MASS CASUALTY TRIAGE: AN IN-DEPTH ANALYSIS OF VARIOUS SYSTEMS AND THEIR IMPLICATIONS FOR FUTURE CONSIDERATIONS

by

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ABSTRACT

Emergency medical triage is a necessary part of our healthcare world. The ability to sort, classify, and treat patients in a crisis is a skill that few perfect. In a disaster situation or mass casualty incident, the number of injured people can often overwhelm the ability of the local healthcare system to treat them. To help create efficient use and rationing of resources, emergency personnel use triage to assess, sort, and treat patients. Questions of public health importance immediately arise when discussing the implications of sorting patients based on their injuries in a crisis, and the triage system was created to answer these inquires. From the ideas of Napoleon's Chief surgeon in the Imperial guard, triage has developed and changed immensely over the years. In this paper, I will analyze the historical development of emergency triage, analyze two major systems (START and SALT) used today in the U.S., discuss the problems and challenges of studying triage, analyze the literature surrounding the training of triage, and discuss the ethical implications associated with performing triage. Although triage algorithms alone are simple decision trees, the implications that accompany it create a multitude of problems for emergency personnel and those being treated. With this analysis, I will provide the evidence available on the systems and recommendations for the future of triage.

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PREFACE

I'd like to take this time to thank my readers, for their help in allowing me to create this essay. I dedicate this paper to my wonderful fiancé, who has provided all of the support and love to make this possible. Without her, this would not be what it is, and I would not be who I am today.

1.0 INTRODUCTION

Emergency medical triage is the process of sorting patients in a predefined way to address resource allocation concerns. In itself, triage is a tricky process with many questions associated with it that have yet to be answered. Even still, some of those questions create more questions than actual answers. In this paper, I intend: to analyze the history of triage, to examine how it has developed and changed for today's society, to conduct an analysis on the systems' effectiveness based on the current literature, to discuss the ethical implications associated with performing triage, and to recommend ideas for the future.

The ability to sort patients during a chaotic and uncertain time is an expertise not everyone can possess and multiple trainings need to be performed to perfect the skillset required for these situations. When training, it is important to recognize the difficulty of reproducing the chaotic atmosphere of an emergency, along with the uncertainty of triage patients during these events. In an emergency situation, the duties and responsibilities of triaging patients usually falls on "triage officers." The profession of this officer usually depends on the emergency at hand. If the patients are arriving in the hospital's emergency department, a nurse is typically assigned to the triage role. On the battlefield, the role is often fulfilled by the military physicians receiving the wounded soldiers. In disaster situations, where the number of patients far exceeds the abilities of the first responders arriving on scene, the triage officer role falls to those first responders that arrive on the scene first; or, if they are not trained in the triage skillset, the role will fall to the first arriving person who is trained for triaging patients (Beach, 2010).

Whomever fulfills the triage officer role, must face the difficult question of which patients to treat first. Should the seriously wounded individuals receive more care to save their lives and restrict resources for later patients? Or should "the many" be treated with the fewest resources, and the seriously wounded treated last with whatever remains? Although many daunting questions surround emergency triage protocols, this paper will address how should triage be used for future incidents, what considerations need to be taken into account when performing triage, and what is the best method of preparation for when these events occur?

PUBLIC HEALTH RELEVANCE

Triage is a necessary part of healthcare, as it provides a system and process to deal with situations where the number of patients needing treatment exceeds the capacity of the healthcare system attempting to help them. It is important to understand the tools available to our society to aid in our response to crisis situations. Understanding the system, along with its implications, allows for better decision making when patients are being triaged. At the same time, by analyzing the triage system, the goal is to encourage discussion and further research into the subject to not only improve effectiveness but to also increase awareness of the triage processes and its outcomes. In this paper, I approach one of the most difficult decision-making procedures in a scientific scope in the hope to better our public health atmosphere for not only ourselves, but those affected by these situations.

1.1 WHAT IS TRIAGE

The following historical analysis is mostly based on an excellent review by Iserson and Moskop (2007). When providing care to patients in need, multiple terms are used throughout the healthcare world: allocation, rationing, and triage are just a few examples. Allocation encompasses the largest scope, as it describes the distribution of both medical and non-medical resources. Allocation also does not necessarily imply that any of those resources are scarce. Rationing begins to include the scarcity of resources with the implication is that not all the needs of patient(s) can be satisfied at the time. This term also applies to more than just the healthcare system, as food, water, and supply rations have been in existence since beyond human memory (Iserson & Moskop, 2007). Triage, in all implications, specifically applies to the limited resources of healthcare and the situation causing those limitations. Triage typically satisfies the following three conditions:

1) Modest scarcity of healthcare resources exists in some capacity; varying widely depending on the location and type of situation at hand.
2) A health care worker often becomes a designated "triage officer" who assess each patient's needs, and distinguishes the future decisions for treatment of that patient.
3) The triage officer typically utilizes a pre-established plan to classify patients, based on an agreed-upon algorithm or criteria set. (Iserson & Moskop, 2007)

Thus, triage becomes necessary when healthcare resources are scarce (not sufficient to treat the patients' needs). To solve this problem, a healthcare worker must examine, categorize, and classify patients following a pre-established plan to ensure that the available resources are utilized in the most effective way possible. These plans were used, tested, and amended throughout history, potentially dating back hundreds of years. In the next section, I will analyze the historical development of the triage protocols.

1.2 HISTORY OF TRIAGE

The beginnings of triage arose from the reality of war, and the development of military medicine to help treat the wounded soldiers from the field. No formal record or history exists of Ancient or medieval armies organizing a concerted effort to treat their soldiers, and their care was likely to be ineffective. The first officially recorded triage situations developed in the 18th century with the work of French military surgeon Baron Dominique-Jean Larrey, chief-surgeon of Napoleon's Imperial Guard (Iserson & Moskop, 2007).

Triage is derived from the French word *trier*, to sort, and was originally used to describe the sorting of agricultural products. Larrey adapted the use of the word when he recognized the need to evaluate and classify wounded soldiers for treatment during a battle. In his time, it was customary to wait until after the battle had concluded (sometimes hours, even days) before tending to the wounded, leaving many soldiers to die. To help resolve this issue, he developed "flying ambulances:" horse drawn carts with storage area, to rapidly remove the wounded from the raging battles. Larrey was also the first to develop the idea that many triage officials still hold true today:

> *"Those who are dangerously wounded should receive the first attention, without regard to rank or distinction. They who are injured in a less degree may wait until their brethren in arms, who are badly mutilated, have been operated on and dress, otherwise the latter would not survive many hours; rarely, until the succeeding day."* (Iserson & Moskop, Triage in Medicine, Part I: Concept, History and Types, 2007)

The next major contribution to military triage was developed in 1846 when British naval surgeon John Wilson stated that, to make their effort the most effective, surgeons should focus on those patients who need immediate attention and for whom treatment is likely to be successful, deferring treatment for those who wounds are less severe and those whose wounds are probably fatal with or without immediate care. This was in concurrence with Larrey's already established practices, but was significant because of his official statement on the subject. In contrast, the US military services did not officially begin triaging soldiers until much later. In 1862, Jonathan Letterman became the first medic who combined triage procedures with front-line medical care and ambulatory services, allowing things to start looking up for wounded US soldiers (Iserson & Moskop, 2007).

As time moved forward, medical professionals were forced to adapt and refine triage protocols to fit the needs of advancing technologies in warfare. World War I brought the inventions and use of deadly new weapons into the world, such as machine guns and poison gases, that created an unprecedented number of casualties requiring triage. However, the ethics and thought processes behind this triage differed from that of Larrey and Letterman, focusing more on treating those that would require the least amount of time and effort to replenish battlefield numbers before moving to the more intensive patients, as "the greatest good of the greatest number must be the rule," (Iserson & Moskop, 2007). World War II continued this ideology, and had US military physicians pushing to get the greatest number of troops back onto the field in the shortest time possible, instead of treating the most demanding war wounds. This promoted the least expenditure of resources and the maximizing of the fighting strength for the participating armies, but left the more severely injured soldiers out to dry.

In today's military world, the scarcity of medical resources is not typically a limiting factor in treatment. Due to the increased speed of extraction of wounded soldiers via helicopters and other modern technologies, large numbers of wounded combatants can be quickly evacuated from the field of battle, and transported to medical facilities located close to the front lines with high-level equipment on site. Only primarily guerilla and developing world armies lack the resources to treat severely injured combatants quickly, and must take this scarcity into account.

Per Iserson and Moskop's review (2007), there has been little written discussion on the history of triage in civilian contexts. Weinerman et al (1966) was one of the first to publish a systematic description of civilian Emergency Department's use of triage in 1964, but was unable to show documented triage usage in a civilian context before the 19th century. Auf der Heide (1989) later stated that although triage systems existed in the world and have been used for centuries, most disaster casualties, at the time, did not undergo out-of-hospital triage because victims are found and transported directly to the hospital by bystanders. Since that time, almost all emergency medical systems, local, state and federal governments, and private institutions have developed triage systems to be used in disaster situations.

