehabilitation services will increase as evidence accrues for their effectiveness and as more people survive longer with substantial disability. Current evidence strongly supports the provision of well-

organized, coordinated, multidisciplinary rehabilitation services based on a problem-oriented approach (Wade & de Jong, 2000, p. 1385).

Research on patients who need rehabilitative care has continued to increase, for example, "the national guidelines on stroke cite 80 or more randomized controlled trials focused specifically on stroke rehabilitation" (Wade & de Jong, 2000, p. 1386). The goal of multi-disciplinary rehabilitation is coordination of care, expertise and patient education. Because of the increase of research and continued best practices of rehabilitative care "the presumption should now be that most patients with a disability would benefit from being seen by a specialist in rehabilitative medicine" (Wade & de Jong, 2000, p. 1387).

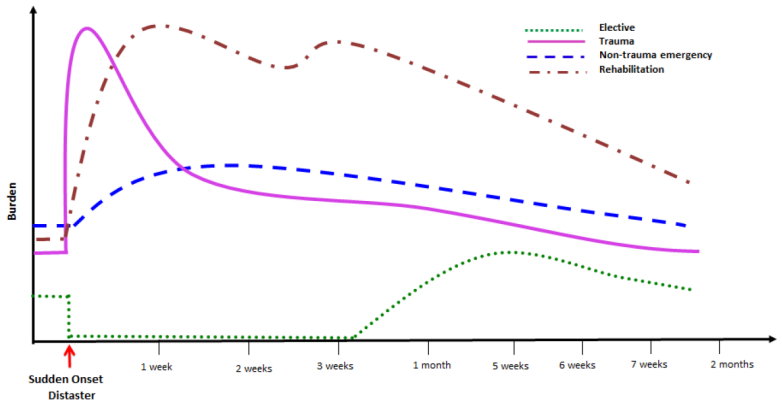
Of interest, the World Health Organization (WHO) established a sub-committee in 2011 to examine the emerging subspecialty of disaster rehabilitation medicine. This sub-committee's mission is to "provide a rapid response rehabilitative team to a disaster; provide training to medical professionals, and conduct research" (Gosney, Reinhardt, Haig, & Li, 2011). The profession of rehabilitative medicine includes care for neurologic injuries, orthopedic injuries, and patients with traumatic injuries, with the goal to return patients back to functional status after their injury. In recent years, specialists in rehabilitative medicine have volunteered for disaster missions, including the Pakistan and Haitian earthquakes. (Gosney, Reinhardt, Haig, & Li, 2011)

Clearly, while considerable planning and preparedness resources have been placed on emergency response and triage, and despite the research cited above, rehabilitation needs following a disaster has been a neglected area. The figure (Figure 1) below shows the surgical and rehabilitation needs over several months following several recent disasters. Note that the elective surgeries at a hospital may be decreased or cancelled due to the increase in disaster patients for the first several weeks post disaster. Also note the rise in rehabilitation services

during weeks 1 – 3; this is due to the increase of resources needed to return each patient back to a functional status.

Figure 1

Trends in Rehabilitation burden in Sudden-Onset Disasters over time



Modified with permission from Von Schreeb J, Riddez L, Samnegård H, Rosling H et al. Foreign field hospitals in the recent sudden-onset disasters in Iran, Haiti, Indonesia, and Pakistan. Prehosp Disaster Med. 2008;23(2):144–51 [75]

(World Confederation for Physical Therapy, 2016, p. 31).

Few researchers have evaluated the availability of rehabilitative services during the recovery phase, which determines both the individual and community's ability to return to a near or new normal lifestyle. Each community member who can remain close to work, family/friends, personal physician, and home will aid in the resiliency of the whole community. (Rathore, et al., 2012) Because of this knowledge gap, missed opportunities for proper planning may occur.

This study evaluates the use of healthcare patient assessment tools of Simple Triage and Rapid Treatment (START) triage and Injury Severity Score (ISS) as they relate to patients who were admitted to a short, intermediate or long-term care rehabilitation facility after

hospitalization. Past disaster patient care data from the National Trauma Data Bank (NTDB) was used to determine each patient's acuity with START and ISS and his/her discharge status (e.g., home, rehab). As previously noted, this patient data analysis could aid in establishing benchmarks for surge planning and preparedness. These concepts and how they influence medical surge are explored in more detail in the next chapter.

Purpose and Significance of Study

Healthcare systems must employ planning tools, knowledge of community resources, and an understanding of community demographics and threats in order to anticipate the resources that might be needed for patient care from a disaster. Many regional planning entities and healthcare coalitions currently include rehabilitation facilities only as a source of additional beds for moving patients from hospitals into these facilities during a hospital surge. They have not yet considered the importance of a rehabilitation facility as the final patient care destination before the patient returns home.

The goal of this research is to explore the lack of planning for rehabilitative patients during or immediately post disaster and to reconceptualize surge planning into three phases: field, hospital, and rehabilitation. Additionally, a determination will be made as to whether START triage and ISS scores can predict which patient will need to be admitted to a rehabilitation facility post hospitalization. The answers to these questions could aid in improved collaborative healthcare planning for a surge of patients prior to a disaster and early acquisition of rehabilitative care after a disaster.

Research Approach

The research approach for this study begins with a quantitative analysis of data from the National Trauma Data Bank (NTDB) patient care records from 2011, a very active year for disasters. The NTDB, which is maintained by the American College of Surgeons, is a national database, which contains patient care information from traumatic injuries. The NTDB contains detailed data collected from over 900 registered (United States) trauma-accredited hospitals. This study uses a subset of the 2011 NTDB records for patients injured in a disaster. The main variables of interest are the individual patient's START triage category and Injury Severity Score (ISS), which are completed by EMS and the hospital respectively, and the location the patient was discharged to, such as home or a rehabilitation facility. Frequency analysis is used to determine whether a START category or ISS could establish the probability, of which patients need to be admitted to a rehabilitation facility.

Additionally, semi-structured interviews with subject matter experts from healthcare planning, emergency management and medicine were administered to explore new strategies on planning for rehabilitation patients in a disaster. Their responses are analyzed using qualitative methods, and will be presented in following chapters.

Organization of Study

This research study is organized into six chapters. Chapter 1 provides the background of the problem, the problem statement and purpose of the study. It also includes an overview of the research approach and benefits of the study. Chapter 2 is an overview of surge planning concepts. Chapter 3 includes a review of the literature on rehabilitative surge and the variables of START and ISS. Chapter 4 describes the methodology used for the study analysis. It explains the procedures and how the data is going to be analyzed. Chapters 5 and 6 contain the results of the data analysis, discussion of findings, and recommendations for future planning and

preparedness activities.

Summary

Currently, healthcare planners consider two phases of patient surge during a disaster. The first surge is at the scene of the disaster when EMS providers may be overwhelmed by the large number of patients. The second patient surge is at the hospital emergency departments, where EMS and patients who self-transport are arriving at the hospital. Planning for disasters routinely includes the concepts of surge capacity and surge capabilities for these two phases.

Little research has been accomplished on planning for a surge of patients needing care at rehabilitative facilities after a disaster. This study explores whether healthcare disaster planning should include a third medical surge phase, rehabilitative, which begins in the hospital when patients are receiving care for their traumatic injuries and continues at an in-patient rehabilitative medical care facility. Additionally, this study explores ideas and strategies from subject matter experts on surge planning for rehabilitation facilities that could be included during community planning. Rehabilitative medical care has seen an increase in research in the past ten years and has been proven to improve functional outcomes for patients. However, in most communities, there is a limited amount of rehabilitation licensed beds and staff. Without structured planning for a sudden influx of patients after a disaster, some community members may have a reduced access to rehabilitation and need to seek this care outside of their community and without their primary care physicians. This could delay the patient's return to functionality.

Lessons that are learned after each disaster should generate new knowledge that can be put into action for healthcare sustainability by community leaders. However, it is still unknown the numbers of patients who may need rehabilitative care after a disaster, the probability of

patients who need to be admitted, and how to plan for these patients. Benchmarks such as these are needed as an aid to complete planning for a surge of patients. Understanding the past research of patient surge concepts and healthcare planning and preparedness for disasters will be reviewed in the next chapter.

2 The Medical Surge Planning Context

Medical surge concepts form the framework for planning for mass casualty incidents within the medical community. Watson and colleagues discussed the need for surge "conceptual and analytical frameworks, along with innovations in data collection and methodological approaches" (Watson, Rudge, & Coker, 2013, p. 104). They believe that "time lines need to be explicitly understood that involve multi-phased impacts…so that health system interventions can be identified" (Watson, Rudge, & Coker, 2013, p. 104). Understanding surge timelines and the cascading events within each phase of the disaster would enhance healthcare planning.

Planning is the theoretical lens that is used to review the phases of medical surge. "Surge planning is based on the core concepts of surge capability and surge capacity" (Hick, Barbera, & Kelen, 2009; Koenig & Schultz, 2010; Weifeng, et al., 2014, p. 2524). Systematic data collection and analysis from past mass casualty incidents would assist planners in avoiding common mistakes and improve response and recovery planning. (Weifeng, et al., 2014)

> Dr. Kapucu believes that, adequate planning for catastrophes has been a longstanding national problem. Forty-two percent of recommendations in the Hurricane Katrina After Action Report centered on planning and included gaps at the local, state and federal levels with an emphasis needed on collaborative planning (Kapucu, 2008, p. 322).

This chapter will review surge planning concepts for EMS and hospitals. Additionally, information about surge concepts that are included in the federal hospital preparedness program will be discussed.

Medical Surge:

The Centers for Disease Control (CDC) define medical surge as "the ability to provide adequate medical evaluation and care (to patients) during events that exceed the limits of the normal medical infrastructure of an affected community" (Center for Disease Control, 2012). Over one hundred years of evaluating medical response during wars and disasters has refined medical surge to the standards today. During the Great World War in 1915-1918, wounded soldiers who were treated in the field received transportation (for the first time) by motorized ambulances to field hospitals. About the same time, the worst pandemic we have experienced to date was traveling throughout the world. This virus was sickening millions of people and civilian hospitals were overwhelmed. Tent hospitals with medical care being given by patient's families, nurses and medical school students were adapted as field hospitals. (Kearns, Cairns, & Cairns, 2014)

During the Korean War (1950), the first use of helicopters to transport patients emerged with new standards on triage. During the 1970s, there was an organized effort to address gaps in trauma care in the United States by the federal government. National guidelines and improvements began to emerge for trauma systems in civilian hospitals and a national Emergency Medical Services (EMS) system that included both federal and state educational requirements was implemented based on past military experiences. (Kearns, Cairns, & Cairns, 2014)

Following the terror attacks in 2001 were catastrophic hurricanes in 2004 and 2005, which left hospitals with failed electrical systems, non-potable water and heavy damage. These disasters led to more refinements to medical surge research and new requirements for hospitals and EMS systems. (Kearns, Cairns, & Cairns, 2014) "In 2004, a manuscript by Hick et al. was

the first of several that began to cohesively discuss the various and unique aspects of surge capacity and capability" (Kearns, Cairns, & Cairns, 2014, p. 2). Because of this, medical surge has now been defined and divided into two categories; surge capacity and surge capability. Kelen and McCarthy (2006) "proposed that surge capability is the extent to which surge capacity (resources that are available) can accommodate the surge (sudden demand for those resources)" (Kelen & McCarthy, 2006). Many researchers (Barbisch & Koenig, 2006; Dayton, et al., 2008; Kearns, Cairns, & Cairns, 2014; Kelen, et al., 2009) use the terms; staff, stuff, structures/space and system to conceptualize surge, but in reality, a surge event entails much more than these four items.

Field Surge:

Emergency Medical Services (EMS) is responsible for field surge. As the first responders to incidents, EMS systems are heavily impacted by these events and their resources are expected to manage both the disaster patients and the normal patient load (diabetics, heart attacks) that occur simultaneously in the community. This patient management is usually accomplished by a field response mutual aid system that will bring needed resources from adjacent communities.

Disasters that include a large number of people with injuries are termed a mass casualty incident. For example, injuries can occur from bus accidents, plane crashes, tornadoes, earthquakes, active shooters, explosions and fires. The types of traumatic injuries (e.g., broken bones, burns, and lacerations) and the total number of patients will determine the number of EMS responders, ambulances and other transportation vehicles needed, to treat and transport the patients. Most EMS agencies use established field triage guidelines such as the Simple Triage

and Rapid Transport (START) model. There are several other triage systems proposed for use in the field, but most all of the triage field systems have a "who can walk" filter to determine who has a minor injury versus those who cannot walk or cannot understand instructions, or those patients who may be unconscious or deceased. (Koenig & Schultz, 2010, p. 175)

The rest of the patients remaining at the site who cannot walk are then sorted into categories based on injury acuity. START triage places patients who have severe injuries into the red category and these patients require immediate medical care. Patients with moderate injuries are placed into the yellow category and their care can be delayed, while the green patient category is for minor injuries. The black category is used for those who have died or are expected to die. (Koenig & Schultz, 2010) There are several other triage systems that are used in the field but "to date, no triage system has been shown conclusively to be better than any other in terms of patient outcomes, scene management, or resource allocation" (Koenig & Schultz, 2010, p. 175).

