

THE USE OF SIMULATION IN CAUSAL ANALYSIS OF SENTINEL EVENTS IN  
HEALTHCARE

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## Dedication

This dissertation is dedicated to my mom, whose death could be argued is one of the estimated 200,000 patients that are harmed annually by unintentional medical error in the United States. Through research and reflection we can understand the contributing factors to error in health care. Only then can we promote a deeper understanding of patient safety and become as highly reliable as one should expect from those that provide that care.

## Acknowledgment

I would like to acknowledge the friends and family that have supported me through this journey. I never would have accomplished this without the paramedics of the EMS agency. Without their trust in my research methodology and agreement to open themselves up to the methods that were used in this research, this project would not have been completed. I want to thank my friends and colleagues, in particular Aaron Renner BS, EMT-P, who assisted in the completion of the research and assured that I was not introducing bias into my work; and Cindi Moore, RN, BSN, MBOE who helped me formulate the presentation of this information.

## ABSTRACT

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HEALTHCARE

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Annually, over 200,000 people suffer injury or death due to preventable medical errors. Unintentional medical errors continue to be a problem despite repeated attempts within health care to reduce sentinel events. High Fidelity Medical Simulation (HFMS) provides a realistic, computer generated patient care environment. Simulation has been used successfully to educate and train healthcare providers. Little research has examined how simulation could contribute to the investigation of causal analysis of sentinel events in healthcare. This dissertation addresses the question: How can medical simulation play a role in the understanding of sentinel events in healthcare? Three sentinel event cases were identified and investigated using typical morbidity and mortality (M&MC) methods. Ten contributing factors averaging 3.33 (2–5) were found in each sentinel event through traditional debriefing. Nineteen additional contributing factors were identified through simulation averaging 6.3 (4–7) additional contributing factors. Simulation provided a 65.5% increase in causal factors of sentinel events compared to traditional debriefing. In addition, there were an additional fifty-eight points of learning that were identified through the simulations and debriefings. This research concludes that

the use of medical simulation can increase the understanding of contributing factors to sentinel events in healthcare.

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## Chapter 1

### Introduction

Despite several methods currently used to understand the contributing factors to sentinel events, medical error continues to impact patient care delivery. This dissertation examines how the use of medical simulation can contribute to causal analysis of sentinel events in healthcare. The goal of this dissertation is to see how simulation can enhance the current methods of investigating sentinel events to promote a deeper understanding of the factors that contribute to sentinel events.

In June 2014, a headline in the *Washington Post* read, “Once again, U.S. has most expensive, least effective health care system in survey.” The article by *Post* journalist Lenny Bernstein describes how the United States spends \$8,508 per capita on health care yet continues to struggle with efficiency and safety in the delivery of patient care. Karen Davis, the lead author of the study referenced by the *Post* article, stated, “It’s a matter of accountability, having information on your performance relative to your peers and being held accountable to achieving a kind of care that patients should expect to get” (Bernstein, 2014). This has been a continual struggle for healthcare since the 1999 Institute of Medicine (IOM) report *To Err is Human*, which detailed how the medical community was responsible for an estimated 98,000 deaths a per year related to harm caused to patients by those providing their care.

A report in the *Journal of Patient Safety* weighted the averages of four previous research studies about patient safety and concluded that over 210,000 deaths per year

were related to preventable patient harm in hospitals (James, 2013). Although initially disputed within healthcare, attempts to decrease the risk associated with hospital admission is a national issue, and there is consensus that the number of deaths related to preventable error continues to climb despite advances in technology and research (Institute of Medicine, 1999). In response, patient safety initiatives have captured the attention and interest of healthcare accreditation organizations.

### **Joint Commission Accreditation of Healthcare Organizations**

The Joint Commission on the Accreditation of Healthcare Organizations (Joint Commission) is an independent not-for-profit organization that accredits and certifies health care organizations throughout the United States (Joint Commission, 2015). Their mission is to continuously improve healthcare by evaluating healthcare organizations and their patient care programs. They promote themselves as being an advocate for safer patient care and have developed guidelines for retrospectively addressing sentinel events in healthcare. The Joint Commission defines a sentinel event as “an unexpected occurrence in healthcare involving death or serious physical or psychological injury, or risk thereof” (Joint Commission, 2014). Investigating the factors that influence a sentinel event is known as root cause analysis (RCA). The factors that contribute to the sentinel event may involve a finding related to the people, the process, or the system that people work within. Frequently there is more than one contributing factor to an adverse event and each contributing factor offers a potential training opportunity or process redesign to reduce future risk.

Since the landmark IOM report in 1999, there have been many attempts within healthcare to reduce sentinel events and promote patient safety. Health care organizations have spent considerable funding, training, and additional staff resources attempting to reduce the number of reportable medical errors (Andel, 2012). Systematic changes have included electronic medical records. This technology was expected to reduce medication errors related to poor physician handwriting (Sittig, 2010). Training and education programs on conducting investigations of causal analysis have been developed, specifically for healthcare, in an attempt to better understand error. Yet, with all the advances in healthcare and attempts to make patient/care giver encounters safer, The Joint Commission has reported an increase in sentinel events every year in almost every reportable category since the release of *To Error is Human* (Joint Commission, 2015).