1.3 TYPES OF TRIAGE

Multiple triage types exist throughout the modern healthcare delivery system. The most common areas where triage is used includes, but is not limited to: the emergency department, inpatient intensive care units, multi-casualty incidents, military battlefield situations, and disasters (mass casualties). Even though all areas have distinctive elements of triage that makes them unique, each exhibit the three conditions – existence of scarcity, presence of a triage officer, and use of a triage protocol – listed earlier by Iserson and Moskop (2007). The systems discussed in the upcoming sections are not an exhaustive list of all the triage systems available to emergency services personnel. They are only the systems I have chosen to discuss and analyze in this paper.

Emergency Department Triage (ED)

In most modern U.S. hospitals with emergency departments (EDs), the nurse triage officers constantly assess and classify all patients who arrive for treatment. Their goal is to identify the most urgent and in-need patients to ensure that they receive care before more adverse effects can occur (such as death or loss of extremities). After those patients are admitted for treatment, the less urgent patients are typically addressed on a first-come-first-serve basis. In most emergency departments, there are usually enough resources to treat every patient that arrives, just not at the same time. With the limitations on bed space, medical staff, or other factors, triage becomes necessary to determine who needs treatment immediately versus those who can wait the extra time (Iserson & Moskop, 2007).

Routinely, U.S. emergency departments have used a 3-level system to sort and classify patients. The three levels include: “most immediate,” “can be delayed,” and “does not need emergency care.” The nurse assesses the patient’s reason for entering the ED and vital signs, then decides from there. However, a new system called the Emergency Severity Index (ESI) is making its way into hospitals. This is a 5-level classification system that uses four pre-determined “decision points” to establish which level a patient should be triaged. Those decision points are then examined and applied to an algorithm that places the patients in the correct category for treatment. The levels promulgated by ESI range from 1-5, with one being the most severe and in need of immediate treatment and decreasing from there. (Agency for Helathcare Research and Quality, 2014). The decision analysis algorithm is shown below in Figure 1.

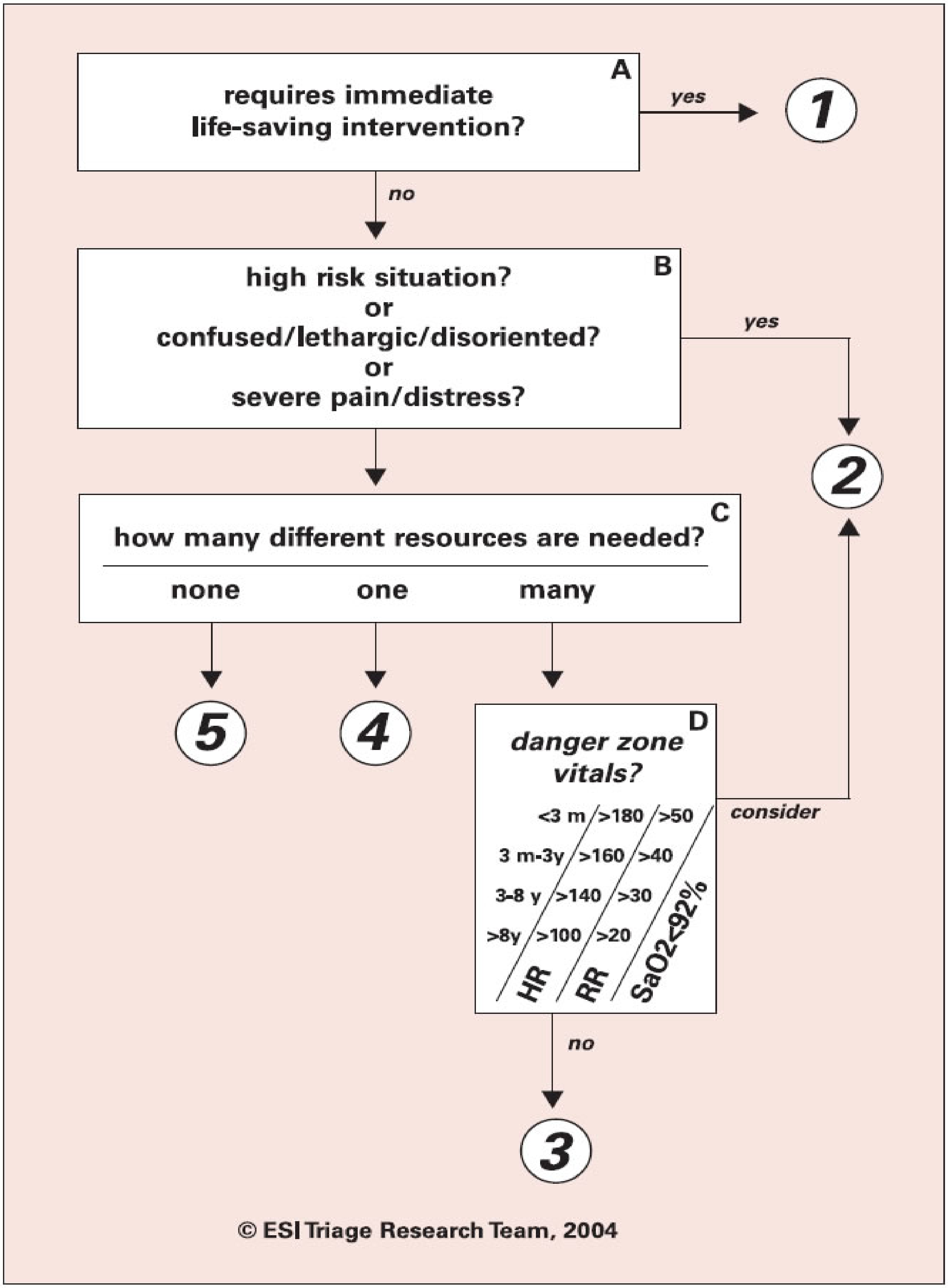

Figure 1. ESI Triage Algorithm for U.S. Hospitals

ICU Triage

Intensive Care Unit (ICU) triage, like ED triage, helps determine and separate those patients who require treatment immediately, from those who can wait for a time. Ideally, hospitals strive to be able to serve and care for all patients being admitted into the ICU. However, this is often not the case and forces critical decisions to be made. These decisions are classified as triage decisions, and the triage officer is most often a nurse, but can sometimes be an attending physician if the nurse is not available or unsure about a specific patient. To help streamline the process, the Agency for Healthcare Research and Quality (AHRQ) (2014) proposed using an adapted form of the ESI for ICU's to help alleviate the stress of decision making. However, the specific algorithm of this modified triage was not published by the ARHQ and is cannot be shown in this paper. I assume that the decision tree on the algorithm would be similar to the previously shown Figure 1, as the triage officer would have to make similar evaluations of the patients requiring treatments.

Military Battlefield Triage

As previously noted, triage began with military battlefield personnel and wounded soldiers. With this comes a major difference between military triage and the typical civilian triage systems: the command structure shared among the military triage officers. Employed health care professionals in the military can have an obligation to follow their superior officers' orders, potentially affecting the way healthcare and/or scarce resources are used in certain situations. For example, an assassination mission by special forces may designate who will be treated for injuries first, i.e. military members and civilians injured by the specific action of the personnel, then civilians and others not involved with the operation. (Iserson & Moskop, 2007). Typical military triage systems follow the aforementioned ability to extract all wounded soldiers quickly and efficiently to medical facilities. Military physicians then triage the patients and determine which ones should be treated and with what resources. This decision tree is not specifically published in any literature, but I am assuming that these triage officers treat the most severely wounded soldiers first, then the less severely wounded. After the soldiers are treated, the civilians wounded by the tactical operations are treated, followed by those who were not involved in the military operations.

Mass Casualty Incidents and Disaster Triage

A mass casualty incident is defined as an emergency that involves 4 or more victims that are injured. A disaster, by definition is a natural or man-made event that overwhelms all available resources for a given area or community to meet the needs of a specific incident (Beach, 2010). The difference between disaster triage and incident triage can vary, but is mostly defined by the magnitude of the destruction and if the health care system of the area is overwhelmed. In a multi-vehicle accident, the available resources in a rural area (1-2 ambulances) may cause incident triage, but does not overwhelm the hospital's resources that the patients are being transferred to and treated. Therefore, in a disaster that overwhelms all available resources, triage becomes essential to determine which patients need to be allocated resources and which must wait until more are available. (Beach, 2010).

There are multiple ways that triage occurs during disasters. The World Medical Association has developed a system that has been adopted by countries around the world and includes the following criteria:

1) Those who can be saved but whose lives are in immediate danger, require treatment immediately.
2) Those whose lives are not in immediate danger, but will need urgent care, just not immediately.
3) Those requiring only minor treatment at the time of triage
4) Those who are psychologically traumatized who might need reassurance or sedation.
5) Those whose lives are beyond the available resources, and whose injuries cannot be treated in the immediate circumstances (Kennedy, Aghababian, Gans, & Lewis, 1996)

In the United States, however, there are varying systems being used by emergency response personnel. The first among many, is called START, or Simple Triage And Rapid Treatment. This system was developed by Huag Hospital and the Newport Beach Fire Department. Its purpose is to allow the personnel with limited time, resources, and medical knowledge to be able to sort and distinguish patient classifications for patients within 60 seconds or less. Four criteria are used to help determine patient classification: can the patients respond and walk, how fast are the patients breathing, what are the patient's perfusion stats, and what is the patient's mental status (Beach, 2010). Figure 2 shows the exact algorithm used in the decision-making process (U.S. Department of Health and Human Services, 2014).