Getting the right patient to the right hospital is one of the critical steps in field triage. EMS providers are taught that trauma patient care is time dependent with a one-hour goal to deliver a critically injured patient to the hospital. This one-hour status may lead the transportation officer at a disaster scene to move the patients to the closest hospital instead of a trauma center just a few more minutes away to conserve time, as witnessed by past disasters. Even when using a hospital disaster network communication system, such as the one in many large cities, a review of a past incidents found that the closer community hospitals were overwhelmed while trauma centers nearby received few patients. (Zoraster, Chidester, & Koenig, 2007) Communication problems such as the local hospitals not being notified of a large

number of patients at a disaster by the field incident commander or an incident with multiple sites of injured patients (such as an earthquake) compounds patient transportation decisions.

One thought as to why many of the closest hospitals to a disaster tend to receive more patients from the disaster was due to the ability of each ambulance to be able to deliver a patient to the closest hospital and then return to the scene for an additional patient(s). However, the nearest community hospital to the incident in a study by Zoraster, et al., did not have surgeons in-house and neurosurgeons on call, so these patients had to wait for specialized services to arrive at the community hospital or be transported to another hospital by ground or by air thus increasing their time to definitive care well past the one-hour mark. (Zoraster, Chidester, & Koenig, 2007)

A critical aspect of field surge planning is education on triage principles, medical treatment resources and multiple transportation options during a disaster. In addition, the use of planning tools such as a Haddon Matrix can be constructed to evaluate triage practices, update triage protocols, review incident command procedures, and interagency cooperation and transportation options. Education and practice with the triage system as a part of the EMS and hospital integration aids in disaster preparedness.

Hospital Surge

Not every patient is transported by EMS to a hospital during a disaster. Some patients are transported by private vehicle and often arrive at the hospital before EMS. (Auf der Heide, 2006) Hospitals have been struggling in recent years to define surge parameters for a sudden influx of patients because many hospitals are consistently operating at over 90% capacity, which leaves little room for a mass casualty response. A hospital's capacity can change due to multiple

factors that include, current emergency department bed availability; operating room schedules; just in time supply resource ordering; and, the amount of available credentialed staff. At some point, which varies by hospital, the hospital will arrive at a saturation point where they can no longer accept any more patients. At this saturation point, if the disaster is local, then assistance from nearby regions, states and/or the federal government may be available through local mutual aid agreements and a national program called the Emergency Management Assistance Compact. (Schultz & Koenig, 2006)

In 1995, the Murrah Federal Building bombing resulted in 759 injuries and the 2001 World Trade Center bombing included 1,103 injuries. The Northridge earthquake reported 138 serious injuries and the Loma Prieta earthquake reported 3,757 injuries. Hurricane Katrina (2004) included 2,018 injuries. (Stratton & Tyler, 2006) All of these events listed both serious and non-serious injuries that were treated in the field, at hospitals, and at shelters. The classifications of injuries included broken bones, burns, and soft tissue injuries, as well as the usual normal usage of the health care system for acute incidents such as heart attacks and ongoing chronic illnesses. During some of these events, hospitals themselves needed to be evacuated due to structural damage, which decreased the availability of local medical resources. (Stratton & Tyler, 2006) In 2009, authors Hick, Barbera and Kelen discussed a refining of surge capacity based on established benchmarks from past research. Most hospitals use "bed" availability and capacity (beds not occupied and staffing in place) standards. These standards include licensed beds and extra beds that can be placed in pre-designated locations such as those placed in a hallway or cafeteria. (Hick, Barbera, & Kelen, 2009) Experts argue that standardization of surge capacity that includes the number and types of bed definitions is needed across the United States.

Some hospitals choose to cancel elective surgeries and next-day elective admissions during a disaster, and they begin early discharge assessments on in-patient wards to increase bed capacity. (Dayton, et al., 2008) One group of researchers evaluated hospital in-patient units to see if recommendations for safe early discharge for patients at academic and community hospitals could be made. They evaluated patients over four days (96 hours), and not during a disaster or mass casualty exercise. "Each hospital in the study had on average 18% of readily available capacity from staffed unoccupied beds. An additional 5% to 9% of capacity, depending on the site, could be made available if all unstaffed licensed beds could be resourced" (Kelen, et al., 2009).

Researchers studying a hospital in San Diego explored transferring patients from the hospital to an on-site nursing facility as a solution for surge events. (Davis, et al., 2005) This study used the standard National Disaster Medical System (NDMS) bed counts of unstaffed beds that could be made available and estimated the number of patients that could be safely discharged. They found that,

> hospitals with on-site long term nursing facilities could absorb in-patient transfers at little movement for the patients and the patient's supplies (medications, durable medical goods). The patients could easily be transferred back to the in-patient hospital when the disaster event is completed if beds are available or their medical conditions worsen (Davis, et al., 2005, p. 175).

Another strategy for increasing bed capacity has included a discharge unit for patients to wait until family members could retrieve them (Goldschmitt & Bonvino, 2009). The above strategies are all adequate alternatives for a surge event, but no panacea. All are temporary

solutions, usually short term and are not appropriate for an incident where the community infrastructure (roads) or the hospital itself has received damage.

Federal Hospital Surge Planning and Preparedness

The federal Hospital Preparedness Program (HPP), which began in 2002, defined its mission as, "to improve healthcare preparedness and response by providing leadership, funding, evaluation, and technical assistance to HPP awardees" (Marcozzi & Hunt, 2013, p. 2). Marcozzi and Hunt emphasized, "that the preparedness programs are a leader in aligning healthcare delivery and public health" (Marcozzi & Hunt, 2013, p. 2).

As can be seen from the figure below, the Healthcare Preparedness Program Capabilities are integrated with Medical Surge and Continuity of Healthcare Operations. The important concepts to consider when discussing medical surge and the Immediate Bed Availability (IBA) standards that the federal government recommends are,

- "The United States healthcare delivery system is focused on cost reduction which includes service retraction resulting in just-in-time operating principles and staffing;
- The United States continues to experience overcrowding in emergency departments with limited mechanisms to reallocate patients throughout the hospital or the community" (Marcozzi & Hunt, 2013, p. 3).

A new medical surge model goal would be "to quickly provide higher-level care to more serious patients during a disaster with no new space, personnel, or equipment" (Marcozzi & Hunt, 2013, p. 4). The federal Hospital Preparedness Program capabilities:

Figure 2

HPP Capabilities

1. Healthcare System Preparedness
2. Healthcare System Recovery
3. Emergency Operations Coordination
4. Fatality Management
5. Information Sharing
6. Medical Surge (Immediate Bed Availability)
7. Responder Safety and Health
8. Volunteer Management

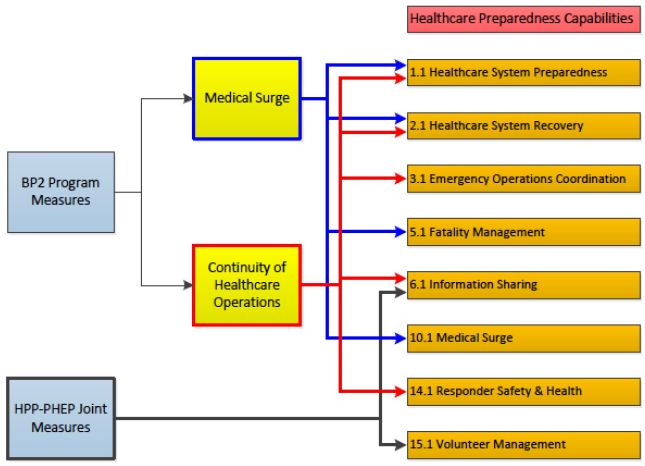


Figure 4. BP2 HPP Program Measure Alignment with the *Healthcare Preparedness Capabilities*. The mapping of the BP2 HPP Program Measures (Medical Surge lines in blue, Continuity of Healthcare Operations lines in red) and HPP-PHEP Joint Measures (black lines) to the Healthcare Preparedness Capabilities illustrates that all capabilities are accounted for in BP2.

(Hospital Preparedness Program (HPP) Cooperative Agreement, Implementation Guidance for the HPP Program Measures)

Marcozzi and Stryckman (2015), proposed:

> including key indicators of preparedness into the nationally recognized measures of clinical quality within Medicare's shared savings program and its Merit-Based Incentive Payment System. In essence, hospitals would be incentivized to prepare for disasters by including critical preparedness indicators such as IBA in payment structures, thereby fostering a shared sense of responsibility for the community (Marcozzi & Stryckman, 2015, p. 3).

The authors believe that this new model could improve regional planning and community resilience.

Hospital surge is complicated by many factors. Some of these factors include the type of hospital (e.g., community, free-standing, trauma-designated), the number and types of beds available (e.g., staffed, unstaffed, critical care and non-critical care), the number and types of healthcare providers (e.g., physicians, nurses, technicians), the ability to move patients to alternate care sites (EMS), and the ability to cancel clinic appointments and out-patient non-critical surgeries.

Summary

Planning for a surge of patients requires extensive knowledge of local hazards and the healthcare system. Each patient enters the healthcare system from a disaster through EMS or directly at the hospital. EMS and hospitals often work with healthcare coalitions to establish mass casualty response plans that include, a specified triage algorithm, communications, and transport decisions based on hospital bed availability, strategically placed supply caches, decontamination and hazardous materials resources and use of the incident command system.

Hospitals must be ready to care for a surge of patients that arrive by car and ambulance. Hospitals use strategies such as cancelling surgeries and moving patients to other care facilities such as long-term care and rehabilitative care to open hospital beds during a patient surge. EMS manages the first phase of a surge incident and hospitals manage the second. As witnessed in the literature above, it is a complicated process that needs to include all community stakeholders.

A new third phase, rehabilitative, which begins while a patient is in the hospital and ends when the patient is released to home, is a new surge planning concept. Integration of medical specialties, such as rehabilitation medicine, into regional planning committees needs to be

considered for the future. The next chapter will review the advances of rehabilitation medicine and how some of these specialists have paved the foundation for future disaster medical care.

3 Rehabilitation Surge Planning: A Review of the Literature

Inadequate planning and preparedness by in-patient rehabilitation facilities for a potential surge of patients could lead to a decrease in available beds, personnel, and resources as well as a serious delay in patient care. Very few researchers have examined these planning concepts, despite the evidence that rehabilitative care has reduced patient death and disability. (Wade & de Jong, 2000)

A resurgence of surge research and planning occurred following the terrorist attacks on the World Trade Center in 2001, emphasizing the EMS and hospital phases. (Kearns, Cairns, & Cairns, 2014) Rehabilitative care of disaster patients was not addressed. Additionally, the hospital preparedness program was designed to increase planning and preparedness for members of healthcare coalitions, but it, too, failed to include rehabilitative care. This chapter explores the literature on planning and preparedness to include this important area of disaster patient care.

An analytic tool known as a Haddon matrix will be used to help conceptualize a framework for medical surge, with particular emphasis on surge capacity and capability during the rehabilitation phase. This important discussion also helps to inform the methods used in this study. In addition, this chapter will examine the potential use of patient status classification systems employed in the field (START) and hospital (ISS) as a way to project demand for disaster rehabilitation services.

Rehabilitation Surge:

The use of rehabilitative care (e.g., physician, therapy, care plans and care goals) from cardiac events, strokes, diabetes and traumatic injuries has increased in the last twenty years due to research redefining best practices for patient outcomes. (Rathore, et al., 2012) More patients

are receiving rehabilitative services and improving functional outcomes, thus leading to a more productive and longer life. (Rathore, et al., 2012) Medical rehabilitative care begins in the hospital, before discharge, with the consultation of a physician specialist. By including early physiatrist care there are documented decreases in the hospital length of stay, fewer medical complications, and a better functional outcome. Increasing the functional outcome for the patient can "contribute to greater social integration and community participation, which help build the post-disaster society" (Rathore, et al., 2012, p. 1878).

A retrospective study in 2004 evaluated whether a time delay before admittance to a rehabilitation facility caused an increased length of stay. In-hospital patients usually receive an average of 50 minutes of therapy per day. For a patient in a rehabilitation facility, the average therapy is three hours per day and consists of occupational, physical and speech therapy and social services. Each patient has a care plan tailored to his or her individual medical and functional needs. The study found that a time delay from in-patient care to rehabilitative facility care has a negative effect on the patient's functional outcomes. This study finding then suggests that planning for rehabilitative care after a disaster is paramount. (Sirois, Lavoie, & Dionne, 2004)

Due to the usual high rehabilitation facility census, a patient may experience a delay in admission to an in-patient rehabilitative facility. A surge of hospital admissions after a disaster will cause a surge of patients needing rehabilitation admissions as early as 48 hours after their disaster injury. These additional patients cause added stress on the rehabilitative programs that are already currently stretched to their limits and have few beds available.