### **Highly Reliable Organizations**

The public expects certain standards from organizations that provide services. As an example, travelers expect to get to their destinations safely when you fly by commercial aircraft. The public expects no less from health care. A highly reliable organization (HRO) is defined as one that recognizes that failure can lead to catastrophic consequences and that puts systems or processes in place to reduce the associated risks (The Joint Commission, 2015). HROs then evaluate the organizational and system wide impact over defined periods of time. The general public expects health care institutions to be highly reliable even though patients are increasingly concerned about students



practicing skills on them (Okuda, 2009). Many organizations known to be highly reliable utilize simulation technology to enhance learning, reduce costs, and promote safety. This includes the military, airline industry, information technology, and to some extent, health care. The aviation industry has invested heavily in simulation technology and believes that the return on investment saves time, money, and lives (Dahlstrom, 2009). Today, the military F-35 pilots complete 72% of their training in a full mission simulator (Hunt, 2007; Brand Studio, 2015). Although the aviation industry has considerable experience with simulation, health care is still experimenting with the possibilities.

### **Statement of the Problem**

The World Health Organization estimates that between 5% and 15% of patient hospital admissions in developed countries result in error (World Health Organization, 2008). There has been considerable work in the area of error reduction in healthcare, yet the incidents of preventable medical errors continue to climb (The Joint Commission, 2011). A recent study from John Hopkins University cited medical error as the third leading cause of death in the United States (Makary, 2016). Although several methods are available to investigate the cause of errors in healthcare, research concludes that the current systems of investigation and error reduction strategies are obsolete and should be replaced by more modern approaches (Stoop, 2012). This is a problem, because organizations are using methods to conduct causal analysis that are outdated and have challenges associated with their use (Liu, 2005). These methods are reactive, lack learning potential, and are outdated (Stoop, 2012).

Other industries that the public expects to be highly reliable have successfully used simulation, and simulation has more recently proven its value in patient safety and student education (Fatimah, 2010). However, as simulation technology continues to evolve, the health care community has not conducted sufficient research to determine how this technology may contribute to causal analysis in sentinel events in healthcare (Issenberg, 2011; Cheng, 2014). Although considerable funding has been appropriated to support simulation programs, health care organizations have failed to determine whether simulation can enhance current strategies of RCA and promote patient safety through a defined causal analysis program. The primary focus of this research was to determine how health care can enhance medical RCA through the re-creation of a sentinel event scenario using simulation.

Therefore, the primary research question (RQ) to be addressed in this research project is: How can medical simulation play a role in the understanding of sentinel events in healthcare? This project is timely and current, because patient medical errors contribute to 200,000 annual preventable deaths and ten million lost days of productivity (Institute of Medicine, 1999). In 2008 alone, costs of medical error surpassed \$19.5 billion dollars (Andel, 2012). This project is of interest to me personally. I currently serve as the Assistant Fire Chief of Training and Emergency Medical Services (EMS) with the Columbus, Ohio Division of Fire, where my job responsibilities include investigating sentinel events within the EMS response system. I have completed graduate education in operational excellence and process improvement at The Ohio State

University. The focus of this education was on enhancing productivity, process improvement, and problem solving. Through these experiences, I look to contribute original research to enhance patient safety in healthcare by exploring how simulation can contribute to the understanding of sentinel events in healthcare.

### **Research Goal**

In order to complete this research, development of a deep understanding of issues that contribute to errors in healthcare and investigated and how other professions learn from errors associated with their practices was required. I examined other methods used to study errors in healthcare that attempt to provide a comprehensive understanding of contributing factors involved in a sentinel event. Based upon this perspective, I attempted to contribute original research that studies the use of medical simulation as an adjunct to traditional methods of investigating errors in healthcare. By following this process of research development, I hope to determine if simulation can provide additional contributing factors to a sentinel event that may not have been found in traditional methods of investigation. I hope to provide a framework for healthcare to incorporate medical simulation in the understanding of sentinel events to create a safer patient experience.

### **Significance of the Study**

A growing body of research demonstrates that medical simulation can be used in health care to support learning and promote patient safety (Fatimah, 2010; Aggarwal, 2010). Students placed in a simulated environment have physiological responses such as

elevated heart rates similar to live patient encounters (Hinchley, 2011). Because learning can occur through simulation and the simulated environment triggers a response that is similar to the real environment, simulation is therefore a good candidate for learning more about sentinel events. Can a health care organization use medical simulation prospectively to enhance learning with a goal of reducing the risk of error associated with patient care? Can a health care organization use medical simulation retrospectively to understand the contributing factors of a sentinel event? If the goal of health care is to be highly reliable, then the value of this research project is in reducing the risk of avoidable death or injury to patients. Through the creation of an experiential learning environment that enhances patient safety, we may use simulation to understand additional contributing factors to sentinel events.

Limited empirical research is available to demonstrate how medical simulation may contribute to a causal analysis investigation involving the poor outcome of a patient. I propose the introduction of simulation into the process of completing a causal analysis of a sentinel event in healthcare. The purpose of this research project is to examine how the use of simulation could promote better understanding of sentinel events in healthcare by re-creating the specific circumstances of the adverse event through simulation. My goal is to understand the strengths, weaknesses, and opportunities that medical simulation offers in a causal analysis of sentinel events in healthcare. I hope to provide a framework for developing a causal analysis program that uses simulation to recreate the conditions

around the sentinel event. The hope is that this research will contribute to learning and patient safety.

It was important to review the current research regarding the use of medical simulation to promote patient safety through educational experiences to understand how this technology has evolved and currently contributes to patient safety through education. I hope to expand the research in this area by using medical simulation to understand sentinel events through re-creation of an adverse event in a simulated setting. This research will be relevant to any organization that delivers patient care or develops new policies, products, or procedures involving the delivery of patient care. As well, those that investigate the failure opportunities or contributing factors to medical error in low frequency – high risk (LFHR) events involving patient care may benefit. This research attempts to determine whether the systems currently used to increase patient safety could be improved upon and if medical simulation could play a role in promoting safety and learning. Furthermore, the literature review that follows demonstrates that limited empirical research is available to answer the question of whether using medical simulation to complete causal analysis in LFHR patient care encounters is valuable.