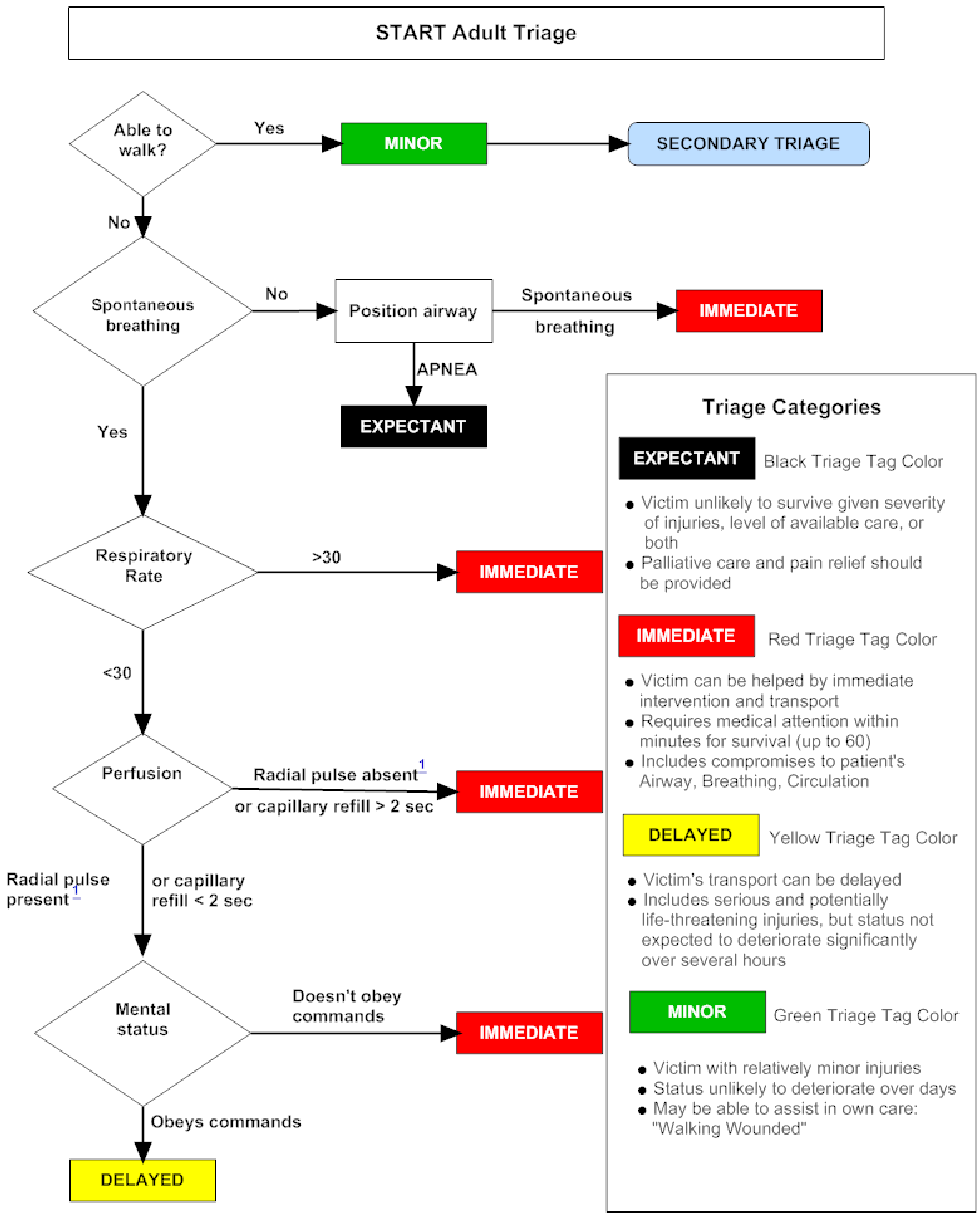

Figure 2. START Adult Triage Decision Algorithm

Another widely used triage system within the U.S. is called JumpSTART. Developed by Dr. Lou E. Romig in 1995, JumpSTART was her way to address the concerns of applying the triage process to pediatric physiology (Team Life Support Inc., 2012). Before the creation of JumpSTART, there was no objective mass casualty triage tool available for use that included pediatric measures. Team Life Support Inc. now disseminates trainings and consultations based around the START/JumpSTART combined triage algorithm, which is shown in Figure 3. The main difference between START and JumpSTART is the option to include 5 rescue breaths to determine if the child's airway can be activated again if not working.

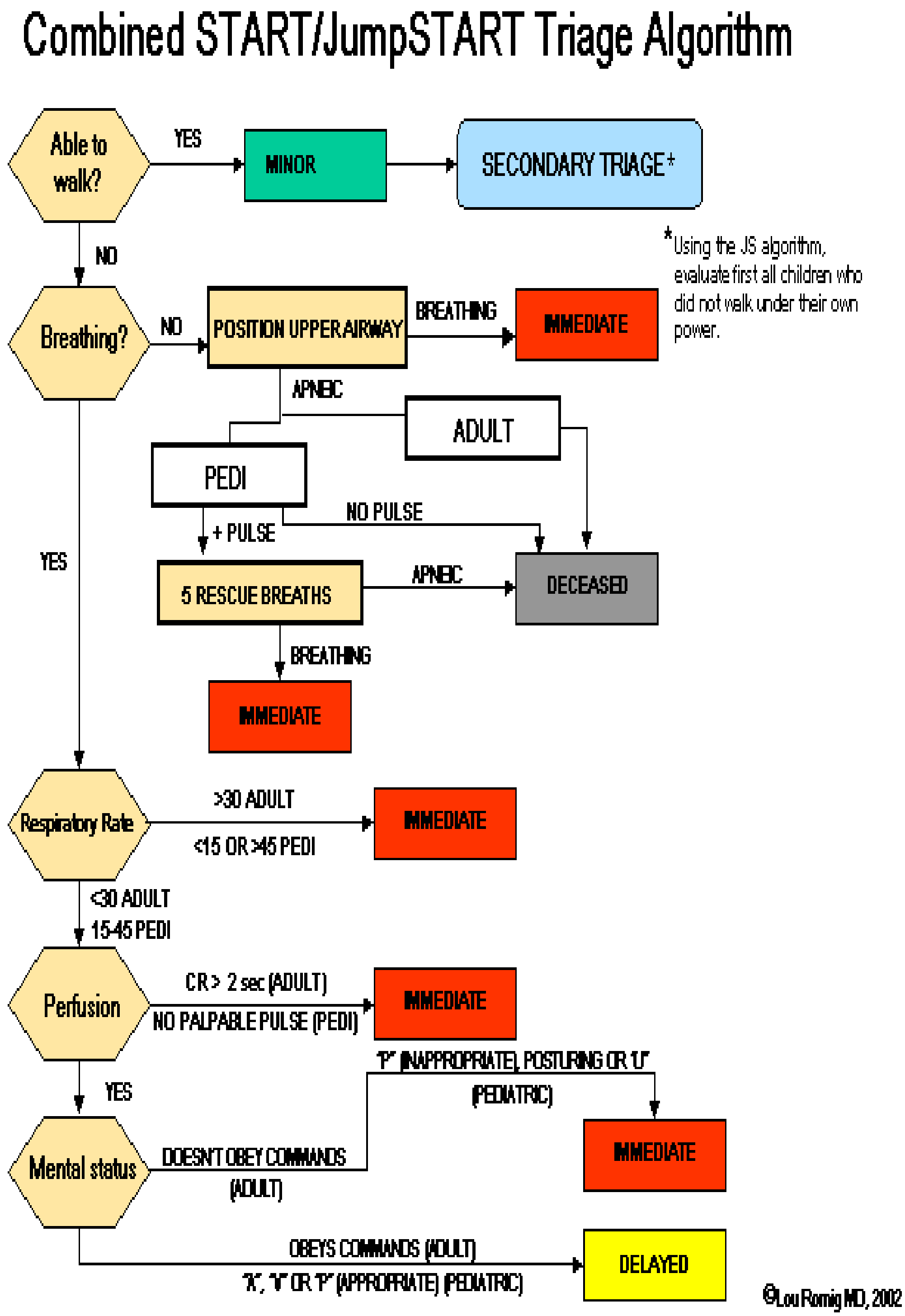

Figure 3. Combined START/JumpSTART Decision-Making Algorithm

There are many additional systems available to triage officers, beyond ESI, START, and JumpSTART within the U.S. that are not be discussed in this essay.