In 2011, a focused review of the use of rehabilitation services during international disaster relief found that "health-related rehabilitation is only marginally employed (by disaster

relief medical organizations) as a disaster planning and response strategy" (Reinhardt, et al., 2011, p. 7). This study cited examples of past disasters where even limited rehabilitative medicine has increased the patient's functional outcomes. Early rehabilitative care of spinal cord injury patients following the 2008 Sichuan Earthquake showed these positive results. However, after the 2003 earthquake in Bam (Iran), missed or delayed rehabilitative care resulted in longer hospital stays and negative results for spinal cord injured patients. (Reinhardt, et al., 2011)

In 2001, Gujarat, India had a major 6.9 (Richter scale) earthquake, which caused many traumatic injuries. A group of researchers re-visited the victims of the earthquake in 2003 to research surgical outcomes and their physical rehabilitation. There were approximately 20,717 serious injuries from this earthquake. The injuries were located in the spine, pelvis, soft-tissue, femur, tibia-fibula, chest and head with 43% of the patients having multiple injuries. A few medical teams stayed up to two weeks at the disaster site where they created individual medical care plans and taught injured patients' relatives physiotherapy care for their family members. The research showed that "good physiotherapy (without any equipment) given in the temporary shelters by the informal care givers within the family and voluntary groups, kept up a good range of motion and reduced the final disability" (Roy, Shah, Patel, & Bagalkote, 2005, p. 933). This research is important because it shows the strength of rehabilitative care post disaster. If a patient does not have the opportunity for full medical recovery, their life span may be shortened, their ability to care for self or family may be altered and the inability to earn a living may lead to a decrease in living standards. (Roy, Shah, Patel, & Bagalkote, 2005)

After Hurricane Katrina in 2005, five rehabilitation physicians volunteered to care for patients who were evacuated from the Superdome to the Houston Astrodome for sheltering. This shelter opened three days after the hurricane hit New Orleans. These physicians treated both

traumatic injuries and other minor injuries, noting gaps in the preparedness plans for the Astrodome. (Bloodworth, Kevorkian, Rumbaut, & Chiou-Tan, 2007) Specifically, a lack of durable medical equipment (e.g., wheel chairs) and a lack of basic medical supplies, which can lead to an increase in infections and decreased mobility were found. They observed that:

> In a large-scale emergency or disaster, the needs of disabled persons have not been fully investigated or described. Few descriptions of physiatric response to disaster exist. Experiences resulting from Hurricane Katrina suggest that natural and unplanned environmental barriers, new impairments and disabilities for previously able-bodied persons, underestimation of disability-specific supplies, durable medical equipment, and specific medications, as well as a limited response of rehabilitation personnel, may place disabled persons at an additional disadvantage (Bloodworth, Kevorkian, Rumbaut, & Chiou-Tan, 2007, p. 774).

Rehabilitative medical care providers have been responding to disasters for many years. Within the World Health Organization (WHO), an active rehabilitation medicine sub-committee exists for disaster relief. This group presented a paper to the WHO in 2001 that highlighted ten years of disaster response, and made the following observation:

> With global health agendas advancing rapidly, disaster rehabilitation medicine cannot be left behind. Active participation in, and contribution to, research and universal standard setting … will ensure a seat at the table in future global policy and practice decisions (Gosney, Reinhardt, Haig, & Li, 2011, p. 967).

Dr. Gosney and colleagues have been practicing rehabilitative care and research on disaster patients for many years. They have shown that rehabilitative care received within the patient's community is optimal for recovery. (Gosney, Reinhardt, Haig, & Li, 2011) "Long-

term morbidity can be significantly reduced by the performance of early rehabilitation interventions by the rehabilitation traumatologist. Many survivors have multiple, severe impairments requiring comprehensive rehabilitation to achieve optimal physical functioning and reintegration into post disaster society" (Gosney, 2010, p. 1). While these physicians have been practicing disaster rehabilitative care, they have not been included in surge planning within the healthcare community.

Patient Status Classification Systems: START and ISS

Many past research studies have used the Simple Triage and Rapid Treatment (START) and Injury Severity Score (ISS) tools to review patient outcomes. Use of triage means to "separate those who will benefit from immediate medical intervention(s) from those who will not" based on physiologic measures (Jenkins, et al., 2008, p. 3). A study by Cross and Cicero in 2013 reviewed disaster triage methods in pediatric, adult, and geriatric patients using the National Trauma Data Bank records from 2007 to 2009. They compared six different triage methods. The START triage method comparatively performed better with burn and penetrating trauma than blunt trauma. The authors believed that improvements could be made with START by increasing the number of patient acuity categories. (Cross & Cicero, 2013)

A study to determine the effectiveness of START triage was published in 2009 after a collision between a commuter train and a freight train in 2002. A retrospective analysis of 262 persons from this mass casualty incident found that "the walking filter which defines the green triage category appears to have functioned well, with a specificity of approximately 90%. Although there were only a small number of critically injured victims, each received an appropriate red triage designation, resulting in a sensitivity of 100%" (Kahn, Schultz, Miller, &

Anderson, 2009, p. 13). An additional study by Garner, et al., used "trauma registry data from 1,144 adult trauma patients and assigned each one a START category" and found that START was "significantly better" than other triage systems and found to have "discriminant validity and predictive validity" (Garner, Harrison, & Schultz, 2001; Jenkins, et al., 2008, p. 433).

The selection of a scoring system depends on the proposed use. "The first scoring system (within hospitals) was developed for trauma patients and used specific anatomical methods or physiological methods" (Gunning & Rowan, 1999, p. 241). The Abbreviated Injury Scale (AIS) was "developed by engineers to rate and compare blunt injuries from road vehicle accidents and has undergone several modifications. The Injury Severity Score (ISS) was derived from the AIS to summarize the severity of the condition and now includes both blunt and penetrating trauma" (Champion, 2002, p. 12). The ISS was first conceived to predict mortality however, with the updates from 1971 to today it is now used to "predict the time it takes individuals to return to pre-injury levels of functioning" (Stevenson, Segui-Gomez, Lescohier, Di Scala, & McDonald-Smith, 2001, p. 10). The use of the Injury Severity Score (ISS) is meant to "determine the extent of injury to a patient and is used during patient evaluation. The result has been the ISS being regarded as the 'gold standard' in trauma severity grading" (Palmer, 2007, p. 2).

START triage and ISS scores are common healthcare tools that are employed to predict patient functional outcomes and survival after a traumatic injury. Bayrum and colleagues studied surge capacity with the values of START triage and ISS. The patient acuity was identified as the START "red" category to equal an ISS of "15 and over" as their benchmarks for a critically injured patient. (Bayrum, Zuabi, & Subbarao, 2011, p. 118). However, many past studies have used varying numerical categories to represent a critical patient. "The precise dimensions of severity have not been explicitly determined because these components change with time"

(Palmer, 2007, p. 15). Thoughts on ISS values that indicate a severe or critical patient have changed through the last ten years with increases in medical research and long-term rehabilitation. (Palmer, 2007) Dr. Palmer's research revealed, "patients with an ISS of 8 or higher could be considered for inclusion as 'severely injured' if morbidity as well as mortality is to be assessed" (Palmer, 2007, p. 22). The American College of Surgeons continues to use an ISS of 16 or higher to denote a patient with severe injuries.

Recent research by Nemunaitis and colleagues on rehabilitation functional outcomes, after trauma, matched a Level One Trauma hospital patient records from 2005-2010 with their records from rehabilitation to evaluate outcomes. Those admitted to the rehabilitation facility were classified as spinal cord injury, traumatic brain injury, and poly trauma. The researchers found that for every one-point increase in a patient's injury severity score, the patient's functional independence measure decreased by 0.393 points *($p < .001$)*. "The early identification of factors that provide information regarding enhanced function may help refine triage protocols and treatment methods" (Nemunaitis, Roach, Claridge, & Mejia, 2016, p. 318).

Planning and the Use of the Haddon Matrix

The Haddon matrix was developed by William Haddon, Jr. in 1968 and was first used to examine the principles of public health and traffic safety. (Runyan, 1998) His conceptual model has broadened the perspective of how and when certain dimensions of health affect the public. The Haddon matrix can be used as a tool for planning for a surge of trauma patients who may need rehabilitative care. Use of the Haddon matrix has "proved valuable over the last two decades as a conceptual model, it has helped guide research and the development of interventions" (Runyan, 1998, p. 306). Using a planning tool such as the Haddon matrix will

enable healthcare leaders to better understand emerging threats and prioritize resources. (Barnett D. J., et al., 2005)

The original Haddon matrix involved the three phases of pre-event, event, and post-event injury sequence and three factors of host, agent and physical environment. Another dimension called social-cultural environment was added in 1998. (Runyan, 1998) The matrix is divided into pre-event concepts such as injury prevention and education, event concepts which include the use of benchmarks and post-event concepts to prioritize resources. The Haddon matrix breaks a hazard into smaller and more manageable sections, which can then be used to prioritize tasks and strategies. "For example, the logistics of sheltering in place due to an infectious disease is better managed by a population who has received pre-event education, supply kits, and resources" (Barnett D. J., et al., 2005, p. 565). The division of a disaster into chronological parts by using the Haddon matrix adds value by developing appropriate countermeasures that include preventive and mitigation measures. (Noji & Sivertson, 1987)

Planning for a surge of disaster patients has been in effect in most communities for many years. This planning requires all healthcare entities and the local community to "meet on a routine basis to develop a comprehensive emergency medical disaster plan" (Harrison, Harrison, & Piermattei, 2008, p. 358). This plan has to be ready to go into effect at a moment's notice and complete enough to include all hazards that may present themselves. Dr. Koenig calls for a focus on "patient care capacity" when planning for any type of disaster. "Beds by themselves don't take care of patients – we need all the elements of a surge system to operate effectively" (Koenig K. L., 2013). Use of the Haddon matrix can evaluate each of the surge phases and the needed resources. Dr. Runyan observed that,

> For interventions that have been tried already, various types of information may be available to quantify the effects, costs, and other attributes. Qualitative information also can be examined. This might include reviewing testimony about preferences expressed in reference to prior efforts to enact a policy, news clippings giving indications of public sentiment about a proposed program, or reviews of process evaluations of programs or policies implemented in the past to assess potential barriers that could influence effectiveness. Whether using quantitative or qualitative information, the process needs to be systematic, allowing planners to carefully assess the options (Runyan, 1998, p. 304).

Dr. Runyan developed and added a third dimension (the social factor) to the original Haddon matrix. The social factor is used "to facilitate making decisions about which countermeasures to apply" (Runyan, 1998, p. 302). The original matrix included "interactive factors that contribute to the injury process" (Runyan, 1998, p. 303) while the addition of Dr. Runyan's social environment adds the option for policy or program planning interventions. The social environment often includes, "use of the incident command system, budgeting for preparedness resource allocation and the economic impact on the affected community" (Barnett D. J., et al., 2005, p. 564). The matrix has "revealed itself as a useful public health readiness tool for tackling difficult public health emergencies" (Barnett D. J., et al., 2005, p. 565). It can provide a framework for understanding each phase of an incident (pre-event, event and post-event) so that an approach for solving potential problems can be developed prior to the incident during community planning.

There are multiple steps in constructing the three dimensional Haddon matrix. The first step is to determine the problem in need of intervention. For this study, a lack of rehabilitation planning for a patient surge that occurs after a disaster would be the "problem" that needs an intervention. The next steps to constructing the matrix involve defining the columns as the targets of change (host, agent, physical environment, social environment). After the targets of change comes a listing of the rows by phases of the event (pre-event, event, post-event). Step four will be to define each column's value and to find potential interventions/solutions. See below for an example:

Figure 3

Haddon Matrix

(Runyan, Using the Haddon matrix: introducing the third dimension, 1998)

The final steps include organizing, collecting and analyzing each value. Dr. Runyan found that "for many injury problems, particularly those involving repeat occurrences, strategies identified in the post-event phase may actually be effective as pre-event strategies" (Runyan, 1998, p. 303).

Use of the Haddon Matrix for Planning for a Surge of Patients needing Rehabilitative Care Post Disaster

The Haddon matrix can be used to understand complex problems by reviewing the "contributing factors to injury before, during, and after an event" (Barnett D. J., et al., 2005, p. 2). Prior knowledge of what causes traumatic injuries during a disaster can be used to potentially minimize morbidity and mortality. (Noji & Sivertson, 1987) Additionally, rehabilitative care administered after a disaster has been found to reduce morbidity and mortality. (Wade & de Jong, 2000) Interventions that target injury prevention and healthcare preparedness can be thought of as a twofold step to improve patient recovery.

Haddon's review of injury patterns in motor vehicle accidents (Haddon, 1980) and Noji and Sivertson's application of Dr. Haddon's matrix to injury prevention in natural disasters (Noji & Sivertson, 1987) were reviewed as templates to explore planning for patients from any type of disaster. Other authors such as Runyan, Williams, and Barnett and colleagues have used the Haddon matrix for various types of injury prevention planning that include; fire prevention, injury prevention, pandemic planning, dirty bomb planning and public health emergency readiness and response.