### **Literature Review**

The literature that was reviewed for this project begins by understanding medical simulation and discussing human error. In order to understand how medical simulation may benefit causal analysis in sentinel events, one must examine how human interaction contributes to errors in health care. The literature review also examines how different

methods of causal analysis can be applied both prospectively and retrospectively to understand root cause in sentinel events. Literature was assessed on the benefits, challenges, and gaps within the current methods health care uses to investigate sentinel events. In other high-risk industries, learning from errors and near misses is a long established practice (Liker, 2006). The literature review examines how other professions, such as aviation, have used the tools of causal analysis to become highly reliable. Techniques used in other high-risk industries could also be used in healthcare to gain a better understanding of the underlying causes of error in healthcare (Woloshynowych, 2005). The literature review also includes root cause analysis, simulations, and failure mode effect analysis. A complete literature review is provided in Chapter 2.

### **Assumptions**

Every research study is built on some underlying assumptions. In this research study, one assumption is that contributing factors to human error in healthcare will involve people, processes, and procedures. It was also assumed that medical simulation can be used to complete a causal analysis in sentinel events. Another assumption of my research is that if we place teams into a simulation laboratory and recreate the sentinel event scenario through simulation and debriefing, then through active experimentation and reflection, we can provide additional learning opportunities and identify contributing factors to better understand the sentinel event. This may include knowledge gaps, equipment issues, and/or inadequate policies. It was assumed that through active participation in debriefing, we would be able to alter a process, improve education of

those involved, or identify additional factors that need to be addressed within the organization to promote patient safety.

Another assumption of my research is that more than one contributing factor is involved in a sentinel event, and that the lack of adequate communication among team members is a primary contributor to errors. Another assumption is that staffing and department budgets are a barrier associated with using medical simulation. Additionally, organizational support is assumed to be a barrier due to the liability that the organization may experience if an identified error is determined to be a contributing factor to the sentinel event.

### **Conclusion**

This project addressed the question: How could medical simulation play a role in the understanding of sentinel events in healthcare? Medical simulation is a proven method of providing realistic medical education (Fatimah, 2010), because conditions in the environment can be modified dependent upon the student's actions. The use of medical simulation allows the student to gain skills and apply learning points in an environment that is safe from harm to human patients to "bridge the gap between knowing and doing" (Hunt, 2006). Even though there are several methods currently used to review sentinel events in healthcare, most of these methods have strengths and weaknesses. In addition, although medical simulation is a successful method of training and educating healthcare providers, there is limited research to demonstrate its use in causal analysis. The significance of this project is in creating research that demonstrates

how medical simulation could contribute to a deeper understanding of medical error to enhance patient safety during a causal analysis investigation. A major goal of this research is to determine how medical simulation can contribute to an understanding of the root causes of sentinel events in healthcare.



## **Chapter Two**

### **Literature review**

This literature review supports the research question related to how medical simulation can play a role in understanding sentinel events in healthcare. To support the methodology employed in this research, it is important to understand what simulation is and how simulation is used throughout learning, specifically in medical education. In addition, it is important to understand how different types of error impact patient safety as well as what methods are currently used to prevent and investigate error. This literature review describes the human, educational, and systematic factors that contribute to error. This literature review examines the available research regarding how sentinel events in healthcare are currently investigated and what the barriers are to a successful investigation utilizing the current methods.

The literature review discusses how other industries use simulation, how the use of simulation has made these industries highly reliable in the delivery of services, and what impact medical simulation may have on furthering the understanding of a sentinel event in healthcare. The literature provides evidence that the current methods of investigating sentinel events are outdated and have challenges associated with their use. The literature review concludes by citing research that indicates that medical simulation, used in conjunction with current prospective and retrospective methods of investigation, may increase patient safety and our understanding of sentinel events.

The current literature does not specifically address the steps of implementing, the associated costs, or the training component of a causal analysis program using medical simulation. Therefore, evidence on how to implement a successful simulation program is lacking in the literature. This informs the interest and timeliness of this research. One premise of this research is that there would be benefits in conducting additional research on how medical simulation can play a role in causal analysis. One research project has examined this issue, and the same research was reported in several journals, giving the impression that more research has been conducted than has actually taken place. Simulation is often used in medical training, yet the literature has not probed deeply into whether it could have an expanded role in the prevention and understanding of sentinel events in healthcare.

### **The Use of Simulation in Healthcare**

Simulation has been defined as something artificial that replicates the look, feel, or behavior of something real (Aggarwal, 2010; Barbeito, 2015). Simulations are conducted by many disciplines, including banking, military, and aviation, to imitate actual or potential conditions and to study the impact of decision making on an organization prior to the actual decision making (Bradley, 2006; Aggarwal, 2010). The use of simulation for training originated with military aviation (Bradley, 2006). Due to an increase in aircraft accidents, the aviation industry developed airplane simulations to train new pilots on the controls involved in flight (Rosen, 2008). The primary focus of training was on developing the cognitive and psychomotor skill sets required to reduce

accidents (Rosen, 2008). Although expensive, the airline industry has recognized that investing in simulation technology creates an environment that saves time and money. Simulation allows for the development of knowledge and skills to promote resilience within the pilot teams to recognize, absorb, and quickly adapt to events that fall outside the norm (Dahlstrom, 2009).