Because of variation in protocols, problems arise when minute differences in triage procedures cause certain patients to be classified differently, depending on which algorithm the triage officer is utilizing. In an attempt to standardize the triage protocols and merge the multiple varying systems, the Center for Disease Control (CDC) gathered a working group and created the SALT triage protocol (Sort, Assess, Life-saving interventions, Treatment/Transport) (Federal Interagency Committee on EMS, 2014). SALT is based on a set of guidelines called the Model Uniformed Core Criteria (MUCC) that were determined as the “most important” sets of guidelines that a triage system must contain. One major difference between SALT and the previously mentioned systems, is that life-saving interventions are not usually applied until after the triage classification had occurred, whereas, with SALT, life-saving interventions are applied before the sorting of the patient is done (Federal Interagency Committee on EMS, 2014). The decision-making algorithm used in SALT can be seen in Figure 4 below.

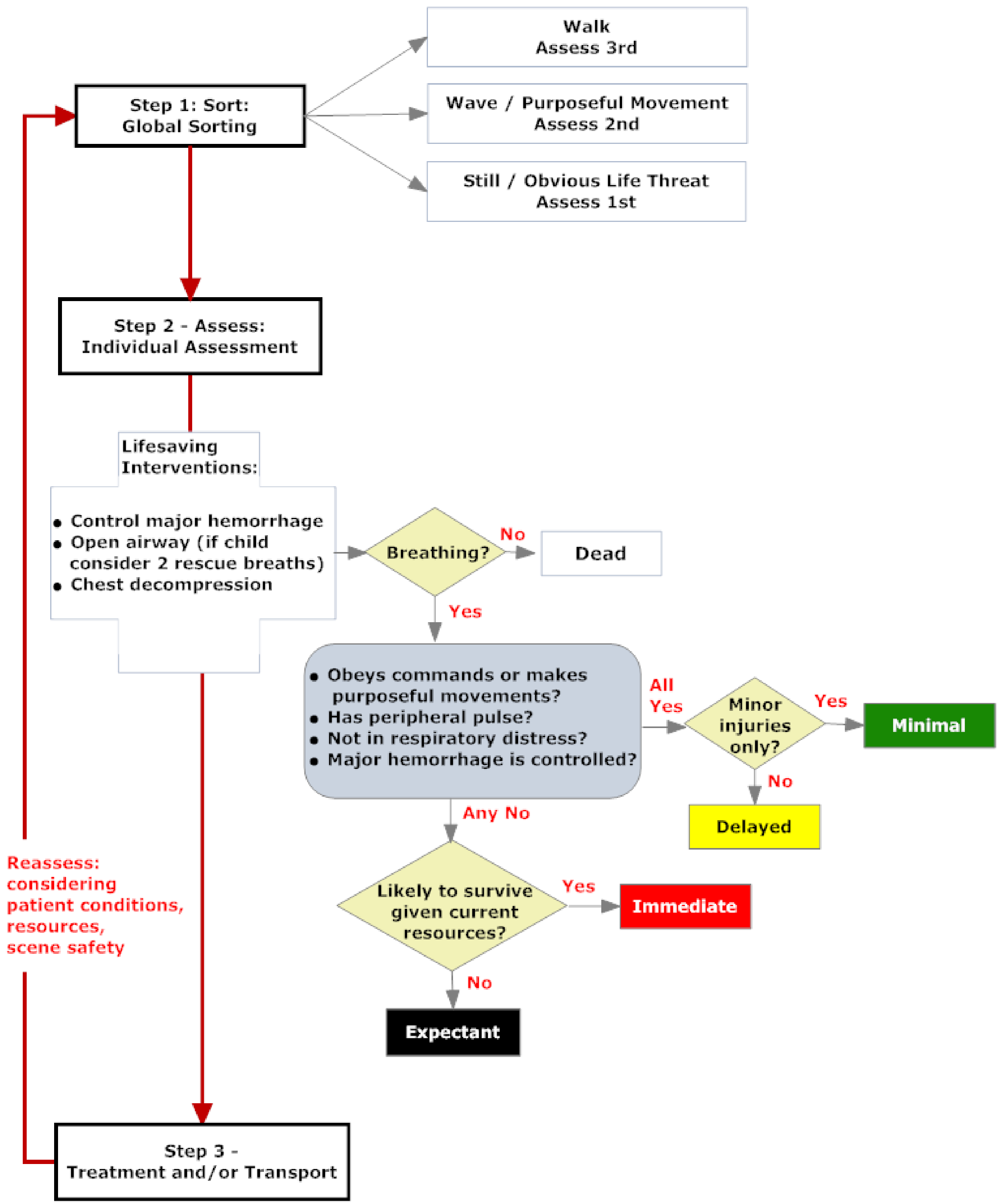

Figure 4. SALT Triage Algorithm

With the varying forms of triage comes the potential for confusing and dangerous situations when disasters and other crisis situations occur. The danger is created when emergency personnel become confused on the protocols of triage during a crisis situation, delaying treatment and potentially causing the loss of life for the critically injured. Now that the historical development and triage systems have been introduced, I am going to move to the in-depth analysis of the presented systems, evidence supporting them, and how we can use this evidence to create a system of uniformity throughout the U.S.

2.0 REVIEW OF TRIAGE SYSTEMS

When it comes to triage decision making, officers, nurses, EMTs and other personnel must have a general understanding of what event has occurred to cause the injuries, who they are treating, and the necessary actions that will help save the lives of those in need. This requires preparation, planning, practice, and an organizational approach that accounts for the scarcity of available resources, and implements them in the most effective way to resolve the mass as quickly as possible. Depending on the decisions being made, some patients may only receive palliative care as they pass away, while other get sent home with minor injuries (Kennedy, Aghababian, Gans, & Lewis, 1996).

In this section, the triage systems are compared on multiple levels, and studies are reviewed to help determine which process and decision making analysis can become the gold-standard for the future mass casualty events. The available research, studies and evidence-based analysis relating to the triage systems are severely limited. As a result, of the 200 articles reviewed, fewer than 10 articles included evidence based studies that analyzed the triage systems in question. In addition to the analyses, I will present the challenges to studying such systems as a potential cause for the lack of literature available on the subject.

The first step is to inquire whether the frequently used START system has certifiable data to back it up its usage. In a study done by Garner et al. (2001), they retrospectively measured the accuracy of multiple mass casualty triage algorithms when it came to predicting critical injuries in adult patients. Garner's review was completed in Australia, and includes triage systems that are not used in the U.S.: CareFlight and modified START. CareFlight differs from the usual START triage system because it does not include a respiratory rate assessment, and the level of consciousness is assessed first. Modified START substitutes palpability of radial pulse for capillary refill for perfusion status (Garner, Lee, Harrison, & Schultz, 2001). Although CareFlight, and modified START are the triage systems not used in the U.S., the review was included because it also analyzed JumpSTART and START.

Their review consisted of 1,144 consecutive patients admitted to 2 different trauma centers by ambulance transportation. The patients were divided into groups based on the triage system they were classified by, and then it was determined whether the triage classification was correct. The results: START had an 85% sensitivity (how often a true classification was done correctly) and an 86% specificity (how accurate the classifications were described) of predicting critical injuries within adult patients. None of the other triage systems reviewed (CareFlight, JumpSTART, and modified START) had any statistically significant sensitivity than the others; however, the CareFlight Triage system had statistically significant specificity than the other systems that have been reviewed (Garner, Lee, Harrison, & Schultz, 2001). It is important that START triage had a lower specificity than Australia's CareFlight system. This supports an interesting point that the U.S. triage systems may be less effective than systems that other countries are currently using.

The limitation with studies like this one, is that they are not specifically looking at a disaster or specific mass casualty event where one of these triage systems were put in place. Thus, their results can be said to be minor, at best, at reviewing the effectiveness of START for mass casualty and disaster situations. Yet, START seems to be fairly effective at identifying critical injuries and sorting these patients into the correct triage categories.

Similarly, Gebhart et al. (2007) reviewed trauma patients and attempted to classify them based on the START algorithm. Then, whenever they left the hospital, either by death or discharge, the ability of the algorithm to correctly predict their treatment and outcome was analyzed. Overall, 75.77% of the time, START correctly predicted the "survivability" of the person's injuries within the trauma center (Gebhart & Pence, 2007). Like Garner's review, this study focuses on people that were already admitted, or on their way, to the hospital and attempted to identify and include them into the START triage system without an actual mass casualty event occurring. It is still significant to note that the START accuracy, according to both studies, was higher than 75% in correctly classifying the patients. With both studies combined retrospective efforts, it would seem that START is well designed and accomplishes the goal of identifying those that can be saved with available resources and those who cannot. The question of whether 75% or greater accuracy is enough, will be addressed later in the paper.

When used in an actual disaster, instead of patients who are already admitted to the hospital, the START triage system has different ratings, creating a question of its efficacy of correctly sorting and classifying wounded patients. Kahn et al. (2009) analyzed the use of START with an actual train crash disaster in 2003. They reviewed medical records at hospitals and identified the patient's START triage classification upon entering the hospital, and the result of their treatment (discharge, death, etc.). After reviewing almost 150 patients from 14 receiving hospitals from the incident the found that START accurately and correctly classified the patient's injuries 44.6% of the time. The reason for such a low accuracy was claimed to be overtriage (Kahn, Schultz, Miller, & Anderson, 2009). Overtriage is the term used when a patient is classified into a higher category, with injuries that are suited for a lower classification. For example, a patient can be categorized as red tag/immediate, when their actual injuries suggest that they should be classified as a yellow tag/delayed. Along similar lines, a concept called undertriage is just the opposite. This is when a patient's injuries are classified lower than they should be. For example, a patient who should be classified red/immediate is triaged into the yellow/delayed. Both terms will be discussed more in detail later in the paper.