When using the Haddon matrix the "first step is to be able to clearly identify the problem to be addressed using appropriate data from the community to assess need" (Runyan, 1998, p. 302). "Secondly, one needs to define each row and column of the matrix" through use of past disaster experiences (Runyan, 1998, p. 303). "When filling in the cells of the matrix, a sentence completion exercise can be helpful. That is, one might state…. (idea) is an intervention to affect change in …. (factor), having its effect at the time of…. (phase)" (Runyan, 1998, p. 303). Using the sentence completion exercise to plan for a continuum of care for disaster patients the following was explored...planning for rehabilitative care for traumatically injured disaster patients is an intervention to affect change in morbidity and mortality, having its effect at the

time of post-event (recovery phase). The table below represents the Haddon matrix as applied to surge planning for traumatically injured disaster patients with a descriptive analysis to follow:

Table 1

Haddon Matrix Applied to Surge Planning for Traumatically Injured Disaster Patients

	HOST (Personal and Community Factors)	**AGENT (Surge Factors)**	**PHYSICAL ENVIRONMENT**	**SOCIAL ENVIRONMENT**
PRE-EVENT (mitigation/ preparedness)	-risk assessment -personal health conditions -risk communications -personal perception of hazard (e. g. not evacuating during a hurricane) -injury prevention education	-planning for cascading events -assessment of local resources -forecast/warnings to public	-time of day -transportation resources (to hospital) -clinical infrastructure (EMS, hospital, rehab) -emergency management collaborative of community and healthcare	-surge planning - community demographics-HVA -education and exercises
EVENT (response)	disaster that includes a patient surge: - EMS transport to appropriate hospital -hospital readiness -decontamination needed?	impact of a hazard with the population that causes many people to become injured and seek medical attention	-hospital surge capacity & capability -hospital facility damaged? -rehabilitation facility damaged? -health coalition resources -building codes - SNS/chempack	-community medical response and resources -state medical response and resources -federal medical response and resources
POST-EVENT (recovery)	ability of each patient to recover: -post injury care (reassess resources and capacity) -after action report -lessons learned - national patient disaster database	-EMS surge plan review -hospital surge plan review -rehabilitation surge plan review	-consider regional stockpile of supplies - pre-event credentialing of medical personnel for hospital and rehabilitation facilities -just in time training modules pre-made	- restore utilities so patients can be discharged to home -re-establish usual medical care in community -patients to rehab in community for recovery

			-hardening of medical facilities	

Haddon Matrix for Rehabilitation Planning Pre-Event Analysis

The pre-event phase explores several ideas for people to be able to protect themselves from traumatic injuries. For example, what is the public perception of disasters? Will they evacuate during a hurricane when they have survived a past hurricane in their residence or a shelter? Will the community broadcast emergency warnings in multiple languages, to sight and hearing disabled populations and over multiple communication routes (e.g. radio, television)? Finally, what is the social vulnerability of the population? Is the community healthy or are many citizens living at home with medical comorbidities that will add to the hospital population during an emergency if they suffer a power outage? Personal preparedness education to all citizens as well as effective risk communications may assist in reducing injuries. Community building codes and land acquisitions after disasters (e.g., flood, fire) can also be utilized to protect the population and decrease injuries prior to the next disaster.

Working across the matrix to the pre-event surge factors explores the cascading events that are included during a disaster. These events could include any type of disaster (e.g., natural, technical, man-made) and the need for planning for all hazards. For example, various types of disasters cause power outages such as; tornado, wind storms, ice storms, hurricanes, explosions, and earthquakes. Assessment of local utilities and resources is needed within each community to determine mitigation strategies to keep utilities viable during a disaster. The pre-event "deals with the contribution of social and cultural characteristics to the frequency and severity of injuries in natural disasters, and how their modification would reduce injury" (Noji & Sivertson, 1987, p. 294). For example, a review of disaster injuries from "tornadoes or flooding in low

income housing or indigent populations with pre-event preparedness may result in less injuries" (Noji & Sivertson, 1987, p. 294).

The pre-event physical environment looks at how the time of day can affect disaster medical care. Traditionally, evening, night, and weekend shifts (both EMS and hospital) have less staff than on day shifts so additional time may be needed to mobilize adequate personnel and open up alternate care centers and additional operating rooms. Collaboration with a healthcare coalition and emergency management officials to develop a mass casualty incident plan and pre-position resources such as decontamination supplies, mass casualty supplies and communication vehicles will help during a surge event. The mass casualty plan should include mutual aid agreements with neighboring regions for additional personnel and equipment. (Koenig & Schultz, 2010)

Finally, the pre-event social environment includes a hazard risk assessment and community demographics. Planning for a sudden influx of patients should include establishing a plan for EMS patients, hospital patients and the patients who need rehabilitative care. Education and exercises based on the community hazards are important pieces in preparedness and operational readiness.

Haddon Matrix for Rehabilitation Planning Event Analysis

The event (response) analysis begins with a review of mass casualty response plans at the local, state and national levels and how each plan intersects with the next tier's plan. The federal government has sponsored disaster medicine education for prehospital and hospital providers through the Centers for Disease Control and the Health and Human Services Department. Healthcare accreditation bodies such as The Joint Commission (TJC) require disaster plan

education and exercises with one exercise per year recommended to be in collaboration with the community and include a surge of patients for hospitals. Hospitals are required to be able to surge 20% of their licensed beds within four hours under the Federal Healthcare Preparedness Program. Skilled nursing, long-term care and rehabilitation facilities that have open beds are often used for patient movement when needing to decompress a hospital during a patient surge.

Healthcare coalitions have been instrumental in increasing disaster preparedness within a region through education, plan collaboration, exercises, and federal grant funding. A healthcare coalition is required to develop a regional mass casualty surge plan based on the regional hazard vulnerability assessment. Additionally, many coalitions assist their regional partners with stockpiling of equipment, planning for medical shelters for vulnerable populations, and supporting medical reserve teams that can be called into action during a disaster.

Use of Community Emergency Response Teams (CERT) during the response phase will assist local first responders with finding and treating disaster patients. Additionally, the federal disaster medical assistance teams are strategically placed throughout the United States. This group of medical providers and staff is available to deploy and become integrated into the local healthcare system when additional assistance is requested. Other specialty groups such as the American Red Cross and faith-based organizations may be available to assist with mental health counseling of disaster survivors.

Haddon Matrix for Rehabilitation Planning Post-Event Analysis

The post-event phase of the Haddon matrix is centered on the recovery phase of a disaster. This phase considers what type and extent of injuries have presented to EMS and the hospitals and what medical care is needed for definitive treatment. A national disaster patient

database for research is needed to be able to investigate answers to such questions as, "assessment of injury outcome characteristics and the development of quantitative severity of injury and illness scales" (Noji & Sivertson, 1987, p. 292). Noji and Sivertson also state that "evaluation of effectiveness of medical response and improving data collection systems" is needed (Noji & Sivertson, 1987, p. 294).

Many insights can be gained from the use of the Haddon matrix to evaluate surge planning for a mass casualty incident. For example, pre-event injury prevention education would clearly reduce the total amount of injuries incurred during a disaster. Additionally, pre-event planning for a surge of patients with traumatic injuries that includes pre-positioning supplies and establishing triage criteria are important actions for EMS and hospitals to consider. While there is currently a lack of planning for patients who need rehabilitative care, the Haddon matrix points to the importance of medical care during the recovery phase. The post-event (recovery) phase planning is essential to both community and personal resilience.

"The Haddon matrix has limitations that should be considered. The matrix is not a planning tool to be used in isolation. It must be operationalized with policies and procedures to become effective. Additionally, the matrix is subjective and needs to be reviewed and updated with changes in the community infrastructure, capabilities and demographics often" (Barnett D. J., et al., 2005, p. 5).

The Haddon matrix has been used to support qualitative research by a number of researchers, including Barnett and colleagues (2005) on public health readiness and response planning. Some advantages to using the Haddon matrix were noted by Deljavan and colleagues (2012) who commented on, "the ability to design key questions for data collection, categories for clustering (to understand the phenomenon) questions that have similar patterns, and the ability to

divide the results into sections" (Deljavan, Sadeghi-Bazargani, Fouladi, Arshi, & Mohammadi, 2012, p. 262). In addition, the use of the Haddon matrix to divide a planning problem into integrated sections could be "considered as an epidemiological tool that can be applied as a practical user-friendly interdisciplinary brainstorming and planning tool to help understand, prepare for, and respond to, a broad range of public health emergencies" (Deljavan, Sadeghi-Bazargani, Fouladi, Arshi, & Mohammadi, 2012, p. 265).

Summary

Past disasters, which included a surge of patients, have been shown to overwhelm local medical systems repeatedly. Planning for a surge of patients should include an all-hazards approach, by all stakeholders in a region, and for all levels and phases of response. Patients impact the healthcare system from the scene of the incident until released to home, yet current planning does not include the last and important phase of rehabilitative patient care. The review of the literature has shown that disaster patients with traumatic injuries benefit significantly from this care.

The Haddon matrix as a planning tool for surge concepts, may be able to identify processes and programs that could reduce injuries and increase surge planning. This research study uses the concepts presented in the first three chapters as a framework to investigate new planning strategies for rehabilitation facilities. The next chapter highlights the methods to be used in the research study.

4 Methods

Planning for a surge of disaster patients involves knowledge of community demographics, community hazards, and the capability and capacity of EMS and hospitals. It also requires information from past disasters on the types of injuries, acuity and number of patients treated by EMS and by the hospitals. Additionally, it is important to understand the length of time a patient affects the healthcare system from the time of injury to the time the patient is able to return home. Little research was found that could project the number and types of patients who may need rehabilitative care after a disaster.

This study was designed to explore planning for a surge of patients injured in a disaster, based on their acuity and the probability of admittance to a rehabilitation facility, to complete the surge planning model. A quantitative study of disaster patients who were admitted to a rehabilitation facility will be conducted by examining their START triage acuity category and their ISS score to determine if either of these healthcare tools could be used as a future benchmark for surge planning. Having a benchmark established before the disaster could aid in planning of personnel, beds, supplies and other resources that may be needed during the disaster.

A qualitative study was developed to explore surge planning for rehabilitation facilities. Interviews with subject matter experts to discuss new strategies for rehabilitative facility readiness will be conducted. The questions for the interviewees were based on the current state of surge planning, including barriers to planning and resources needed prior to a disaster.

Quantitative Methods

Based on past trauma and disaster patient research studies, the variables of START, ISS, and hospital discharge status were chosen as the surge rehabilitation benchmarks for this exploratory

and descriptive study of disaster patients. The quantitative research study questions are:

1. Can START classifications predict whether a patient will need to be admitted into a rehabilitation facility after a disaster?
2. Can ISS scores predict which patients will need to be admitted into a rehabilitative facility after a disaster?

The study used a quantitative secondary data analysis to explore the variables of START, ISS, and hospital discharge data for patients injured in a disaster in the year 2011, who were treated at a hospital that submits their data to the National Trauma Data Bank (NTDB). The NTDB dataset includes thirteen variables that include, EMS vital signs, emergency department vital signs, emergency department diagnosis, injury severity scores (ISS), and diagnosis related codes (DRG), average lengths of stay in the hospital and final disposition. A NTDB secondary disaster dataset was constructed to determine if START triage categories and ISS values could determine the probability for the need for rehabilitative care as evidenced by admission to a rehabilitation in-patient facility.

Data Collection

The National Trauma Data Bank (NTDB) contains data collected from over 900 registered (United States) trauma-accredited hospitals. "NTDB data is used in strict compliance with the Health Insurance Portability and Accountability Act (HIPAA) of 1996 (American College of Surgeons, 2012, p. 6). The dataset collected by NTDB is considered a limited dataset which means that the dataset has no patient identifiers" (American College of Surgeons, 2012, p. 6).

The NTDB is not a population-based dataset so it is subject to the limitations of a convenience sample. "The data may not be representative of all trauma hospitals in the nation and thus does not allow statistically valid inferences about national injury incidence and prevalence" (American College of Surgeons, 2012, p. 6). The dataset is also not a complete accounting of all injured patients because not every hospital in the United States participates (approximately 3000 hospitals). Additionally, a national disaster patient database has not yet been established so the NTDB can be considered the best available source to compare EMS data, hospital data and outcome data.

The NTDB dataset is a "set of relational tables and consists of 20 separate data files. Thirteen of the data files include a unique incident identifier (patient number) for merging the data files together" (American College of Surgeons, 2012, p. 11). The dataset file variables include, hospital facility codes, Abbreviated Injury Severity (AIS) Injury Severity Score (ISS) codes, International Classification of Diseases (ICD) Diagnosis Related Group (DRG) codes, demographics of age, gender, race and the region of the United States the hospital is located, vital signs, external cause of injury, admission to hospital, procedures codes, patient medical co-morbidity and any complications experienced while in the hospital, and discharge status for each patient. However, each patient may not have a complete record of all his or her variables. The variables from the NTDB 2011 original dataset for this research study include:

- Patient identification number
- External cause of injury (DRG) code – this will be changed to a descriptive instead of a code in the analysis (e.g., tornado)
- Region of the United States for each hospital
- Vital signs and Glascow Coma Score to calculate START

- Emergency department disposition
- ISS score (determined by hospital trauma registry)
- Hospital disposition

The original NTDB dataset for 2011 has 784,688 total trauma patient records. The majority of these patients were not injured during a disaster so a subset that represents only disaster patients was constructed.

The first step to building this new dataset was to determine the number of disaster patients who were recorded in the NTDB for 2011. Each patient record (784,688) was reviewed for the DRG external code that signifies the patient was injured during a disaster. Each external code found in the original data set that denoted that the patient was injured during any type of disaster (e.g., tornado, hurricane) was copied along with their individual patient identifier and moved to a new data file. A total of 619 patients were removed from the original NTDB dataset and established in this new 2011 disaster dataset. The original data from the NTDB is separated into thirteen separate (e.g., vital signs, DRG, ISS, hospital disposition) patient information files so the process of finding patients by their unique identifier for each category had to be repeated for each of the specific variables for the study.

A search of each of the thirteen data files for each disaster patient was accomplished for the study variables of age, hospital region, vital signs, type of injuries, ISS, emergency department disposition, hospital length of stay and hospital disposition. The search was completed and the information for each patient extracted and placed into the new 2011 disaster dataset. The completed secondary 2011 disaster dataset will be used for statistical analysis for this study.

Setting and Participants

Disaster declarations for 2011 included: flooding, tropical storms, earthquakes, hurricanes, tornadoes, wildfires and active shooter incidents. During a disaster, each patient will go through a series of steps for medical treatment. Each patient transported to a hospital by EMS is assessed for his or her medical injuries and vital signs. All patient data is recorded on an EMS field report. Upon arrival at each hospital, each patient is re-triaged by a nurse or physician and a hospital patient care record is begun noting all previous medical care recorded in the field, types and severity of injuries, and vital signs. The patient may be placed in the emergency department, the waiting area or an alternative care area within that hospital to receive medical care. This is dependent on the resources available at each hospital and will vary by hospital. Often patients self-transport to the hospital and when they arrive in the emergency department they will be triaged into an acuity level and have their vital signs accessed and a care report begun.