Simulation is not new to medical education, and today it is used extensively in medical education. In 1960, medical educators were seeking a solution to provide realistic cardiopulmonary resuscitation (CPR) training. This led to the development of Resuci-Anne®, the mannequin used for CPR training, trademarked today by the Laerdal Corporation. This work is considered the first use of low fidelity medical simulation for training (Bradley, 2006; Rosen, 2008; Aggarwal, 2010). The term fidelity is used to describe the authenticity or realism of the learning experience (Maran, 2003). There are three forms of learning fidelity related to simulation: low, medium, and high. In a low fidelity simulation, learning outcomes are focused on skill repetition and are generally low-cost options for educating. This includes equipment such as the CPR training mannequin (Maran, 2003). Medium fidelity simulation increases the realism for the learner using more complex mannequins but are not fully interactive. In high fidelity medical simulators (HFMS), advanced full-body computer technology replicates real life situations. Aside from using actual human encounters for learning, high fidelity simulators provide the most realistic student learning experience available today (Maran, 2003).

Healthcare simulation technology provides a realistic learning environment whereby the medical team is immersed in the setting where patient care occurs, with real scenario-based education (McGaghie, 2010). The health care community can use simulation-based learning to reduce errors and improve patient safety when it is designed and delivered appropriately (Salas, 2005). Patient safety is enhanced because all procedures are completed on a full-size, life-like computer mannequin, not upon human subjects (Bradley, 2006). Through integration with computer programs, these mannequins are fully functional and allow student-to-mannequin interaction. The mannequins appear to come to life during the simulation experience. They verbalize complaints when asked, have the capability to generate heart rates and blood pressures, and respond to the actions of the health care provider. This is all managed through an instructor who controls the parameters of the scenario with a computer program that alters the course of the patient's condition based upon the actions of the medical team. Since simulation can replicate conditions experienced during the course of care, scenarios can be programmed into the computer, and the scenario will automatically respond to the actions of the participants (Maran, 2003). Procedures such as defibrillation can change the heart rhythm, medication administration can change blood pressure and heart rate, and oxygen administration can change oxygen saturation if programmed to do so by the faculty leader (Maran, 2003).

The high fidelity simulation systems have the ability to record, evaluate, and provide immediate feedback, through debriefing, to students upon completion of the

simulated training experience. Therefore, students and instructors are active participants throughout the learning experience. Through the use of simulation, the students can reinforce old tasks and simultaneously build on these experiences to perform more complex tasks. This form of education promotes problem-based learning (Hunt, 2006). Although the use of this technology in medical education has expanded greatly, the evidence emerging from the use of the technology is limited (Bradley, 2006).

### **Medical Simulation in Learning**

As advances in health care continue to evolve, the complexity and challenges associated with providing safe, effective care increases. Recognizing that patients have become more engaged in their plan of care, institutions providing medical education have been asked to better prepare their students for the increasing complexity of healthcare. However, the pedagogy has not advanced at the same rapid rate of medical innovations and technology (McLaughlin, 2014). In a 2009 article in the *Mt. Sinai Journal of Medicine*, researchers concluded that patients were increasingly concerned about students practicing skills on them (Okuda, 2009). This demonstrates the challenges of providing medical education when students feel inadequately prepared in areas related to history taking, physical examination, diagnosis, and management of their patients.

Today, medical educators are increasingly encouraged to use medical simulation for initial training, because simulation has the ability to teach to all levels of health care students without the risks associated with live patients (Hunt, 2006; Fatimah, 2010). Development of knowledge occurs throughout the learning process and forms the basic

building blocks of student growth and understanding (Safard, 1998). Described as scaffolding, the learning builds upon itself. Evidence from several healthcare disciplines shows that simulation can improve knowledge and skill performance (McKenna, 2015). The use of simulation-based learning allows the learner to gain these skills and reaffirms teaching points in a safe environment that is comparable to a clinical setting without increasing organizational liability due to risk of patient injury (Aggarwal, 2010; Cheng, 2014). Simulation can be an effective strategy to practice skills, develop routines, and practice safety behaviors through addressing reactions that can lead to medical errors (McKenna, 2015).

As an example, two-person teams of EMS providers were placed in a simulated scenario of an infant with altered mental status (Lammers, 2009). Using a consistent scoring matrix, each team was assessed for the care provided to this simulated ill child. Fifty-five teams took part in the scenario. Just over 50% of the crews accurately checked the blood glucose of the patient, and there was a 54% failure rate at providing adequate ventilation. Equipment malfunction was identified in several cases, and the crews also found that equipment was being stored incorrectly. The case required two different medication administrations. Medication errors occurred in a combined 53.5% of the simulations. The results of this study concluded that simulation followed by immediate debriefing uncovered underlying causes of errors related to procedures, cognition, teamwork, and other error-producing conditions (Lammers, 2015).

In addition, a 2011 survey conducted by the Association of American Medical Colleges confirms that simulation is used primarily for education and that a gap exists in the use of simulation to promote quality improvement (Passiment, 2011). Of the 90 survey responses received from teaching hospitals, 81% of the responses described using simulation for educational purposes, while only 30% cited simulation use for quality improvement (Passiment, 2011). Several research studies have demonstrated clinical improvements in areas where simulation is used, including an increase in medical knowledge, comfort in procedures, and improvement in team performance and clinical skills (Smith, 2014). A study of 72 simulated cardiac arrest scenarios was conducted within a Veteran Affairs institution over a three-year period. The simulation identified several environmental, human, cultural, and policy issues. A multi-disciplinary team was able to develop solutions to each of the identified problem areas. They then conducted additional simulations to try the restructured system and concluded that simulation was able to identify and mitigate latent hazards that impacted the patient encounter of cardiac arrest in their response system (Barbeito, 2015).