In their review, overtriage occurred 81% of the time, causing START accuracy to drop significantly (Kahn, Schultz, Miller, & Anderson, 2009). When this study is analyzed holistically, there are some limitations. Most notably, the methodology was unable to discern whether errors in the START classification was a result of the algorithm being difficult/confusing, or whether the failure rests with the emergency personnel's choice to apply it correctly. The authors claim that the most likely cause of the low START accuracy was due to "overtriage bias," or the tendency of personnel workers to desire to treat and save as many as possible, regardless of the available resources. The reluctance to triage someone into a lower classification can cause strains on the healthcare system, and significantly impact the accuracy of the START triage system results. (Kahn, Schultz, Miller, & Anderson, 2009). I will discuss overtriage bias more in-depth during section 3.1.

Another retrospective disaster analysis of START reviewed the maldistribution of patients after a train crash in Los Angeles in 2005 (Zoraster, Chidester, & Koenig, 2006). This study analyzed the effectiveness of the communication between the field-triage staff and the transportation accuracy of those patients labeled "Immediate" (red tag) to the various hospitals in the surrounding communities. Their results showed that 26 of the total 114 patients labeled "Immediate" were transported to community hospitals that were >15 miles from the crash site, while multiple hospitals with established trauma centers (not community hospitals) did not receive any patients (Zoraster, Chidester, & Koenig, 2006). Overall, this study does not support the effectiveness or ineffectiveness of START triage. I included it in this analysis because it explores another problem associated with triage. If the system is in place, how do first responders and emergency personnel coordinate themselves and the surrounding community to effectively and efficiently triage, transport and treat patients in a mass casualty incident such as this? If the classification system that is implemented is perfect, but nobody is effective in implementing it then the system becomes completely useless. To help prevent problems like this, trainings on how to use the triage systems need to be coordinated with communication plans with the community and local healthcare providers. This creates an organizational plan that will prevent instances that were reviewed by Zoraster et al. (2006). A more inclusive discussion of training systems is included in the following section.

2.1 CHALLENGES OF STUDYING TRIAGE SYSTEMS

As previously mentioned, the number of analytical studies on triage systems within the literature are extremely limited. There are multiple reasons for this occurrence:

1. Studying effectiveness of triage systems becomes difficult when few actual disasters have occurred in recent history to study. During these events, it is difficult to control for the multiple variables and factors that would need to be examined in a typical, randomized, scientific analysis.
2. If the mass casualty event does occur, and it is not analyzed during the event, it can be especially difficult to retrospectively analyze the available data. The inherent chaos surrounding the event lends itself to difficult data collection. The only way to solve this would be to produce conscientious minds that are willing and able to record and track all types of data in the middle of the event; then to return and analyze the collected information afterwards.

3. Simulations of mass casualty events can be difficult to recreate. Immersing one into the chaos and reality of triage is a tricky aspect of studying the effectiveness of triage, and those "in the moment" decisions can change from training to an actual situation.

With these challenges in mind, it becomes clear why analytical studies and literature reviews on the triage systems of the U.S. are few and far between. It also helps to explain why there are so many varying triage systems used by emergency personnel. There is no "gold standard" to streamline the entire process because there is not enough evidence to support it one way or another. However, with a standard triage system, comes the ability to communicate and theoretically sort all patients during a crisis using the same algorithm. With this, personnel from multiple jurisdictions can come together and perform the triage officer roles without miscommunication of triage classifications. In the next section, I combine the evidence of available literature reviews in an attempt to recommend which system should be considered the "standard practice" for U.S. triage protocols.

2.2 CALLING FOR A NATIONAL STANDARD

To help solve some of the previously mentioned complications, multiple literature reviews were completed to attempt to establish the most efficient way to manage resources and show the best triage approach, with the evidence base supporting it, to create a national standard for emergency triage personnel. A review done by Cully and Svendsen (2014), showed that in the literature from 1970-2000, 42 articles met their inclusion criteria, and only 19 addressed the validity of the triage systems. From there, only 4 articles used real mass casualty outcome data to describe or analyze the efficacy of the triage systems that were employed throughout the event.

The remaining 15 used simulation data, literature searches, or consensus groups to describe the efficacy of various triage systems used here in the U.S. (Culley & Svendsen, 2014). Their conclusion was that even with the comprehensive literature search, it was impossible to review the effectiveness of triage systems, and more evidence would need to be gathered and obtained during mass casualty events.

Another literature review, conducted by Timbie et al. (2013), reviewed over 5,500 potentially relevant publications to attempt to find the most efficient way to manage and allocate limited resources during mass casualty incidents. Of those reviewed, only 74 studies met the inclusion criteria. Only 25 of those studies reviewed mass casualty events. Thirteen of those 25 examined triage performance during incidents. However, only 6 publications reviewed results from events that occurred; the other 7 were from simulated events. Each of the triage studies focused on different aspects of systems, or different systems entirely, many focusing only on the efficacy of one system with little to no comparative analyses done (Timbie, et al., 2013). Again, this comprehensive literature review was unable to produce significant data to show which triage systems, if any, were considered "effective," and more research would need to be completed.

The call for more evidence was further echoed with a literature review done by Jenkins et al. (2008). In their report, several triage systems have been developed, both here in the U.S., and worldwide, but there is no standardized way to research these systems, nor is there significant evidence to suggest which of the many systems should be utilized on a regular basis. With these types of results, it becomes difficult to understand and know which protocol any first responder should be learning; thus, contributing to the chaos during the actual event (Jenkins, et al., 2008). Jenkins, Timbie, and Cully/Svendsen all support the idea of having more evidence based research on the triage systems. With such limited data, and only three literature reviews found that discuss the evidence on triage here in the U.S., it is no surprise why the CDC worked to convene a work group that would not only gather evidence on the triage systems, but create a new standard that could be implemented throughout the country. In this next section, I intend to analyze SALT and its evidence base as the proposed national guidelines for triage.

2.3 CREATING A NATIONAL STANDARD

In response to the calls for more evidence and research, the CDC funded a grant through the National Association of EMS Physicians in 2006 to convene a workgroup and develop a national standard of triage systems. They began by creating 24 criteria that they believed all triage systems should include and utilize (MUCC). Taking these newly created criteria, work began on developing a new triage classification system. SALT, introduced earlier in the paper, was the eventual creation of the workgroup (Federal Interagency Committee on EMS, 2014).

Once the standardized triage system was developed, the real issue became clear: getting states and local organizations to adopt and utilize it consistently. By the time SALT was created, 34 states had developed EMS specific mass casualty protocols at the local levels. In addition, 18 of those states developed and implemented statewide standard protocols of care for EMS response to mass casualty incidents. All 34 of the states who have their own systems reported using START or JumpSTART as the most commonly triage system for these incidents (Federal Interagency Committee on EMS, 2014). The challenge faced by proponents of SALT was to gather enough evidence and support to show that it was more effective that START, and needed to be implemented as the nationwide standard; however, this proved more difficult than previously anticipated.

Not long after the introduction of SALT and the MUCC, scientists and other critics began to analyze the new triage system, hoping to find sufficient evidence to either support its use, or disprove the MUCC and SALT. Lerner et al. (2011) were one of the first to attempt this course of study. In their report, they analyzed every criterion of the MUCC in depth, its origin, and how these could be used to either improve the existing triage systems or continue to improve the brand-new SALT triage system. What they found was unsurprising to many, as there was not enough current evidence to support the use of SALT as a replacement for START or any other previously implemented system (Lerner, et al., 2011). However, in their review of the literature, they found one study that compared both SALT and START using virtual reality simulations of disaster situations. The results showed that the START system was more accurate, faster, and gave better results that SALT. However, the main limitation to this study is that with any type of simulations, the experiment designers develop the correct answers to triaging patients, and the simulation is designed around the triage systems being tested. This includes having the patient's injuries fit the predefined categories of the triage system, and there being one correct answer for each patient. In a real situation, there is no direct answer, and the injured patients are not divided into specific predefined categories (Lerner, et al., 2011). With this limitation, although useful evidence was provided, the experiment showed simulation support data, but cannot be correlated to an actual disaster situation.

The only other comparative analysis between SALT and START (or SALT and any other triage system) was done in 2014 by Jones et al. Using a simulated mass casualty event, paramedics were randomly assigned to use either SALT or JumpSTART (considering the experiment was using pediatric patients). Before the exercise, the individual groups were given "just-in-time" training to refresh their skills and knowledge on the task they were about to perform. They were then set to triage simulated pediatric patients in an emergency situation. Jones et al. analyzed a few different aspects of each system: overall triage accuracy, overtriage, undertriage, and time to triage per patient. For SALT, the overall triage accuracy, overtriage rate, and undertriage rates were 66%, 22%, and 10% respectively. For JumpSTART, the rates were concluded to be 66%, 23%, and 11.2% for overall, overtriage, and undertriage respectively. Time to triage per patient was statistically faster in the JumpSTART group (26 seconds), versus the SALT group (34 seconds) (Jones, et al., 2014). Overall, their results showed no overall statistically significant difference between SALT and START when it came to overall accuracy, undertriage, or overtriage. However, JumpSTART did allow the paramedics to be faster in their decision-making analysis with the patients than the SALT group.