Not all patients that arrive at the hospital will need to be admitted to the hospital. Instead they may be treated for their injuries and released to go home or to a shelter. Patients are only admitted to a hospital when they need additional medical care or specialized care such as an operation. Each patient will have his or her Diagnosis-Related Group (DRG) classification recorded by hospital personnel. Use of the DRG is for "data management, reimbursement and comparability, benchmarking, and other types of research" (American Health Information Management Association, 2010, p. 1). The DRG has separate codes for, medical diagnosis, an average length of hospital stay, patient comorbidities, and how the patient became injured (e.g., tornado, motor vehicle crash). A hospital may list up to twenty different codes for each patient.

After the patient receives care, including any operations or specialized treatments, an Injury Severity Score (ISS) is calculated based on the patient's injury(s) by the hospital trauma

team. To calculate the ISS, the patient's medical records are reviewed including radiology and operative records. The ISS values range from 0 to 75 and provides a benchmark used by many trauma-designated hospitals, some community hospitals and within many research protocols.

Each hospital patient should have a discharge disposition recorded. From the emergency department it may read, discharged to home, shelter or expired. After a hospital admission, it could then include, discharged to a skilled nursing facility, in-patient rehabilitation facility, or home. The 2011 disaster dataset included the variables needed for data analysis.

Data Description

Federal disaster declarations issued yearly have increased since 1953 when assistance from the federal government began. (Lindsay & McCarthy, 2015) The average number of major disaster declarations per year in the 1960s was nineteen. "In contrast, from 2000 to 2009 the average number of declarations issued per year was 56. Calendar year 2011 set a new record with 99 major disaster declarations" (Lindsay & McCarthy, 2015, p. 1). Lindsey and McCarthy believe that some of the reasons why disaster declarations have increased have been due to "trends in severe weather patterns, population growth and coastal development and the role of government" (Lindsay & McCarthy, 2015, p. 31).

This study examined patient care information from the National Trauma Data Bank (NTDB) registry. These patients had been injured during a disaster in 2011, in the United States. Because only 900 out of approximately 3000 hospitals participate in the NTDB, not every patient injured in a disaster (2011) could be represented in this research. In reality, the incidence of disaster injuries could be higher and this research may only reflect a portion of the total of those patients who were admitted to an in-patient rehabilitation facility.

The NTDB dataset includes an external code that identifies the type of disaster. The research dataset does not contain any identifiable patient information. Because of this the patient demographics were limited to age and region where the hospital is located. During 2011, there were 784,688 total patients recorded in the NTDB dataset. Of the 784,688 total patients, a disaster subset was constructed with 619 patients identified as being injured in a disaster in 2011. Of those 619 patients, each individual record was reviewed for the variables used to determine the START triage category, the ISS and hospital discharge summary. This review found 407 complete patient records (all variables recorded in the NTDB) for the quantitative analysis.

There were seven types of disasters recorded in the data subset for 2011, earthquake, blizzard, dust storm, hurricane, tornado, cataclysmic storm other and cataclysmic storm unspecified. Three hundred eighty-one (94%) patients were injured during a tornado, eleven patients (3%) were injured in an unspecified storm and eight patients (2%) were injured during a hurricane in 2011. Table 2 below represents the types of disasters recorded for disaster patients in 2011.

Table 2

Types of Disasters by NTDB ECode (2011)

	Frequency	Percent	Cumulative Percent
Earth Movements/Eruption	1	0.2	0.2
Storms - Blizzard (snow/ice)	1	0.2	0.5
Storms - Dust Storm	4	1.0	1.5
Storms - Hurricane, Storm Surge, Tidal Wave, Typhoon	8	2.0	3.4
Storms - Other	1	0.2	3.7

Storms - Tornado, Cyclone, Twisters	381	93.6	97.3
Storms - Unspecified	11	2.7	100.0
Total	407	100.0	

The patient demographic section for the NTDB research dataset is intentionally limited due to health privacy protection laws, however, the dataset does include the region of the United States that the hospital resides in (not the region the patient lives in). Two hundred forty-nine (61%) of the patients were injured in the South region and one hundred thirty-nine (34%) patients were injured in the Midwest region. The West region had five (1%) and the Northeast had 13 (3%) patients. It is important to remember that this information only represents the disaster subset of patients from hospitals who report to the NTDB and not all hospitals nationwide. Hospitals who report to the NTDB are not equally distributed across the United States. Table 3 below represents the regions and number of patients in the disaster dataset.

Table 3

Patients by Region of the United States (2011)

	Frequency	Percent	Cumulative Percent
	1	.2	.2
MIDWEST	139	34.2	34.4
NORTHEAST	13	3.2	37.6
SOUTH	249	61.2	98.8
WEST	5	1.2	100.0
Total	407	100.0	

Study Design

All statistical analysis of the quantitative results should be conducted with the help of Statistical Package for Social Sciences software (SPSS). After completion of the 2011 disaster dataset, the next step was to organize the data into a meaningful form to determine if trends were found. One common method for organizing data is to construct frequency distributions. A frequency distribution is an organized tabulation/graphical representation of the variables in each category on a scale of measurement. This shows whether the observations are high or low and whether they are concentrated in one area or spread out across the entire scale. Thus, a frequency distribution graph presents a picture of how the individual observations are distributed in the measurement scale. (Manikandan, 2011) The Ogive is a graphical representation of the frequency distribution. This study will use the cumulative frequency of ISS scores for patient's admitted and not admitted to rehabilitative care. The cumulative frequency will be divided into four categories of marginal, low, moderate and high. Past use of an ogive by Landewe and Van Der Heije, was for a "probability plot for patient data" (Landewe & Van Der Heijde, 2004, p. 699). They state, "probability plots can be used to visually compare the distributions of results" and that "a disadvantage of presenting data as percentiles is that the percentile only relates to one observation in the distribution and neglects the majority of the variable values" (Landewe & Van Der Heijde, 2004, p. 699). The Ogive will reflect the probability a patient will be sent to rehabilitative care above or below a certain ISS score.

A Chi-Square Test of Independence is completed using a cross tabulation. "The cross tabulation presents the distributions of categorical variables simultaneously, with the intersections of the categories of the variables appearing in the cells of the table" (Statistics Solutions, 2015, p. 1). The Test of Independence determines if an association exists between the variables by examining the pattern of responses in the cells. "This is done by calculating the

Chi-Square statistic and comparing it against a critical value from the Chi-Square distribution to allow the researcher to assess whether the association seen between the variables is likely to represent an actual relationship between those variables in the population" (Statistics Solutions, 2015, p. 1). A Chi-Square test will be performed for both START and ISS categories with a cross tabulation of admittance to a rehabilitation facility. An additional Chi-Square analysis is conducted following the descriptive statistical analysis to test association.

Qualitative Methods

Surge planning as the conceptual framework was used to explore alternative ideas that could improve response and recovery after a disaster as well as surge capability and surge capacity as discussed in past research. (Hick, Barbera, & Kelen, 2009; Koenig & Schultz, 2010; Weifeng, et al., 2014) For example, Kapucu (2008) found that collaborative planning was a missing component in the After Action Report from Hurricane Katrina. Healthcare systems plan for a surge of patients from a disaster, however, many regional planning entities and healthcare coalitions only include rehabilitation facilities as a source of additional beds to decompress the hospital of patients during the surge event. They have not yet considered that an in-patient rehabilitation facility may be the final destination for disaster patients who need to recover from their traumatic injuries. The goal of the in-depth interviews with subject matter experts was to examine surge planning strategies within the healthcare community for rehabilitative care for disaster patients and to explore how surge planning could be reconceptualized into the three phases of field, hospital, and rehabilitation.

Data Collection

"Qualitative purposes include understanding the context, process, and meaning for participants in the phenomena studied, discovering unanticipated events, influences, and conditions, inductively developing theory, and understanding a single case" (Tashakkori & Teddlie, 2003, p. 252). A semi-structured interview with open-ended questions was developed to explore current and future surge planning ideas for patients who need rehabilitative care after a disaster. Study subjects are subject matter experts from the fields of planning, emergency management and medicine who have experience in planning for many types and phases of disasters. The semi-structured interviews were conducted either in person or by phone for each participant after a signed consent form was collected. Each interview was audio recorded for transcription purposes and transcribed within NVivo software (QSR International).

Study Subjects

Ten people agreed to be interviewed for the qualitative study and each one is considered a subject matter expert in his/her field. In this convenience sample, all ten interviewees have a background in healthcare (5 physicians, 3 nurses and 2 paramedics) and seven are active members of healthcare coalitions. All interviewees have experience in surge planning and have experienced a disaster as a healthcare team member in their home region. Six participants have been deployed with a response team (e.g., Disaster Medical Assistance Team, Urban Search and Rescue Team) to a disaster outside of their home area and four have both domestic and international deployments.

Study Design and Data Description

After a review of the medical surge and rehabilitative disaster medicine literature and the construction of a Haddon matrix based on planning for a surge of patients needing rehabilitative care, an interview protocol was developed. The Haddon matrix developed included the standard sections of pre-event, event, and post-event timeframes to investigate various planning strategies. The interview dialogue and questions were trialed on three subject matter experts who were not in the interviewee group. The final protocol was submitted for approval from the Jacksonville State University Institutional Review Board.

Each interview was conducted by phone or in person after a signed informed consent document was completed. Four interviews were conducted over the phone and six interviews were conducted in person. Each interview was audio recorded and transcribed. The transcription will be used for the analysis of content and categorization. Each separate interview question is considered a theme in the qualitative software program. Within each theme, the interviewee statements are coded as case node(s) with assigned attributes by the NVivo software. The software uses queries and visualizations to explore the connections between the themes and nodes. Comparisons can additionally be made between interviewees for additional ideas, nodes or themes.

"There are four main categories of validity in qualitative research; descriptive validity, interpretive validity, explanatory validity and generalizability" (Tashakkori & Teddlie, 2003, p. 257). This study is founded in interpretive validity because it explores the meaning(s) of each participant statements and their individual perspectives of the problem. Explanatory validity would be difficult because of any claim of causal relationships, nor generalizability due to a small sample size. (Tashakkori & Teddlie, 2003)

Institutional Review Board

The National Trauma Data Bank removes all patient data identifiers prior to receiving access to the dataset. The NTDB dataset is void of identifiers for the quantitative portion of this dissertation so the Jacksonville State University Institutional Review Board did not need a review.

An application to the Jacksonville State University Institutional Review Board was approved for the qualitative portion of the study that centered on medical surge planning for rehabilitation facilities by use of semi-structured interviews with subject matter experts.

Summary

This research study is designed to examine a lack of planning for rehabilitative patients during or immediately after a disaster and to reconceptualize surge planning into the three phases of field, hospital, and rehabilitation. In the absence of a national database, the quantitative research used a limited dataset provided by the National Trauma Data Bank (NTDB), which includes patients injured in a disaster. A secondary disaster dataset was constructed of only disaster patients. The quantitative analysis centers on the START, ISS, and hospital discharge variables.

Surge planning for disaster patients is common for EMS and hospitals with much of the planning being conducted with healthcare coalitions. Even though rehabilitative care has increased in the last ten years for the daily patient population, many local healthcare coalitions have failed to include this medical specialty in surge planning. In order to explore new strategies for surge planning, a qualitative study using semi-structured interviews was designed to investigate new strategies and other perceptions related to rehabilitation. This protocol was

developed to gain these new insights from subject matter experts. Use of mixed methods research to explore the multiple aspects of this problem could lead to new strategies for surge planning for rehabilitative care.

5 Analysis and Results

This chapter centers on the statistical analysis for the quantitative and qualitative research studies. The statistical analysis includes descriptive frequencies and non-parametric tests of the research questions along with visual representations and discussions of the results. The quantitative analysis revealed that 19% of patients were admitted to a rehabilitation facility post hospitalization from a disaster in 2011. Of the 19% of patients, the probability of a patient needing rehabilitative care is reflected using the cumulative frequency (Ogive graph) which revealed four possible outcomes from his/her ISS scores. ISS values from 0 to 5 saw a marginal use of rehabilitative care for disaster patients. ISS values from 6 to 10 revealed a low admission rate to rehabilitative care. An ISS score of 11 to 20 showed a moderate probability of admittance and an ISS score of 21 and above revealed a high rate of admittance to a rehabilitation facility.

The qualitative analysis of subject matter expert interviews revealed new and important strategies that will improve planning for patients who need rehabilitative care. Breaking the planning process into the sections of pre-event, event and post event, aided in defining important new goals that could easily be implemented by the healthcare community. Details of the strategies are discussed later in the chapter.

Quantitative Analysis

Of the 407 patients recorded in the disaster subset, 76 (19%) were admitted to an in-patient rehabilitation facility after release from a hospital for additional treatment. Reviewing the question of can START classifications predict whether a patient will need to be admitted into a rehabilitation facility after a disaster, the analysis showed that 44% of the red patients (severe

injury) needed to be admitted into a rehabilitation facility. Additionally, 29% of the yellow (moderately injured) patients and 15% of the green (minor injury) were admitted into a rehabilitation facility.