Although the evidence appears to validate that simulation can be used for learning, the success of simulation is dependent upon several factors (Cheng, 2014). Because the student comes to the classroom with some prior experiences, these experiences are transferred into the new learning. Although previous experiences can establish a strong baseline for advancing education, it can also be counterproductive to approaching new learning with an open mind, potentially impacting students' cognitive

development due to previous street experiences (Anderson, 1996). For example, a gap in learning frequently occurs between understanding the need for a medical intervention and the implementation of that intervention. Similarly, Reber (1993) found that a student may have strong procedural knowledge, such as knowing when and how to accomplish a task, yet be unable to correlate that procedural knowledge with the reason they are completing the task. This is where patient safety begins to be compromised and the incorporation of medical simulation may be a benefit. Simulations could involve a new student or an experienced provider that is learning a new procedure or updating knowledge because their skills are under-utilized. The instructor in these situations can design personalized training that is authentic and directed specifically to the deficiencies identified by the learner or the instructors (Wortham, 2003). This is supported by Okuda (2009), who concluded that research conducted on simulations has demonstrated advantages in cognitive development during these types of learning situations, although more studies are needed to determine if simulation training improves patient outcomes over the long term. Although simulation can enhance learning, we must understand the contributing factors to human error in order to determine how simulation could contribute to a casual analysis program.

### **Understanding Human Error**

Few health care providers intentionally cause harm to a patient while providing care. Since health care is a complex environment, to appreciate how simulation can impact the understanding of sentinel events, we must understand how human error



contributes to sentinel events. A complex system is defined as steps in a process that have multiple components that may be independent or interdependent of each other and are not always predictable (Plsek, 2001). Any variation in the performance of these components can lead to overall systematic failure of the product. Introducing human factors into a complex situation like healthcare creates opportunities for failure; however, simulation may be able to enhance our understanding of what causes those failures (Rouse, 2008).

According to a 2014 publication *Clarity: A Patient Safety Organization* systems that patients encounter within healthcare are dynamic, complex, and depend upon individual behaviors that result in the collective organizational behavior. Since health care has different levels of complexity, it is essential to recognize failure opportunities that require additional assessment (Campbell, 2007). Sidney Dekker (2006) believes that in order to understand the causes of variation within a process, we need to study human error. This literature review will describe the types of errors frequently identified during sentinel event investigations and how human and systematic issues impact the incident of error.

### **Human versus Systemic Elements**

Frequently, investigations of sentinel events will find human error as a contributing factor without further investigating additional underlying factors. Often described as the bad apple theory, human error is related to erratic behavior from unreliable people. In these situations, the response of management is often to retrain or

hold individual team members accountable by tightening policies and procedures (Dekker, 2002). Although additional training is an essential component and is easily seen as the “fix” to error-related issues, it is not always the sole means of reducing error.

Many problems believed to be associated to cognition or human error may actually be attributed to poor system design. When you put good people into a process where the education or the systems are flawed, error is likely to occur (Sittig, 2010). Human error is then more likely when people pursue excellence in an imperfect system (Dekker, 2006). If the system does not function well for the people that are operating within the system, they will find shortcuts to circumvent the poorly functioning process (Rouse, 2008). Investigations may conclude that the error occurred because someone did not follow a policy or an operator failed to notice certain data or did not follow procedures set forth. However, underneath every simple, obvious error is a deeper, more complex situation where well-intentioned people work in imperfect systems. The health professional’s deviance from accepted practice is almost never performed with a criminal or malicious intent (Banja, 2010); rather, it frequently occurs as a result of intentional rational actions (Rudolph, 2006; Rouse, 2008). To those involved in the sentinel event, how the team framed or rationalized the specific situation at the time it was occurring is an important consideration to investigate. Described as intentional rational actions, staff assumes their deviance is not only legitimate but acceptable and necessary (Banja, 2010), because the actions that retrospectively were incorrect may have made perfect sense to

the team at the time of injury. In hindsight, clues that may have been evident were missed.

This could be where simulation begins to provide an advantage during the investigation. By recreating the events and placing the team in the simulated conditions, we may be able to determine the conflicts that staff members had that may have contributed to the sentinel event. However, reconstructing human contribution to error is not easy, because the events must be triangulated from many sources of data (Dekker, 2002). Although some of the data is easy to obtain, other information is much harder, such as when you try to include the actions, thoughts, and assessments of those involved, which can lead to hindsight bias (Dekker, 2002). In addition, participants may have additional information available to them during the simulation, such as what was actually wrong with the patient. Since this information was not available to them during the actual case, they may find it hard to reflect on their thoughts and actions at the time the case was developing. This is an example of hindsight bias. Since a team already knows the outcome, they may change their decision making to reflect what they now know versus what they were experiencing. Hindsight bias was explored by Dekker (2002) in an attempt to help investigators avoid this bias. He concluded that the variables are hard to control, although it was clear that further development of strategies to systematically reconstruct the human contribution to accident investigation was needed (Dekker, 2002).

System problems such as the facilities, working environment, equipment design or placement, policies, culture, leadership, and level of teamwork are all known

contributing factors to sentinel events. Understanding that additional factors or underlying conditions can influence the understanding of errors in healthcare, simulation offers an opportunity to investigate other possibilities (Hunt, 2006). Understanding the vulnerabilities and failure opportunities of sentinel events can be accomplished by creating similar conditions and studying the team performance (Davis, 2008). Simulation has the potential to contribute a greater understanding to these systematic problems; however, the application of these concepts and methods to healthcare is lacking (Barbeito, 2015).