Because of the limited amount of data on triage systems, there are no standard rates for accuracy, overtriage, or undertriage in the literature, so national comparative analysis was unable to be done for this study. It was also noted that cognitive errors were common in both groups, and more than one participant in the study reported using the "gut instincts" to decide on triage decisions instead of referring to the algorithm given to them in their trainings. Limitations for this study ranged from small sample size, misinterpreted features of the simulations. Thus, the results should not be used as national standard guidelines, and should only be used as "contributing data to the growing research pool" (Jones, et al., 2014).

With the SALT system being so new, it is clear that once again there is not enough evidence and/or experiments completed to show significant difference between it and the existing systems. As a result, more analyses will need to be completed before I feel that SALT will be able to be implemented and adopted as the "nation standard for triage systems" that its creation was meant to be.

2.4 ANALYSIS OF TRAINING TRIAGE

It is one thing to understand the challenges that come from studying the triage systems, and another to address the problems that arise in the learning and training of the triage protocols. Nobody becomes an expert in triage overnight, and no emergency personnel would walk in to a situation and expect to know all the information needed to perform triage effectively. Learning and training is essential to help create these experts for when the situation does occur. In this section, I am going to review the limited data on training triage to emergency personnel and how we can adapt it with modern technology to not only increase effectiveness, but the efficacy of the training, as well.

The main way people have been training for these types of incidents is through simulated training scenarios. Usually, volunteers and personnel will be placed in a fake scenario and must respond per the trainings they have been given. Many times, this includes triaging patients with wounds represented by makeup, forcing the emergency personnel to decide how to classify them based on their injuries. Afterwards, the results will then be collected and analyzed to help determine if the emergency personnel responded in the best way possible. The data will also be studied and used to improve future exercises in the future, along with the emergency response system (including triage) can be improved from the results.

However, problems are immediately clear with these types of scenarios. The ability to do scenario practice solely relies on the amount of time, money, personnel, and open availability that a group has within their reach. If they are short staffed, underfunded, cannot access enough volunteers, or have no subject matter experts to coordinate the scenarios, then these trainings often do not occur. Obviously without trainings and real practice for emergency personnel, there is no way to develop and refine the skills needed to respond adequately to an emergency. The second problem arises with how “real” these situations actually are, and how well can they be applied back into the real-world scenarios of mass casualty incidents. With the technology of manikins and other more “real aspects” being developed with today’s technological advances, trainings are becoming more realistic by the day. Yet, the question remains: is it even possible to replicate the chaos and uncertainty of a mass casualty incident? In a training exercise, it is usually predetermined injuries and other aspects that are highly controlled to create “good science.” But it might be more useful to create a more chaotic situation within the training exercise (without putting the trainees at risk) to help simulate a more real scenario.

One way that the issues of training are being solved is through the virtual reality scene. As technology advances, virtual reality is becoming more commercially available, and training exercises are being developed in a more “real” way, by completely immersing the trainees into the world of a virtual mass casualty event. With the right equipment, the actual chaos and uncertainty can be recreated in a more realistic fashion than just working with manikins (or volunteers) lying around in a grass field. After reviewing the literature, only one study was found comparing the benefits of virtual reality to standard practice drills. In the experiment, participants were placed in similar scenarios, one group being immersed in virtual reality, the other in a standard drill setting. In the results, the virtual reality group scored a little higher than the standard group on overall triage accuracy and response time. However, during a posttest to determine if the training improved skill levels, the standard group reported a higher increase in skill levels than virtual reality (Andreatta, et al., 2010).

This study creates some interesting points to be considered when examining the two different types of trainings mentioned. The flexibility of virtual reality seemed to put it above the standard drill, in terms of practice and ability to adapt the situation to fit the scenario. Standard scenarios are limited by the participants, resources available, and even sometimes the weather. With virtual reality, the experiment can be crafted, adjusted, utilized, then adjusted some more to create the perfect training scenario. The overall results suggest that virtual reality can provide a similar learning outcome as compared to those who participate in standard drills; yet with the flexibility of virtual reality, the on-demand training options, and repeatable platform, it seems that virtual reality could be "the future of training platforms for these mass casualty incidents" (Andreatta, et al., 2010). That being said, the study showed that the virtual reality fell short of creating a long-lasting skill set with the emergency personnel who participated. Having the trainees perform the scenario in a real-life situation, instead of playing a video game, they tend to learn and keep a more flexible skill set with them as they move forward. In addition, as mentioned before with the Jones study, some personnel relate back to their "gut-instinct" instead of following the actual algorithm that has been set in place. These instincts could be developed and nurtured through both types of trainings, but it remains to be seen whether more evidence will be created to help solidify the future of emergency triage training.

2.5 CONCLUSION FROM TRIAGE ANALYSIS

The most prevalent issue with the triage analysis is that there is extremely limited data found on the subject. From comparing the triage systems, themselves, to trainings, the challenges are preventing researchers from conducting experiments surrounding this topic. Until there is a more solid evidence base to support future steps for the development of triage, I suggest for emergency personnel to continue working and training in whatever capacity they have available to them. The only way to create people who know and understand how to triage patients is to create those gut instincts in people that have been mentioned earlier. By practicing the skills necessary, and working with the triage system that is being utilized by the organization, first responders can better prepare themselves for whatever chaos might come with a mass casualty event in their area. At the same time, I also recommend studying the triage systems in place (SALT, START, etc.) to help learn and understand which algorithm would best fit the goal of the group. If the organization is small and cannot support providing life-saving treatment on the scene of a disaster, then it would be prudent to practice START triage. At the same time, if life-saving treatment can be applied at the scene, and the trainees are willing to learn the SALT system, it might be worth trying. Regardless of what system is used, the importance of practicing the system and knowing how to perform triage remains.

3.0 ETHICAL ANALYSIS AND IMPLICATIONS OF TRIAGE

With the responsibility of triage comes the impending question: whether to treat the few, or the many? Triage is a controversial topic in many aspects because of this question, and how responsibility is placed on one person to determine who should be treated and who should not. In this section, I will address the many aspects of this question, along with the implications from these many parts. It is important to mention the aspects of triage that are not always in the public's eye: overtriage, undertriage, and the ethical considerations of the entire process. Overtriage is when a victim is classified in a more severe triage category than what they should be identified with. Undertriage is just the opposite, classifying victims in a lower triage category than they should be placed (Beach, 2010). Ethical considerations include those focusing around the ethical principles of autonomy, distributive justice and fairness, the prospect of creating the greatest utility, and the creation of unequal outcomes within a mass casualty situation. In the following section, each topic will be discussed and its effect on the triage process analyzed.

3.1 OVERTRIAGE

In Beach's book, *Disaster Preparedness and Management*, (2010) he states that rates of 50% or under of overtriage have been acceptable in the field. This means that half of all the people injured in a mass casualty incident could be classified in the wrong category. When I discussed studies, which analyzed overtriage rates, they show that the results usually not this high, but the point remains. If there are hundreds of people hurt in an incident, and only enough immediate resources to treat half of them, then triage is used to help sort out those who are most critically injured and separates those who can wait for treatment without developing serious complications (or dying) from their subsequent injuries. If 40% of those hundreds of patients are overtriaged, this puts a strain on the system, as hospitals and trauma centers would be receiving many more patients than are feasible for them to treat. It can then be assumed that patients, when overwhelming the hospitals resources, have a much greater chance for complications from their injuries.

Another issue arising from overtriage during these incidents is how to deal with the cost of treating and pushing these limited resources onto those patients who do not immediately need it. Unfortunately, there were no overtriage literature on mass casualty incidents found. All articles were focused around overtriage in the emergency department, most likely as data was much easier to track and analyze retrospectively. As such, many of the articles found focused around simplifying the trauma triage system to reduce overtriage (and undertriage) as the complicated algorithms are the suspected cause according to the authors. Two articles found in the American Journal of Surgery (Lehmann, et al., 2007) (Shawhan, et al., 2015) stated and showed data to help reduce the cause of overtriage by simplifying the triage hospital system. However, it is important to note that overtriage may not only be caused by complicated triage algorithms. In the chaos and uncertainty of a mass casualty incident, the first responders attempting to triage the injured may not have trouble thinking through the algorithm, but may be under too much stress to be able to remember it.