The research question of, can an ISS score predict which patients would need to be admitted into a rehabilitation facility revealed that patients with ISS values from 0 to 5 saw a marginal use of rehabilitative care. ISS values from 6 to 10 revealed a low admission rate to rehabilitative care. An ISS score of 11 to 20 showed a moderate probability of admittance and an ISS score of 21 and above revealed a high rate of admittance to a rehabilitation facility. Each type of injury (severe, moderate, and minor) for both START and ISS had a percentage of patients who needed rehabilitative care. This is significant because many healthcare planners may not consider moderate or minor injured patients as needing care from a rehabilitation facility.

A chi-square was performed on both START and ISS with admittance to a rehabilitation facility. The relationship of START and admission into a rehabilitation facility was significant at the .001 level ($X^2(2, N=407) = 17.5, p=.001$). In addition, the relationship of ISS and admission into a rehabilitation facility was significant at the .021 level ($X^2(32, N=407) = 50.3, p=.021$).

Details of the Analysis

A frequency analysis was performed and found that the total number of patients that were admitted to a rehabilitation facility after their hospitalization was 76 (19%) and those that were released from the hospital to home or skilled nursing facility were 331 (81%). Table 4 below represents the frequency of patients admitted or not admitted to a rehabilitation facility.

Table 4

Total Patients Admitted or Not Admitted to a Rehabilitation Facility

	Yes	No	Total
Patients	76	331	407
	(19)	(81)	(100)

START Triage

The Simple Triage and Rapid Transport (START) is a triage score that is used by EMS providers at the scene of the disaster and by hospital personnel when the patient first arrives at a hospital. The score uses an algorithm based on the patient's level of consciousness, perfusion and respirations to classify patients into minor injuries (green), moderate injuries (yellow) and severe injuries (red). The analysis found that there were 335 (82%) of the 407 patients classified as minor injuries, 45 patients (11%) with moderate injuries and 27 (7%) patients with severe injuries within the disaster subset using START triage. Table 5 below represents the total number of patients in each START category.

Table 5

Total Patients in Each START Category

	Red	Yellow	Green	Total
Patients	27	45	335	407
	(7)	(11)	(82)	(100)

The research question of, can START classifications predict whether a patient will need to be admitted into a rehabilitation facility after a disaster was analyzed. Table 6 below shows that 44% of the red (severe injury) patients were admitted to a rehabilitation facility. Additionally, 15% of the minor injured (green) patients were admitted to a rehabilitation facility and 29% of the moderately (yellow) injured patients were admitted to a rehabilitation facility.

Table 6

START Frequency Table with Admittance into a Rehabilitation Facility as Yes or No

	Admitted and Not Admitted to Rehabilitation by START			
	Red	Yellow	Green	Total
Yes	12	13	51	76
	(44)	(29)	(15)	(19)
No	15	32	284	331
	(56)	(71)	(85)	(81)
Total	27	45	335	407
	(100)	(100)	(100)	(100)

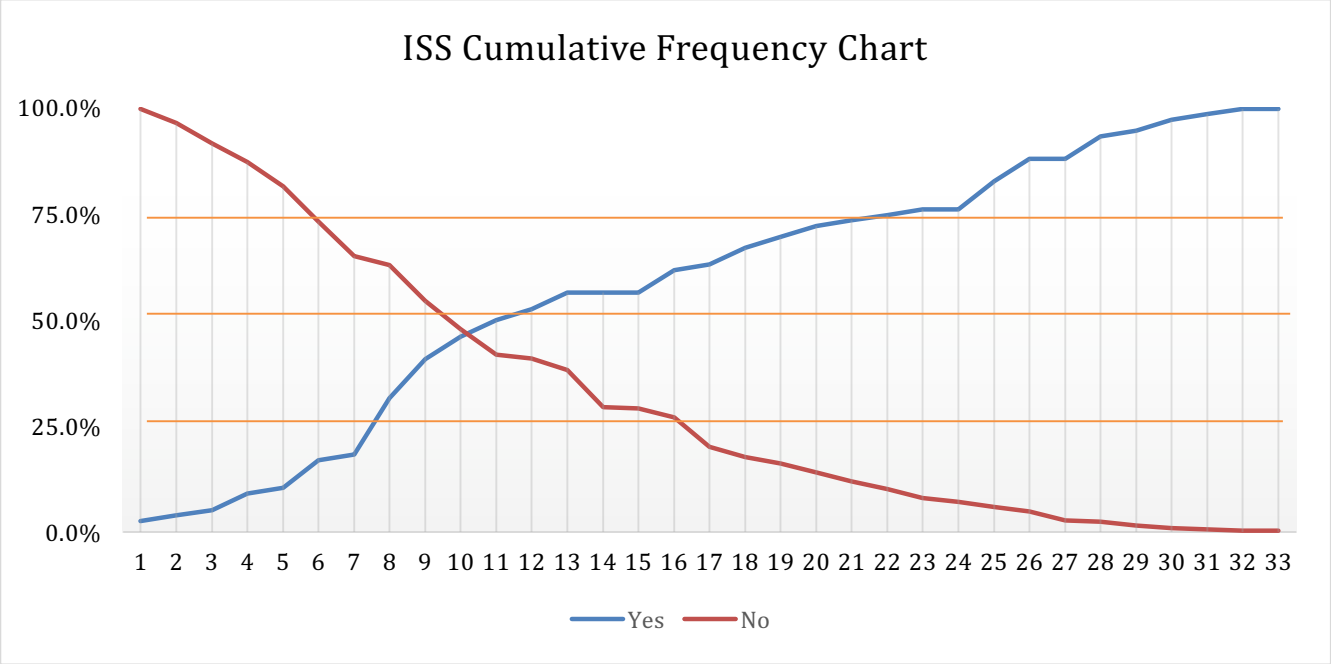
Injury Severity Scores

An injury severity score (ISS) is completed after a patient has been admitted to the hospital and has had all evaluations and most treatments (e.g. diagnosis, x-ray, surgeries) performed. The Injury Severity Score values range from 0 to 75. In this study, the highest recorded ISS score in the disaster dataset was 63. The research question of can an ISS score

predict which patients would need to be admitted into a rehabilitation facility was analyzed. A cumulative frequency table was constructed with the cross tabulations of ISS score and admittance to a rehabilitation facility by yes or no. An Ogive graph was constructed to visualize the cumulative frequencies (Figure 4 below). The cumulative frequency is the sum of the frequencies up to the upper boundary in the distribution.

Figure 4

Ogive Graph of ISS Scores by Frequency



The results of the Ogive graph (above) are important to discuss because it shows the probabilities for patient admission and not being admitted to a rehabilitation facility by ISS score. The horizontal axis represents the ISS number and the vertical axis represents the percentage of patients admitted. According to the American College of Surgeons, an ISS from 0 to 7 is considered a minor injury, 8 to 15 is considered a moderate injury and 16 to 75 is a severe injury.

(American College of Surgeons, 2012) However, other researchers have used an ISS of 8 and above as a patient with severe injuries as was noted in the literature review.

The range of probability that is revealed in the Ogive graph above reflects four possible outcomes from ISS scores. ISS values from 0 to 5 saw a marginal use of rehabilitative care for disaster patients. ISS values from 6 to 10 revealed a low admission rate to rehabilitative care. The cross-point is an ISS value of 10, this value represents 50% of the patients were admitted or not admitted to a rehabilitation facility. An ISS score of 11 to 20 shows a moderate probability of admittance and an ISS score of 21 and above revealed a high rate of admittance to a rehabilitation facility. With the use of a patient's ISS score, along with the probability of needing rehabilitative care, the trauma team could begin to estimate the number of rehabilitation beds needed for their in-hospital patients. Early estimation of beds could lead to early acquisition of rehabilitation beds and an equitable distribution of patients based on community resources.

Chi-Square

"The chi-square test of independence is used to test for the statistical significance of the relationship between two nominal variables" (Holcomb, 2011, p. 179). A chi-square test of independence was performed to examine the relation between START triage categories and patients that had been admitted or not admitted to an in-patient rehabilitation facility. A total of 19% of the patients in this study were admitted to a rehabilitation facility. Of those, a patient in the red (44%) START triage category was more likely to be admitted to a rehabilitation facility than the yellow (29%) or green (15%) category as shown in the table 7 below. A chi-square test was performed and a relationship between the variables of START triage and admission to a

rehabilitation facility was significant, $X^2(2, N=407) = 17.5, p=.001$. Table 7 below shows the cross tabulations for START triage categories and admittance to a rehabilitation facility by yes or no.

Table 7

Cross Tabulations Table for START Triage and Admittance to a Rehabilitation Facility by Yes/No

	No	Yes	*df*
Green	284	51	
	(85)	(15)	
Red	15	12	
	(56)	(44)	
Yellow	32	13	
	(71)	(29)	
Total	331	76	2
	(81)	(19)	

A chi-square test of independence was performed to examine the relationship between ISS scores and whether a patient is admitted or not admitted to an in-patient rehabilitation facility. A total of 76 (19%) patients were admitted to a rehabilitation facility. An ISS score of 11 to 20 shows a moderate probability of admittance and an ISS score of 21 and above revealed a high rate of admittance to a rehabilitation facility. A chi-square test was performed and a relationship between the variables of ISS and admission to a rehabilitation facility was significant, $X^2(32, N=407) = 50.3, p=.021$.

Table 8

Cross Tabulations Table for ISS Categories and Admittance to a Rehabilitation Facility by Yes/No

ISS	no	yes	*df*
1	11	2	
	(85)	(15)	
2	16	1	
	(94)	(6)	
3	15	1	
	(94)	(6)	
4	19	3	
	(86)	(14)	
5	27	1	
	(96)	(4)	
6	27	5	
	(84)	(16)	
8	7	1	
	(87)	(13)	
9	28	10	
	(74)	(26)	
10	22	7	
	(76)	(24)	
11	20	4	
	(83)	(17)	
12	3	3	
	(50)	(50)	
13	9	2	
	(82)	(18)	
14	29	3	
	(91)	(9)	

15	1	0
	(100)	(0)
16	7	0
	(100)	(0)
17	23	4
	(85)	(15)
18	8	1
	(89)	(11)
19	5	3
	(62)	(38)
20	7	2
	(78)	(22)
21	7	2
	(78)	(22)
22	6	1
	(86)	(14)
24	7	1
	(87)	(13)
25	3	1
	(75)	(25)
26	4	0
	(100)	(0)
27	4	5
	(44)	(56)
29	7	4
	(64)	(36)
32	1	0
	(100)	(0)
34	3	4
	(43)	(57)

36	2 (67)	1 (33)	
38	1 (33)	2 (67)	
41	1 (50)	1 (50)	
50	0 (0)	1 (100)	
63	1 (100)	0 (0)	
Total	331 (81)	76 (19)	32

Qualitative Analysis

The qualitative study of surge planning for rehabilitative patients featured semi-structured interviews of 10 subjects. These individuals are subject matter experts with education and experience in planning, emergency management and medical care. The computer-aided qualitative software program NVivo (QSR International, Cambridge, MA) was used to analyze the data. Themes were derived through analysis of the interview questions and coding was accomplished with each individual interviewee transcript.

All subject matter experts were interviewed individually with each interview lasting between 15 and 40 minutes. All interviews were recorded with permission of the interviewees. After each interview, the recording was transcribed within the NVivo software. Interviewee confidentially was assured in the informed consent document.

Six themes were identified based on the interview questions and added to the NVivo software. A node (statement from interviewee's transcript) could be coded into a specific theme. Each interview was semi-structured which led to several questions and nodes being added during interviews. Table 9 below shows the final number of themes, node name and the number of coded statements.

Table 9

Qualitative Themes and Nodes

Themes	Nodes	Number coded
What do you see as the main barriers to planning for a surge of patients who need rehabilitative care?	Barriers Minor injuries Accreditation	14 1 1
Should rehabilitation facilities plan for two surges? (one to decompress the hospitals and one for 24-48 hours later?)	Number of surges	7
What resources or assets might be available (regional and/or individual facility) to help rehabilitation facilities ability to surge for disaster patients?	Resources	12
What strategies can you think of before a disaster that aid in planning or preventing injuries?	Planning strategies	16
Is there an optimal time during the hospital surge phase that the trauma/rehabilitative care team could begin looking for available beds for patients who need to be admitted to a rehabilitative facility?	Optimal Time National Trend	6 3
Do you have any other recommendations for improving planning for a surge of patients who need rehabilitative care?	Recommendations	13
Any additional comments or ideas	Additional comments/ideas	11

Barriers to planning

The majority of the subjects expressed multiple barriers when discussing planning for a surge of patients who need rehabilitative care. Each interviewee mentioned that the main barrier centered on not knowing the capacity or the capability of rehabilitation facilities during a

disaster. Before being able to admit a patient into an in-patient rehabilitation facility certain criteria must be met for Medicare-Medicaid requirements. One of these requirements includes a hospital stay of several days before these patients can be "certified" to be admitted to rehabilitative care. This two-day stay requirement may mean less beds in the hospital for patients when beds are at a premium due to a disaster. Therefore, changes to this requirement early during a disaster would be advantageous to hospital surge planning.

Another barrier that was cited by half of the interviewees was the idea that planners are "short-sighted" on our approach to planning for rehabilitation patients. One interviewee explained that planners "do not look at the whole problem from the 30,000-foot view when we're looking at disasters." Another suggested that often "no one is looking at the long term effects of disasters, only the short term such as getting patients to the emergency department and then getting them admitted to the hospital."

Two interviewees commented on barriers that included, "a lack of accreditation standards for rehabilitation facilities to require planning for a surge of patients" and a recommendation to be able to admit patients to rehabilitative care earlier in the hospital process. Both also spoke about implementing a triage system for rehabilitative care admissions, based on patient acuity, to determine which patients should be admitted to in-patient rehabilitative care and which patients may need to be sent to home or to shelters with outpatient rehabilitative care.