### **Types of Error**

There are generally three types of error that occur in medicine. Procedural error occurs as a result of a technical problem associated with the completion of a procedure involving patient care. Affective error occurs as a result of allowing emotion to influence decision-making (Fu, 2014). Frequently, the emotion that the caregiver is experiencing clouds judgment, and then the best, most reasonable decision is ignored. Errors in cognition are a result of a poor thought process by the caregiver (Fu, 2014), and remain separate from knowledge or procedural errors (Park, 2014). Although medical simulation has been identified as an effective tool for medical educators to optimize training opportunities, it is still evolving in other areas such as understanding of sentinel events (Fraser 2011, Fraser 2015). Early studies believed that the health care community could significantly benefit from using simulation based training to reduce errors and improve

patient safety, provided that performance measurement, feedback, team dynamics, and cognition of the learner were all considered essential elements (Salas, 2005).

### **Cognitive Process**

Although individual experiences can establish a strong baseline for advancing education, it can also be counterproductive to approaching learning with an open mind, impacting cognitive mediation due to previous street experiences (Anderson, 1996). Each individual experience is transferred into new learning (Kolb, 2014). Errors that are caused by faulty thought processes instead of inadequate knowledge are called cognitive errors and can be attributed to individual bias, poor learning, emotions, or other cognitive elements (Stiegler, 2015). A learning gap exists when there is ineffective delivery, incorrect content, or lack of proper instructors or when the experience exceeds the mental capacity of the learner (Fraser, 2014). Instead of assuming that a gap in learning is a contributing factor to a sentinel event, it may be possible to use simulation to create an environment where a gap in knowledge could be identified, because a connection exists between simulated training experiences and learning outcomes (Sweller, 1988).

Training-induced cognitive bias can impact performance due to a decision based on incomplete patterns of thought or judgment, which then threaten patient safety (Park, 2014). To understand how medical simulation can contribute to causal analysis in healthcare, it is important to understand how experiences are translated to new learning. There is correlation between performance in a simulated patient care scenario and a validated cognitive examination (Studnek, 2011). Paramedics work in difficult, complex

situations without direct oversight. Their lack of adequate knowledge during complex patient care scenarios can place a patient at risk related to unintentional error during patient care (Studnek, 2011). It is therefore important to understand how a lack of knowledge or the incorrect application of knowledge impacts the understanding of factors that contribute to sentinel events.

### **Understanding Sentinel Events**

Sentinel events are defined as events that cause harm or risk of harm to a patient (Liu, 2005). Although health care is a scientifically oriented profession and is expected to be highly reliable, limited, scientifically grounded investigations of medical error are conducted (Dekker, 2006). Investigating sentinel events in health care can be difficult, because most investigations are carried out by members of the organization involved in the event. That may lead to bias in the analysis of the sentinel event and may prohibit the organization from conducting a thorough investigation free from influence (Dekker, 2006). This is important because any bias introduced into the investigation will impact the overall findings of the investigation and lead to research conclusions that may not be correct.

For the purpose of this literature review, we will discuss both prospective and retrospective methods of understanding risk within patient care. Prospectively we will discuss how crew resource management programs have been implemented within high risk organizations and the impact that these programs have had on safety. We will then discuss the use of failure mode and effect analysis (FMEA) and how it is used to identify

failure opportunities prior to an event occurring. Retrospectively we will include the use of morbidity and mortality conferences (M&MC), which is the long-established hospital method of exploring medical errors and the use of root cause analysis (RCA), because these techniques are embedded in other industries and have recently gained interest from healthcare through The Joint Commission. In addition, we will examine how each method contributes to patient safety and how these tools, if combined with the use of simulation, could enhance casual analysis.

### **Prospective Methods of Preventing Sentinel Events**

Many investigative tools are available in healthcare to identify the cause of an error. However, some of the tools actually are in place to try to prevent error by understanding how complex organizations operate and how each part of the process has failure opportunity (Davis, 2008). Many of these tools have been successful in reducing error over a period of time; however, achieving sustainability over a longer period of time remains a challenge (Braithwaite, 2006). For the purpose of this research, I will discuss how crew resource management, checklists, and the use of failure effect mode analysis have helped make other industries that are expected to be highly reliable.

#### **Crew Resource Management**

Crew Resource Management (CRM) was originally developed within the aviation industry after the determination that an increase in aircraft accidents was related to human factors. The Federal Aviation Administration (FAA) advisory circular describes CRM as

...making the best use of all available resources. CRM training is one way of addressing the challenge of optimizing the human/machine interface and accompanying interpersonal activities. These activities include team building and maintenance, information transfer, problem solving, decision making, maintaining situation awareness, and dealing with automated systems. CRM training is comprised of three components: initial indoctrination/awareness, recurrent practice and feedback, and continual reinforcement. (Federal Aviation Administration, 2015)

Healthcare can be a challenging and stressful working environment. Stressful work environments produce a number of factors involving communication and working conditions that increase the risk of error (Konstantinos, 2008; Kutzin, 2010). Team communication and performance can be studied to identify gaps and vulnerabilities that increase risks to patient safety (Frankel, 2007). The need for teamwork and communication in emergency situations are closely linked and are frequently found to be a common factor in improving patient safety and reducing clinical errors (Kilner, 2010). Healthcare has attempted to adapt the CRM concept to improve patient safety. Although there have been isolated successes, poor communication remains a key element of risk involving patient care (McGaghie, 2010).

In one study, poor communication was determined to be a contributing factor in up to 70% of sentinel events (Salas, 2008). Kutzin (2010) studied fifty-one nursing students to determine if knowledge and attitude scores improved after exposure to a



simulated event involving communication and teamwork. He concluded that a significant difference in scores existed, demonstrating that simulation is useful for improving knowledge of communication and teamwork, but it does not improve attitudes of those involved related to teamwork or communication.