They also may be affected by what is known as overtriage bias: the desire to want to treat as many patients as possible and save “everyone,” thus triaging people into higher categories to get them treatment quicker. This bias can usually be seen in the healthcare delivery system culture of the U.S. With the recent passage of the Affordable Care Act and the emphasis of providing insurance and healthcare for everyone, it makes sense why emergency personnel would like to treat all patients who are injured in a mass casualty incident immediately. Even so, it is nearly impossible to acquire specific reasons for overtriage in mass casualty events, as the literature is limited, and the data the does exists only creates speculation as to the real causes. But, it is clear that overtriage can be a problem during incidents and must be prevented whenever possible. One of the keys ways to reduce this is to focus on not overtriage patients during training exercises with emergency personnel. By practicing and focusing on triaging patients correctly, triage officers will be better prepared for when an incident does occur.

3.2 UNDERTRIAGE

Undertriage, being basically the opposite of overtriage, faces similar, but slightly different problems. Only 5% undertriage is acceptable in mass casualty events (Beach, 2010). The rate is much lower than undertriage for obvious reasons. If someone is undertriaged in a mass casualty event and does not receive the care they need to survive in time because they were classified incorrectly, then death is a most likely result. In the chaos of a disaster, there is always a chance that something like this may happen. First responders may miss an injury, not realize internal bleeding is occurring, or any other mistake that could cost a patient their life.

To prevent these needless deaths, Nakahara et al. (2010), did an evaluation that established factors that may cause someone to slip through a well-established triage protocol. Their results showed much of what someone would expect: time of day, type of injury (internal/external), chaos of situation, number of critically injured patients, and patient characteristics (middle-aged, personality, conscious) all played a role in the undertriage of mass casualty events. Interestingly, the factor that sticks out is the personality of the patient, and how that can affect them being undertriaged. If a patient was middle-aged, had an easy-going personality (shrugged off an injury), and was conscious, then Nakahara et al. (2010) reported that they were more likely to be undertriaged. It is important for emergency personnel to remember triage protocols, and to treat all patients they come across the same, regardless of their personality characteristics.

In addition, in a review of trauma patients that entered emergency departments throughout the U.S., it was found that nearly all of those who were undertriaged were sent to non-trauma centers for injuries that were more severe than the hospital could handle (Holst, Perman, Capp, Haukoos, & Ginde, 2016). Although this report relates to hospitals, the importance remains for mass casualty incidents, as during the chaos of the event, paramedics and triage personnel may not fully be aware of a patient's injuries fully. This could cause them to be sent to a hospital that is not equipped to deal with the treatment, resulting in undertriage and needless death. To reduce things like this from happening, flawless communication needs to occur during the incident between triage personnel, emergency transport personnel, and hospital officials to coordinate and transport those in most need to the hospitals equipped to treat the patient's injuries fully.

3.3 ETHICAL CONSIDERATIONS OF TRIAGE

During a mass casualty event, should we save the few, or the many? The question, while simple, opens an entire world of controversy and debate that can be parsed out. However, only a short version of that will be discussed here, as an entirely new paper could be written about the debate revolving around the ethics of triage. The stem of the discussion revolves around deciding of "who gets treatment and who does not." This same discussion can take place around disaster and mass casualty incidents that involve large scale evacuations of areas. When hospitals and healthcare providers must evacuate patients, and there is not enough transport to take everyone at the same time, decisions must be made on whether to evacuate those who need less treatment versus those who need more treatment. These decisions are triage. In this section, I intend to discuss: how are those decisions made, who is responsible for making those decisions, and what is the reasoning behind their final decisions?

Triage was developed around the limitations of available resources to treat all the patients in need of care right at that moment. Thus, in mass casualty situations, triage systems push resources towards those who are most in need to save the most lives, and withhold resources from those parties who are not likely to benefit immediately from the treatment provided (Iserson & Moskop, Triage in Medicine Part II: Underlying Values and Principles, 2007). As some will not receive treatment or resources immediately, the first question of equality arises. Ideally, everyone who is involved in the incident should be treated the same, and triaged accordingly. However, according to Tannsjo (2007), those who should receive treatment first are those we would rely on the most to aid in the situation: first responders, law enforcement, fire department, healthcare workers, public health officials, and elected officials. His opinion points towards the idea of utilitarianism (doing the most-good for the greatest number) is by saving those who can aid in the future to help remedy the situation, we can create a greater amount of "good" in the end because our personnel pool will have grown as the incident moves forward (Tannsjo, 2007). This thought process is in conjunction with the ideas of triage that were used during the two World Wars: treating those who can be turned back onto the field "of battle" to help achieve the goal in the shortest amount of time. Yet, this viewpoint conflicts with many who feel that all should be saved in times of mass casualty scenarios, regardless of profession, and that it should not define who should receive care or treatment first. Some, like Holt (2008) argue for the idea of "virtue-based ethics," which reflects the primary responsibility of physicians to provide medical care for all victims of such disasters. Holt claims that it is unethical to divide care of patients [in a mass casualty incident] based on profession, and that triage should focus on providing care for all (Holt, 2008).

Being equitable to all is something that must be strived for in these times of chaos and uncertainty. First responders do not have enough time during a mass casualty incident to interview each patient and identify their occupation and ability to return to the field to aid while triaging. Triage, as a system, recognizes that there will be times where unequal outcomes will occur, and it is grounded in these principals. It relies on the planning taken beforehand to establish the protocols and procedures in place for when incidents do occur. Yet, this does call into question the justification of saving one person over another. If it is reasonable to remove resources from one person to save another, would it also be reasonable to suggest that removing organs from someone who is living and replacing them into someone who is dying a reasonable action? No, it is my opinion that a first responder must adhere to the pre-designed triage system in place to help keep the results as fair as possible. This way, not only will the greatest number of lives be saved, but also resources will be used in the most effective manner to save those lives.

3.4 CONCLUSIONS

Most triage systems are designed to serve the values of human life, human health, efficient use of resources, and fairness. Regardless, there is not one specific triage system that rises above the rest, and no protocol that is the "gold standard" above all others. There are many different types of triage, and certain situations call for different analyses and use of resources on those in need. If faced in an emergency department during routine hours, it can be assumed that resources to treat all who enter will be available. However, in a mass casualty scenario, chances are more than likely that resources will be limited, and decisions must be made on to whom these resources will be applied. If training is not performed, and/or emergency personnel are not prepared for these mass casualty situations, problems will arise on more than one front. Therefore, it is incredibly important to know and understand the triage processes available, the evidence supporting each system, and all the ethical considerations that need considered during a crisis situation. Without this knowledge, it is not only hurting the triage officers, but those patients whom they are attempting to treat.

4.0 RECOMMENDATIONS FOR THE FUTURE

With the limited amount of data and evidence that is available, the decision on which triage system to utilize falls to the emergency responders who use it. The most common triage system used in the U.S. is the START system; however, just because it is the most popular does not mean that it is the best practice. Evidence has shown that the START system is not 100% accurate, and many times the accuracy is called into question when considering the training and expertise of the first responders using it. SALT, although based off MUCC and sponsored by the CDC grant to create a national standard, does not have enough evidence supporting it to show that it is more effective and better at triaging than the current systems that are already in place.

It is my recommendation that the emergency personnel choose a system that they are most comfortable and familiar with, and train to become experts on using that triage protocol. Like was previously mentioned, nobody becomes an expert in performing triage overnight. It takes practice, trainings, and more practice before the skill sets required to adequately respond become "gut-instincts" themselves. Whether the training is done via real-time scenarios or via virtual reality does not matter, as long as the organization is continually working to improve their members to be the best first responders possible. It is also important and recommended to discuss the ethical implications of triage with the members of the organization, and decide upon a rhetoric that is shared among all members. Having a firm foundation of belief, instead of conflicting views will aid the responders in their triage protocols and processes.

It cannot be left unsaid that mistakes do occur, everyone is only human, and suffer from bias, indecision, stress, and many others. To address these concerns, we must fall back upon the time-tested, continually developing, and currently developed triage decisions to keep us from interfering with major ethical concerns and violating human rights in any way while performing triage. This paper has examined triage from beginning to current, the studies on standardization, the possibility of a "gold-standard," the training techniques for the future generations, and implications that must be considered when discussing and utilizing triage in mass casualty events. By no means is this an exhaustive discussion, and more statistics and research should be done on triage before we can all rest comfortably on the system we have created to respond to mass casualty scenarios.