Multiple Surges

The majority of the interviewees agreed that planning for rehabilitation patients should be thought of as planning for two different surge timeframes. One subject believed it should be modeled after the planning that is currently in use for a "wave" of pandemic patients. For

example, “pandemic patients present to EMS and hospitals in two distinct periods with one being early and the next wave occurring several days later.” The interviewee thought that the same holds true for rehabilitation planning. “The first wave is when the hospital needs to decompress and open beds for the incoming disaster patients and the second wave is 2 – 3 days later when the disaster patients need to be admitted to rehabilitative care.”

Planning for Resources

There were twelve different statements for the resources node from the interviewees. Suggestions and ideas spanned from current resources to future possibilities. The majority of the ideas included how and where to “house” a group of patients who need rehabilitative care when the in-patient rehabilitation facilities are at 90% to 100% census. Many suggestions included the use of high schools and hotels that had indoor swimming pools (water therapy) and exercise equipment (physical therapy). Several interviewees suggested that training federal Disaster Medical Assistance Team (DMAT) members on methods to assist with rehabilitative care treatment would be ideal. Two interviewees mentioned recruiting volunteers during a disaster that are not normally engaged in disaster care but understand the rehabilitative care concepts, such as athletic trainers. The last two suggestions would help with the shortage of personnel with rehabilitative care experience to assist in alternate care centers during a disaster.

Planning strategies to Prevent Injuries

Everyone that was interviewed mentioned the importance of preventing the injury if possible. Public education was cited by every participant. Many interviewees’ felt strongly that “first aid courses needed to be taught to the public.” Additionally, personal readiness plans were

mentioned by nearly each interviewee that included, when to evacuate and when to shelter in place. They expressed that readiness should include home supplies such as food, water, and medications. Other items such as first aid kits, generators, and emergency alert radios were discussed with one subject stating that "having that extra assurance that they can stay at home, I think, will take a burden off of the health care system."

One interviewee mentioned that national courses, such as, National Disaster Life Support and Advanced Disaster Life Support, should be taught to all medical personnel to help them become more prepared to assist with patient care during a disaster. These courses are designed to teach medical personnel how to treat spinal injuries and crush injuries correctly, for example, which could lessen the rehabilitative time later for the patient. The interviewee added, "these courses could become the standard of disaster care much like the Advanced Cardiac Life Support course has become for cardiac care."

Optimal Time

Three of the interviewees cited that they are unsure of an optimal time to begin looking for rehabilitation beds during a disaster. A few thought that the current national trend of early rehabilitative care admittance, which is being driven by early consultation with the rehabilitation physicians, is a key. Some subjects would like to implement the concept of admitting a person to rehabilitative care directly from the emergency department instead of the requirement to admit the person into the hospital for the required two-day stay (Medicare/Medicaid requirement).

All respondents did agree that keeping patients in the community, near their physicians and family was important. Use of hospital care coordinators who integrate family, patient needs and bed space (hospital and rehabilitation) were an additional new trend used in many hospitals

today and certainly a key to patient placement. "These care coordinators should be added to the incident command center to facilitate patient movement from hospital to rehabilitative care."

Additional Recommendations and Further Comments

Some of the additional recommendations included adding rehabilitative facility accreditation standards that include surge planning with the community and/or the healthcare coalition. Others cited a lack of training to medical personnel and early rescuers (e.g. national guard, law enforcement) as to what is needed by the person evacuating from their home during a disaster. They felt that often times if these early responders had asked evacuees if they needed to take their walker, their medications or other specialty equipment it would have aided in the individual recovery.

A lack of funding was also often cited. The Hospital Preparedness Program grant funding has been decreasing yearly and adding an additional burden on the healthcare system to become and stay prepared by adding rehabilitative care could be costly. Bringing the rehabilitation care administrators and physicians to the "table" in the community to discuss planning was additionally commented on by half of the participants.

Most interviewees agreed that being proactive and including rehabilitative care was better than being reactive and not having enough rehabilitative care beds in the community. One interviewee believes that the surge reporting system for hospitals that their coalition has in place for use during a disaster should be expanded to include open beds in rehabilitative care, long-term care and skilled nursing facilities. "As you can imagine, just trying to increase the scope of planning to include rehabilitative services which are not included at this point….is going to add

another layer of complexity, another layer of personnel, another layer of money to put it all in place."

A word cloud was constructed by the NVivo software from the interviewee's transcripts and illustrated below in Figure 5.

Figure 5

Qualitative Word Cloud – Top 1000 words from Interviewees

Summary

These studies have determined that 19% of disaster patients (as reported to the NTDB), from 2011, were admitted to an in-patient rehabilitation facility. The research question of, can START classifications predict whether a patient will need to be admitted into a rehabilitation facility after a disaster revealed that 44% of the red (severe injury) patients were admitted to a rehabilitation facility. Additionally, 15% of the minor injured (green) patients were admitted to a

rehabilitation facility and 29% of the moderately (yellow) injured patients were admitted to a rehabilitation facility.

The research question of can an ISS score predict which patients would need to be admitted into a rehabilitation facility revealed that patients with ISS values from 0 to 5 saw a marginal use of rehabilitative care. ISS values from 6 to 10 revealed a low admission rate to rehabilitative care. An ISS score of 11 to 20 shows a moderate probability of admittance and an ISS score of 21 and above revealed a high rate of admittance to a rehabilitation facility.

Planning for the above rehabilitation patients has been lacking and with little research. Many of those interviewed for the qualitative portion of the study indicated that more collaborative planning should be accomplished before a disaster. The interviewees had many ideas of how to integrate rehabilitative care with the rest of the community medical providers and community stakeholders. One interviewee comment included, "the people that are supposed to be doing long term planning still stop at hospital admission, we've operated on them, we've fixed them and they never look beyond that." It is significant to note that the word cloud, which is created from the top 1000 words from interviewees, listed the two most used words during the interviews as "think rehab."

6 Discussion of the Research Findings

This chapter will discuss the research findings, the potential for future applications, and the need for additional research. When considering in what manner disaster capability and capacity, personnel, and resources affect patient outcomes, we can begin to visualize the importance of collaborative planning and operational readiness. A patient may require the healthcare system for several hours to several months depending on their type and severity of injury and each healthcare system should become prepared for this need. There are many challenges after a disaster to rebuild the community. Each community is dependent on infrastructure, leadership, and services of basic needs such as food, water, shelter and healthcare in order to successfully recover.

Currently, field (EMS) providers manage the first phase of a patient surge, and hospitals the second phase. Both field and hospitals have piloted research for a surge of patients for many years. Capacity and capability are important aspects of surge planning that have received federal planning and HPP funding initiatives for both EMS and hospitals. Rehabilitation facilities however, lack the HPP funding and community planning collaboration.

Rehabilitative medical care has been proven to reduce death and disability in past research. Dr. Reinhardt and colleagues believe that "destruction or weakening of pre-existing rehabilitation services translates into minimal rehabilitation strategy being practiced during the immediate emergency response, further burdening an already challenged post-disaster health system" (Reinhardt, et al., 2011, p. 5). This research has reviewed the lack of planning for those patients who will need rehabilitative care and addresses goals and strategies of disaster injury prevention and preparedness to meet the patient surge needs. This research also investigated the use of standard healthcare tools as an aid in determining each patient's reliance on admittance to

a rehabilitation facility. As well, this research sought expert advice from subject matter experts on methods to include rehabilitation medicine into the surge planning process.

Discussion of the Results

The healthcare system will be strained during a disaster unless prior planning has occurred for all three phases of the surge event. The phases of field care (EMS), hospital care and rehabilitative care are managed by each medical provider specialty. They are additionally interdependent on each level of planning, local medical care resources, and integration of the next level of assistance (e.g., local, state, federal) and incident command system to be successful.

The question as to how much planning for a surge of patients is needed, is still an unknown. However, as witnessed in past disasters, we have not planned enough, nor planned collaboratively. Past research on patients injured in disasters has concentrated on types of disasters (e.g., pandemic, earthquake) and/or portions of one phase such as during the EMS or hospital phases of surge, but little research was found on rehabilitative care patient surge or the entire length of time a patient will impact the healthcare system.

This study revealed that 19% of the hospitalized patients injured during a disaster in 2011 needed in-patient rehabilitative care before returning to their home. While this result cannot be generalized to every disaster year or every community, it does represent the importance of planning for disaster patients who need rehabilitative care. While it was not surprising that nearly half of the patients needing rehabilitative care were classified with a severe injury, it was surprising that 10% to 15% (ISS and START respectively) of the patients with minor injuries also resulted in admittance to an in-patient rehabilitation facility. The 19% figure only represents the patients that were treated at a hospital that reports their findings to the National

Trauma Data Bank. This is approximately one-third of the hospitals in the United States. As well, many patients may receive treatment for minor injuries at a shelter and never need transportation to the hospital. Thus, the 19% of patients who were admitted to a rehabilitative care facility is only a beginning estimate. Future research that would include all patients injured during a disaster needs to be undertaken.

Each community is designed differently when it comes to population, types of EMS departments (e.g., fire based, tiered, non-profit), types, sizes, and number of hospitals (e.g., trauma designated, community, rural) and sizes and numbers of rehabilitation facilities. The federal government has recommended hospitals plan for a patient surge at up to 20% of their bed capacity within four hours. During a disaster, hospitals often plan to move their patients to home (if medically stable), a skilled nursing or long-term care facility or an in-patient rehabilitation facility to accomplish this 20%. What is still not known at this time is to what percentage of patients a rehabilitation facility should plan for during a surge event.

There is current research that supports the use of in-patient rehabilitative care to increase patient functionality and overall better outcomes after a disaster. (Gosney, Reinhardt, Haig, & Li, 2011) Poor patient outcomes such as limited mobility could lead to a change in jobs, a change in financial stability and a change in living arrangement or recovery. Rehabilitation facilities plan on receiving hospital patients to decompress the hospitals in the first several hours after a disaster but also need to plan for an additional surge of patients in the next 24-48 hours, remembering that almost half (45%) of these patients will be severely injured. The patient with a higher acuity will require increased personnel and resources.

Community medical surge planning groups, such as healthcare coalitions, should include rehabilitation facilities as members. These groups should plan with all regional organizations

responsible for mass care, work with trauma service providers on pre-event injury prevention and overall reconceptualize surge planning to include rehabilitative care.

Quantitative Results

Use of healthcare tools such as START triage and ISS scores, which measure patient acuity, morbidity, and mortality, has been used in research protocols for over 30 years. START and ISS have both been evaluated in past research for sensitivity and specificity. Past research has also included the use of ISS being correlated to the functional outcomes scores in rehabilitation studies. This research study looked at both START and ISS as a reliable way to project demand for rehabilitative care based on the injury acuity.

Knowing that rehabilitative care is considered best practice for traumatically injured patients is not enough, we lack an estimation of how many injured disaster patients we should begin to plan for and within what timeframes after a disaster. (Wade & de Jong, 2000) There were two research questions for the quantitative section of this study,

1. Can START classifications predict whether a patient will need to be admitted into a rehabilitation facility after a disaster?
2. Can ISS scores predict which patients will need to be admitted into a rehabilitative facility after a disaster?

The research study, in absence of a national disaster patient database, used the National Trauma Data Bank (NTDB) patient data set from 2011. A quantitative analysis was performed on the START categories and ISS from the disaster dataset that was constructed. The study found that 19% of the patients from the disaster dataset were admitted to an in-patient rehabilitation facility.

Additionally, the cumulative frequency analysis showed four possible outcomes from ISS scores. ISS values from 0 to 5 saw a marginal use of rehabilitative care for disaster patients. ISS values from 6 to 10 revealed a low admission rate to rehabilitative care. The cross point of an ISS value of 10 represents that 50% of the patients who were admitted or not admitted to a rehabilitation facility. An ISS score of 11 to 20 shows a moderate probability of admittance and an ISS score of 21 and above revealed a high rate of admittance to a rehabilitation facility.

Qualitative results

Subject matter experts were interviewed about planning for a surge of patients who need rehabilitative care. Planning is often divided into pre-event, event and post-event with multiple planning strategies desired for each section. All the interviewees discussed the need for public education and personal preparedness pre-event, especially for people who have a prior pre-existing illness or injury, being an essential need. Another pre-event idea that was often mentioned included the need for rehabilitation specialists and hospitals to create an algorithm that could be used at the hospital (during the event) to forecast which patients may need in-patient rehabilitative care. Many interviewees felt that after the event, patients who are medically stable could receive rehabilitative care at home with the use of a mobile home service with physician oversight. Additional strategies cited by interviewees included;

- disaster education for medical providers,
- hospitals should be able to rescind the need for a two-day length of stay to satisfy Medicare-Medicaid during a disaster,
- rehabilitation facilities should plan for two surges of patients during a disaster,

- early notification of a disaster to rehabilitation facilities so that they can evaluate their census to potentially move stable patients to home care, and
- alternatives to expand rehabilitative care by use of alternate care facilities and non-traditional personnel.

All subject matter experts agreed that rehabilitative care must be considered for all future disaster patients. Medical surge should additionally be thought of as three phases of patient care. These phases are field, hospital and rehabilitation.

Limitations

There are limitations to this study. The first one is the absence of a national disaster patient database, so a NTDB dataset was used for the quantitative study. Due to a lack of a national disaster patient database, the true scope of this problem may not have been identified. While the NTDB has over 900 hospitals reporting, there are approximately 3,647 hospitals in the United States. Additionally, since the data set from the NTDB is de-identified, an attempt to correlate specific disasters and the patients from those disasters could not be accomplished.