Simulation has been used to enhance training in CRM for health care teams (Hunt, 2007). Simulation was used within a trauma center CRM program to determine if it could improve clinical team performance. Two groups were established and found to have initial similar outcomes. The experimental group was then introduced to simulation for an eight-hour session that included three scenarios. The results demonstrated improvement in the handling of the scenarios, and the team members found the training beneficial. These findings led researchers to conclude that simulation appeared to enhance didactic teamwork (Shapiro, 2004). How the enhancement of teamwork translates to performance in patient care is assumed to be improved but was not a part of the conclusions of this research. Although simulation training is an essential part of the education strategy to improve patient safety in terms of teaching skills and procedures, evidence is lacking in the area of utilizing CRM to improve operational performance within teams at the bedside (Nishisaki, 2007).

### **Checklists**

Each day, 1.7 million passengers board some estimated 50,000 flights (Federal Aviation Administration, 2011). The U.S airline industry has one of the safest aviation records in the world. The use of a checklist is a standard part of this safety regimen.

However, checklists only became a federal standard after the 1935 crash of a Boeing bomber that was the result of pilot error, due to the failure to release the elevator locks (Ely, 2011). Crash investigators determined that the increase in complexity of newer model aircrafts increased the pilot's opportunity to forget the basic elements of flight that keep aircrafts safe (Ely, 2011). The federal government began building checklists into the requirement for airline safety. Today, pilots are required to use checklists to verify all phases of flight operations to promote safety by helping reduce task saturation and variation of standard practice.

Since healthcare is a complex system, it is open to considerable variation due to the differences within clinical practice, organizational structures, information management systems, research interests, patients encountered, education of staff, and the skills of practitioners (Plesek, 2001). Checklists are used in some areas of medicine and have contributed to error reduction in several instances (Mayo, 2011); however, the application has been slow and not fully embraced, despite the improvement in morbidity and mortality rates (Thomassen, 2011). Checklists were found to reduce the incidence of preventable errors in surgery after it was determined that over half of the errors occurring in surgery were preventable, and communication and teamwork were identified as primary contributing factors. In a retrospective study, after the implementation of a surgical checklist, the researchers determined that the rate of death was reduced from 1.5% before the checklist to 0.8% afterward ( $P = 0.003$ ). Inpatient complications occurred in 11.0% of patients at baseline and in 7.0% after introduction of the checklist

( $P < 0.001$ ), leading researchers to conclude that the inclusion of a checklist was associated with a reduction in morbidity and mortality (Haynes, 2009). Pronovost (2006) had similar conclusions after the introduction of checklists to reduce catheter infections. Over an 18-month period, there was a sustained 66% reduction in catheter-related bloodstream infections in the intensive care unit, concluding that the implementation of checklists improved patient outcomes and reduced costs associated with hospital-acquired infections.

Although checklists have had some success, they are not without limitations. Checklists could lead to a false sense of security that leads to complacency on the part of the staff (Ely, 2011). Staff could become focused upon the checklists and fail to recognize other factors that are occurring, which may not align with those anticipated within the checklist. Staff could fail to follow the entire checklist, deciding to forego certain aspects of the process or overestimating their knowledge of each process step within the checklist (Ely, 2011). Simulation may be used for the development and trial of checklists to assure that they are accurate and complete.

### **Failure Modes and Effects Analysis (FMEA)**

The introduction of new technologies or changed work responsibilities can disrupt the practice of an organization (Banja, 2010). Failure Modes and Effects Analysis (FMEA) is a method to identify potential problems with a procedure or patient care scenario prior to the event happening. Identifying associated risks to patient care can promote a safer patient care environment (Tschannen, 2010). FMEA is a form of human

reliability analysis (HRA) that has been integrated into safety management programs (Lyons, 2004). Failure Modes and Effects Analysis is a process improvement tool used to identify potential problems. FMEA is a form of human reliability analysis that has been integrated into safety management programs in other industries, especially manufacturing. However, it has not yet been completely incorporated into healthcare quality activities. The goal of conducting an FMEA is to identify an opportunity for failure or error and weaknesses within a specific system or process prior to an event occurring (The Joint Commission, 2011). It focuses on a specific process rather than a specific event by exploring how a failure could occur (Davis, 2008). Contrary to RCA, which provides a retrospective analysis of what occurred in an attempt to learn from the event and prevent future issues, FMEA uses a prospective approach to promote systematic thinking and to identify areas of potential failures prior to the patient care scenario unfolding (Spath, 2003). Instead of the team investigating the question “what happened,” they look at “what could happen” (Davis, 2008).

FMEA is encouraged by The Joint Commission and has been somewhat successful when introduced in healthcare (van Tilburg, 2006). FMEA was successfully used to reduce the risk of medication errors in the pediatric inpatient setting. A team of five identified stakeholders who prescribe, process, and deliver medications was assembled in a pediatric oncology unit. They completed a flow diagram that identified sixty-one failure opportunity points; fourteen of those points placed the patient at high risk. They then reviewed policies and determined that four of the failure points were not

addressed correctly in their policies and procedures. They introduced a total of nine recommendations, five of which were countermeasures specifically designed to prevent the highest risk. The team completed this project over seven meetings and a total of 140 staff hours. They concluded that the FMEA approach was useful in detecting failure modes and could be successfully utilized in health care (van Tilburg, 2006).

*Steps in Completing an FMEA.* After the failure opportunity has been identified and the team members commit to taking part in the FMEA process, a brainstorming session occurs. During this phase, a description of each step in the process is identified. Once the process is mapped out, all potential failure opportunities are identified. There are several methods to document potential failures, including the use of an Ishikawa or Fishbone diagram, named after the Japanese Professor, Kauro Ishikawa (Liker, 2006). All potential causes of failure are categorized based on similarities, namely, failure as a result of people, method, materials, equipment, environment, and management (Phillips, 2013). The use of these types of tools can enhance critical thinking.