BIBLIOGRAPHY

Agency for Helathcare Research and Quality. (2014, October). *Emergency Severity Index (ESI): A Triage Tool for Emerency Department.* Rockville: Agency for Healthcare Research and Quality. Retrieved September 2016, from AHRQ.gov: http://www.ahrq.gov/professionals/systems/hospital/esi/esicontrib.html

Andreatta, P. B., Maslowski, E., Petty, S., Shim, W., Marsh, M., Hall, T., & Stern, S. (2010). Virtual Reality Triage Training Provides a viable solution for disaster-preparedness. *Academic Emergency Medicine, 17*(8), 870-876. Retrieved October 2016, from http://onlinelibrary.wiley.com/doi/10.1111/j.1553-2712.2010.00728.x/full

Auf der Hiede, E. (1989). *Disaster Response, Principles of Preparation and Coordination.* Atlanta: CV Mosby. Retrieved September 2016, from http://library.ndmctsgh.edu.tw/milmed/avitation/file-med/DisasterResponse.pdf

Beach, M. (2010). *Disaster Preparednes and Management.* Philadelphia: F. A. Davis Company. Retrieved September 2016

Culley, J., & Svendsen, E. (2014, Spring). A review of the literature on the validity of mass casualty triage systems with a focus on chemical exposures. *American Journal of Disaster Medicine, 9*(2), 137-150. Retrieved October 2016, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4187211/

Federal Interagency Committee on EMS. (2014). *National Implementation of the Model Uniform Core Criteria for Mass Casualty Incident Triage.* Washington, D.C.: Center for Disease Control and Prevention. Retrieved October 2016

Garner, A., Lee, A., Harrison, K., & Schultz, C. (2001, November). Comparative Analysis of Multiple-casualty incident triage algorithms. *Annals of Emergency Medicine, 38*(5), 541-548. Retrieved October 2016, from http://rt4rf9qn2y.scholar.serialssolutions.com/?sid=google&auinit=A&aulast=Garner&atitle=Comparative+analysis+of+multiple-casualty+incident+triage+algorithms&id=doi:10.1067/mem.2001.119053&title=Annals+of+emergency+medicine&volume=38&issue=5&date=2001&spa

Gebhart, M., & Pence, R. (2007, September). START Triage: Does it work? *Disaster Managment and Response, 5*(3), 68-73. Retrieved October 2016, from http://www.sciencedirect.com/science/article/pii/S1540248707000727

Holst, J. A., Perman, S. M., Capp, R., Haukoos, J. S., & Ginde, A. A. (2016). Undertriage of trauma-related deaths in U.S. emergency departments. *Western Journal of Emergency Medicine, 17*(3), 316-323. Retrieved October 2016, from http://escholarship.org/uc/item/8114r9w3#page-1

Holt, G. R. (2008, August). Making Difficult ethical decisions in patient care during natural disasters and other mass casualty events. *Otolaryngology - Head and Neck Surgery, 139*(2), 181-186. Retrieved October 2016, from http://rt4rf9qn2y.scholar.serialssolutions.com/?sid=google&auinit=GR&aulast=Holt&atitle=Making+difficult+ethical+decisions+in+patient+care+during+natural+disasters+and+other+mass+casualty+events&id=pmid:18656712

Iserson, K. V., & Moskop, J. C. (2007, March). Triage in Medicine Part II: Underlying Values and Principles. *Annals of Emergency Medicine, 49*(3), 282-287. Retrieved September 2016, from http://www.sciencedirect.com/science/article/pii/S0196064406010195

Iserson, K. V., & Moskop, J. C. (2007, March). Triage in Medicine, Part I: Concept, History and Types. *Annals of Emergency Medicine, 49*(3), 275-281. Retrieved September 15, 2016, from http://www.sciencedirect.com.pitt.idm.oclc.org/science/article/pii/S0196064406007049#bib4

Jenkins, J. L., McCarthy, M. L., Sauer, L. M., Green, G. B., Stuart, S., Thomas, T. L., & Hsu, E. B. (2008). Mass-Casualty Triage: Time for an Evidence-Based Approach. *Prehospital and Disaster Medicine, 23*(1), 4-8. Retrieved October 2016, from http://c.guionnet.free.fr/Mémoire%202012/Biblio/jenkins.pdf

Jones, N., White, M. L., Tofil, N., Picken, M., Younglood, A., Zinkan, L., & Baker, M. D. (2014, March). Randomized Trial Comparing Two Mass Casuatly Triage Systems (JumpSTART versus SALT) in a Pediatric Simulated Mass Casualty Event. *Prehospital Emergency Care, 18*(3), 417-423. Retrieved October 2016, from http://www.tandfonline.com/doi/full/10.3109/10903127.2014.882997

Kahn, C., Schultz, C., Miller, K., & Anderson, C. (2009). Does START triage work? An outcomes Assessment after a disaster. *Annals of Emergency Medicine, 54*(3). Retrieved October 2016, from https://escholarship.org/uc/item/89p3t51j#page-1

Kennedy, K., Aghababian, R. V., Gans, l., & Lewis, C. P. (1996, may). Triage: Techniques and Applications in Decision making. *American College of Emergency Physicians, 28*(2), 136-144. Retrieved September 2016, from http://ac.els-cdn.com.pitt.idm.oclc.org/S0196064496700537/1-s2.0-S0196064496700537-main.pdf?_tid=2ac4dfce-8e73-11e6-9077-00000aacb35d&acdnat=1476053777_54ee92a8956b54d8ce7966117933357a

Lehmann, R. K., Zrthurs, Z. M., Cuadrado, D. G., Casey, L. E., Beekley, A. C., & Martin, M. J. (2007, May). Trauma Team activation: simplified critera safely reduces overtraige. *The American Journal of Surgery, 293*(5), 630-635. Retrieved October 2016, from http://rt4rf9qn2y.scholar.serialssolutions.com/?sid=google&auinit=RK&aulast=Lehmann&atitle=Trauma+team+activation:+simplified+criteria+safely+reduces+overtriage&id=doi:10.1016/j.amjsurg.2007.01.017&title=The+American+journal+of+surgery&volume=193&issue=5&

Lerner, E. B., Cone, D. C., Weinstein, E. S., Schwartz, R. B., Coule, P. L., Michael, C., . . . Hunt, R. (2011). Mass Casualty Triage: An Evaluation of the Scient and Refinement of a National Guideline. *Disaster Medicine and Public Health Preparedness, 5*(2), 129-137. Retrieved October 2016, from https://www-cambridge-org.pitt.idm.oclc.org/core/services/aop-cambridge-core/content/view/6BEA8F88208B3FE4837E9BF442819BAE/S1935789300003360a.pdf/mass-casualty-triage-an-evaluation-of-the-science-and-refinement-of-a-national-guideline.pdf

Nakahara, S., Matsuoka, T., Uneo, M., Mizushima, Y., Ichikawa, M., Tokota, J., & Yoshida, K. (2010, May). Predictive factors fo undertriage among severe blunt trauma patients: What enables them to slip through an establish trauma triage protocol? *Journal of Trauma-Injury Infection & Critical Care, 68*(5), 1044-1051. Retrieved October 2016, from http://journals.lww.com/jtrauma/Abstract/2010/05000/Predictive_Factors_for_Undertriage_Among_Severe.5.aspx

Shawhan, R. R., McVay, D. P., Casey, L., Spears, T., Steele, S. R., & Martin, M. J. (2015, May). A Simplified tauma triage system safely reduces the overtriage and improves provider satisfaction: a prospective study. *The American Journal of Surgery, 209*(5), 856-863. Retrieved October 2016, from http://rt4rf9qn2y.scholar.serialssolutions.com/?sid=google&auinit=RR&aulast=Shawhan&atitle=A+simplified+trauma+triage+system+safely+reduces+overtriage+and+improves+provider+satisfaction:+a+prospective+study&id=doi:10.1016/j.amjsurg.2015.01.008&title=The+A

Tannsjo, T. (2007, April). Ethical aspects of triage in mass casualty. *Current opinion in Anaesthesiology, 20*(2), 143-146. Retrieved October 2016, from http://rt4rf9qn2y.scholar.serialssolutions.com/?sid=google&auinit=T&aulast=T%C3%A4nnsj%C3%B6&atitle=Ethical+aspects+of+triage+in+mass+casualty&id=pmid:17413398

Team Life Support Inc. (2012, May 29). *The JumpSTART Algorithm*. Retrieved October 2016, from The JumpSTART Pediatric MCI Tirage Tool: http://www.jumpstarttriage.com/JumpSTART_and_MCI_Triage.php

Timbie, J., Ringel, J. S., Fox, S., Pillemer, F., Waxman, D. A., Moore, M., . . . Kellermann, A. L. (2013). Systematic Review of Strategies to Manage and Allocate Scare Resources During Mass Casualty Events. *Annals of Emergency Medicine, 61*(6), 677-689. Retrieved October 2016, from https://www.researchgate.net/profile/Cynthia_Hansen/publication/236074418_Systematic_Review_of_Strategies_to_Manage_and_Allocate_Scarce_Resources_During_Mass_Casualty_Events/links/5525a1eb0cf25d66dc945f00.pdf

U.S. Department of Health and Human Services. (2014, October 31). *START Adult Triage Algorithm*. Retrieved October 2016, from Chemical Hazards Emergency Medical Management: https://chemm.nlm.nih.gov/startadult.htm

Weinerman, E. R., Ratner, R. S., Robbins, A., & Lavenhar, M. A. (1966, July). Yale Studies in Aumbulatory Medical Care. V. Determinats of use of Hospital Emerency Services. *American Journal of Public Health, 56*(7), 1037-1056. Retrieved September 2016, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1257168/pdf/amjphnation00145-0035.pdf

Zoraster, R., Chidester, C., & Koenig, W. (2006). Field Triage and Patient Maldistribution in a Mass-Casualty Incident. *Prehospital and Disaster Medicine, 22*(3), 224-229. Retrieved October 2016, from https://www.researchgate.net/profile/Richard_Zoraster/publication/5950893_Field_triage_and_patient_maldistribution_in_a_mass-casualty_incident/links/00b495177eb60afe1a000000.pdf