Patients often are admitted to a skilled nursing facility or other long-term care facility to receive one to two months of rehabilitative care due to the continued high census in many in-patient rehabilitation facilities. This study was unable to investigate if any of the patients from this dataset were admitted to one of these facilities (skilled or long-term care) for rehabilitative care. Because of these limitations, the number of those actually needing rehabilitative care may be larger. Finally, an additional diagnostic code per patient must be entered into the dataset by the hospital to identify the patient as injured during a disaster. This may have been inadvertently missed by the trauma registrar and patients may be missing from the disaster subset. Another

limitation is that both the quantitative and qualitative studies used a convenience sample of participants.

Recommendations for Further Study

In-patient rehabilitation facilities should have an emergency operation plan that includes a mass casualty incident surge plan. Ideally, this surge plan should address how to triage (with rehabilitation guidelines) current patients in the facility who could be safely discharged to home (with home services) and the number beds that could be added (with staff and resources) and be available in the next 4 hours and the next 48 hours for additional patients. Communities may want to consider not transferring patients from hospitals to rehabilitation facilities during the initial hours of a disaster. This would aid the rehabilitation facility to be able to properly prepare for a surge of patients from the disaster.

A national database that includes all disaster patients does not exist. The idea of a national database has been discussed previously by many researchers. A database that links all patients records from field care to rehabilitation outcomes would provide researchers with the data needed to investigate many aspects of disaster patient care, such as the length of time a patient impacts the healthcare system after a disaster, the types of injuries, and patient acuity. This type of database would give researchers the ability to make comprehensive recommendations for future planning and preparedness for disaster patients.

Use of planning tools such as the Haddon matrix to stimulate discussions on collaborative planning for all phases of a disaster should continue to be used by regional healthcare planners. Planning should include all community and healthcare stakeholders and optimally recommend new goals and strategies for patient care that begins in the field and ends when the patient is able

to return home within their locality. The Haddon matrix for this study, along with the interviews of subject matter experts revealed many new strategies that can easily be developed to improve surge planning and patient outcomes.

Conclusion

A national patient database to research disaster patient care and the resultant impact on the healthcare system has to include data points from the time of injury to the time the patient is healed. Without this database, planning for a surge of patients will continue to be an estimation of needed resources and never the total representation of the scope of the problem.

Use of standard healthcare benchmarks such as Injury Severity Scores to predict rehabilitation admissions should be further investigated. This research serves only as a beginning to explore this concept. Use of the ISS score in this study was able to predict rehabilitation admission, and thus can be used in medical surge planning.

Planning for patients has to begin prior to a disaster and should include a community plan that is integrated with the regional plan, the state plan and the federal surge plan. The federal government has concluded that hospitals should be ready to surge 20% of their licensed beds during a disaster. Rehabilitation facilities should consider planning for two surges, one to decompress the hospital and one in the next several days when disaster patients need rehabilitative care beds.

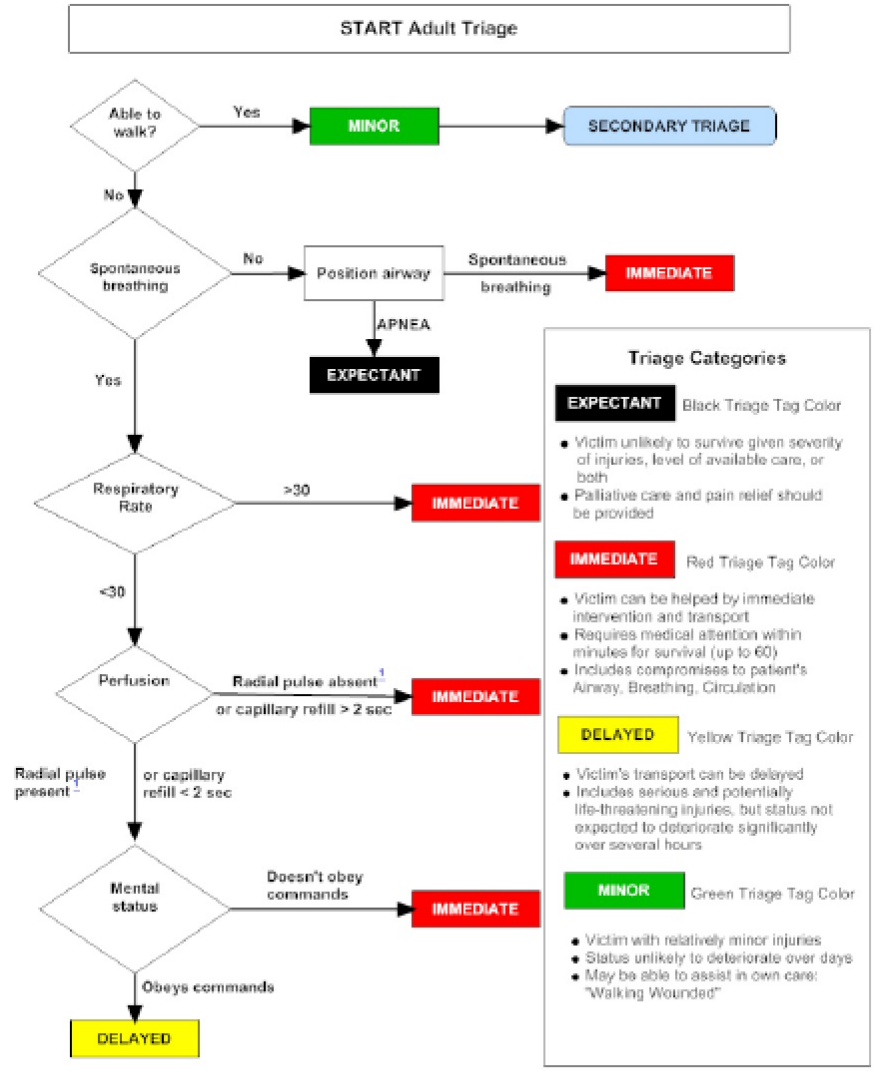
This dissertation proposes a reconceptualization of patient surge into three phases that include field, hospital, and rehabilitation. There were many novel ideas that the subject matter experts suggested during their interviews. Use of these ideas should aid many healthcare coalitions when planning and bring rehabilitative care specialists to the planning table. This

study concludes that a reconceptualization of surge planning to include three phases of field, hospital, and rehabilitation is a needed improvement to medical disaster planning.

The profession of rehabilitation medicine has grown tremendously and proven that through best practices their specialized care will reduce morbidity and mortality. Each citizen should have the opportunity to recover from a disaster back to his or her normal or near normal health status. “Efficient use of rehabilitation strategies will not only help unburden the challenged health system by mobilizing patients, but will also facilitate recovery of the post-disaster society by facilitating victims’ access to education and employment opportunities” (Reinhardt, et al., 2011, p. 5). We must begin surge planning conversations with the needs of the patients in mind, as well as, the needs of the community for a strong recovery.

Appendix A – Definitions

Construct	Theoretical or nominal definition
Medical Surge	"The ability to manage a sudden, unexpected increase in patient volume that would otherwise severely challenge or exceed the current capacity of the healthcare system" (Hick, et al., 2004, p. 2).
Surge Capacity	"The ability to respond to a markedly increased number of patients" (Barbera & MacIntyre, 2009, pp. I-3)
Surge Capability	"Surge capability is the extent to which surge capacity (resources that are available) can accommodate the surge (sudden demand for those resources)" (Kelen, McCarthy, 2006, p.1089).
Healthcare Coalition	"Healthcare organizations and other assets…. That forms a single functional entity to maximize medical surge capacity and capability in a defined geographic area. It coordinates the mitigation, preparedness, response, and recovery actions of medical and healthcare providers, facilitates mutual aid support, and serves as a unified platform for medical input to jurisdictional authorities" (Barbera & MacIntyre, 2009, p. 35)
Haddon Matrix	"An analytic approach for traffic safety injury epidemiology and prevention was developed by Dr. William Haddon, Jr. in the 1960s and has since been termed the Haddon Matrix" (Barnett D. J., et al., 2005, p. 2)
Over Triage	"Over-triage is defined as assigning non-critically injured patients to a high priority for early evacuation and treatment" (Aylwin, et al., 2006, p. 2219).
Immediate Bed Availability (IBA)	"No less than 20% bed availability of staffed members' beds within four hours of a disaster. It is built on three pillars: continuous monitoring across the health system; off-loading of patients who are at low risk for untoward events through reverse triage; and on-loading of patients from the disaster" (U.S. Department of Health and Human Services, n.d.)
Triage	The process of deciding which patients should be treated first based on how sick or seriously injured they are. http://www.merriam-webster.com/dictionary/triage
Figure 5 Simple Triage and Rapid Treatment (START) system	Triage system developed for field care in 1983 by Newport Beach Fire Department and Hoag Hospital. Now serves as the "de facto national triage standard for mass casualty incidents" (Kahn, Schultz, Miller, & Anderson, Does START Triage Work? An Outcomes Assessment After a Disaster, 2009, p. 424)

	 Adopted from http://www.start-triage.com
Diagnosis-Related Group (DRG)	Use of the DRG is for "data management, reimbursement and comparability, benchmarking, and other types of research" (American Health Information Management Association, 2010, p. 1).
Abbreviated Injury Scale – Injury Severity Score	The Injury Severity Score (ISS) is an anatomical scoring system that provides an overall score for patients with multiple injuries. Each injury is assigned an Abbreviated Injury Scale (AIS) score and is allocated to one of six body regions (Head, Face, Chest, Abdomen, Extremities [including Pelvis), and External]. Only the highest AIS score in each body region is used. The 3 most severely injured body regions have their score squared and added together to produce the ISS score. "The Injury Severity Score: a method for describing patients with multiple injuries and evaluating emergency care", (J Trauma 14:187-196; 1974).
Physiatrist	Board certified physician who specializes in physical medicine and rehabilitation (PM&R) (www.armpa.org)

Medical Rehabilitation	Inpatient rehabilitation hospitals and units are an integral part of the nation's health care system. They play a crucial role in advancing the care, treatment and recovery of individuals with disabling injuries and illnesses. Rehabilitation hospitals offer a unique level of care – a highly specialized, medically supervised and carefully coordinated program that improves a patient's health, function, mobility and independence. This includes restoring the skills and abilities to perform daily tasks, such as bathing, dressing and eating. Rehabilitation hospitals and units prepare patients to successfully return to home, work school and community activities. https://www.amrpa.org/Public/AMRPA_About_Medical_Rehabilitation.aspx
In-patient Rehabilitation Facility	The Medicare program has regulations, which define the hospitals and units for its purposes, and refers to them as Inpatient Rehabilitation Facilities (IRFs). The current average length of stay is 13 days. (www. Amrpa.org) IRFs are free standing rehabilitation hospitals and rehabilitation units in acute care hospitals. They provide an intensive rehabilitation program and patients who are admitted must be able to tolerate three hours of intense rehabilitation services per day. CMS collects patient assessment data only on Medicare Part A fee-for service patients. These facilities are exempt from the Medicare Hospital PPS and are paid under the IRF Prospective Payment System (PPS) effective 1/1/2002. In order to be paid under the IRF PPS, they must submit the IRF-PAI (patient assessment instrument). https://www.cms.gov/Medicare/Provider-Enrollment-and-Certification/CertificationandComplianc/InpatientRehab.html
START classifications Independent Variable	Variables = Red, Yellow, Green, Black Red - Severe injury Yellow – Moderate injury Green – Minor injury
Injury Severity Score Independent Variable	Variables = 0 – 75 0 – no injury to 75 = fatal injury
Dependent Variable	Admittance to a rehabilitative facility

Appendix B – Qualitative Interview Questions

Semi-structured interview dialogue and questions for subject matter experts approved by the

Institutional Review Board:

Each year, the United States experiences many different types of disasters. Many of these disasters cause injuries that require medical attention. Both EMS and hospitals plan for a surge of patients with hospitals required to be able to increase their bed capacity by 20%. Some of the patients who are admitted to the hospital will need additional care at an in-patient rehabilitation facility before they go home. This can occur in as little as 24-48 hours depending on their injuries. I am investigating surge planning for rehabilitation facilities and would like to hear your thoughts on this.

1. What do you see as the main barriers to planning for a surge of patients who need rehabilitative care?

As you know, hospitals are allowed to use different strategies to gain open beds during a surge. These can include cancelling elective surgeries and moving stable patients to long-term care, skilled nursing and rehabilitation facilities. A previous study used National Trauma Data Base records from 2011 and found that 18.7% of disaster patients were admitted to a rehabilitation facility.

2. Should rehabilitation facilities plan for two surges (one to decompress the hospitals and one for 24-48 hours later)?

3. What resources or assets might be available (regional and/or individual facility) to help rehabilitation facilities ability to surge for disaster patients?

Injury prevention before an auto accident has included the use of seat belts and airbags. Stockpiling medical resources such as a cache of ventilators is advantageous during a disaster such as a pandemic. After action reports provide lessons learned to aid in preparing for the next disaster. Planning strategies for disasters pre-event, event and post-event could be used to break surge planning into separate areas.

4. What strategies can you think of before a disaster that aid in planning or preventing injuries?

5. Is there an optimal time during the hospital surge phase that the trauma/rehabilitative care team could begin looking for available beds for patients who need to be admitted to a rehabilitative facility?

6. Do you have any other recommendations for improving planning for a surge of patients who need rehabilitative care?

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