After the identification of potential failure points, the team develops a scoring system. Each failure is given points based upon the likelihood the event will occur, what severity its occurrence presents to the patient, and how easy the issue is to detect when it occurs (The Joint Commission, 2005). The sum of the scores for each event creates a risk priority number (RPN), which the team can use to address the most significant risks to the patient care. From there a plan is put in place to address the identified risks.

*Challenges with FMEA in Healthcare.* Challenges in conducting an FMEA include the dynamics of a team, dismissive attitudes, time commitments, and sufficient education and understanding of team members involved (The Joint Commission, 2005). There is limited research on the use of medical simulation within an FMEA as a tool to prospectively identify risk of error in healthcare in conjunction with a causal analysis program. Although there are limited studies published on the use of FMEA with simulation, researchers have demonstrated that using FMEA with the process outlined above provided a more objective, comprehensive, and systematic way to identify system risks. Through the identification of ten simulated scenarios, based upon actual sentinel events, they found that simulation provided observers a real-time visualization of both the sentinel event risk as well as the unanticipated outcome (Davis, 2008). By observing teamwork and communication, they determined that the inclusion of simulation linked latent conditions with active failure in a method that traditional FMEA would not typically identify (Davis, 2008).

*Current Simulation Projects of National Attention Using FMEA.* Through the use of medical simulation, a multidisciplinary team may be able to use FMEA to create conditions that are likely to occur during the course of patient care. This method was recently used to prepare healthcare providers for the recent Ebola outbreak (Gaba, 2014). Due to the concerns of disease transmission, simulation was used to train healthcare providers in the safe and effective management of patients infected with the Ebola virus (Gaba, 2014). Since the United States lacks experience in managing patients who suffer

from Ebola, healthcare providers lacked any defined best practices gained from previous experiences. There was considerable health care provider stress in managing these patients, because the fatality rate of Ebola is so high. Education was dependent upon guidelines, policies, and experiences of other countries, but health care workers in the United States lacked the confidence to know how these policies would work within their respective institutions.

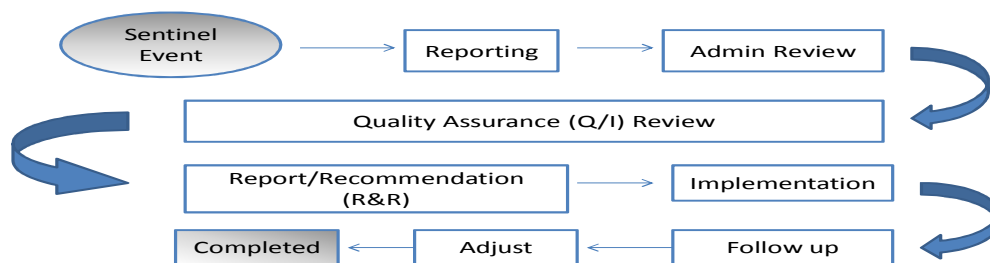
Stanford Medical Center was able to create a simulation to train health care workers in strict isolation protocols and identify potential risks to health care providers in these highly infectious cases. They found that the complexity associated with working in isolation protection clothing required a unique training environment (Gaba, 2014). Stanford was also able to use simulation to develop an authentic training environment and develop methods to prevent risk of exposure to medical staff. The newly developed protocols were tested in a simulation environment to see how efficient and effective they were prior to implementation. Post-simulation debriefing provided feedback from those involved, and suggested changes were made. The use of debriefing makes it possible to uncover underlying causes of cognitive, procedural, affective, and teamwork errors that lead to error-producing conditions (Lammers, 2012). This project demonstrates that FMEA can be accomplished with simulation. The use of simulation during a FMEA can identify risk points and promote group training in which a team works through an expected experience prior to the actual encounter. The training occurs in a safe environment, and lessons learned can then be shared without the risk of exposure to staff

(Gaba, 2014). The use of medical simulation in this setting promoted both patient and healthcare provider safety in a prospective manner.

### **Retrospective Methods of Investigation of Sentinel Events**

Retrospective methods are used after a sentinel event has occurred in an attempt to understand the factors that contributed to the event (Huber, 2008). When a sentinel event is identified, a defined chain of events occurs within an organization. A causal chain is a researcher-constructed linear display of events or actions that suggest a plausible sequence of steps to understand and communicate a process (Miles, 2014). To reduce confusion within this project, I identified the term as a process chain instead of a causal chain to describe the sequence of events associated with completing a causal analysis. The process flow is dependent upon where the recognition of a sentinel event occurs and who initiates a causal analysis investigation. The current process of how a causal analysis investigation occurs is outlined in Figure 1.





*Figure 1.*

*Current process of investigation.*

Although it can be a challenge for the organization to agree on what constitutes a reportable event (Huber, 2008), once the event is defined, the department administration and quality assurance office completes a review of the specific circumstances of the case. This may include methods such as the M&MC conference, patient medical record reviews, and individual interviews to complete the assessment of the events that led to the sentinel event. From this investigation, a report and recommendation is completed that discusses what occurred, what the factors were that contributed to the events, and what countermeasures are developed and implemented to prevent future occurrences.

### **Morbidity and Mortality Conferences (M&MC)**

Healthcare providers are encouraged to improve their practices by reviewing and examining specific patient cases. These conferences have a considerable history throughout most major medical centers, dating back to the early 1900s (Liu, 2005). The goal of an M&MC is to help reduce future errors and poor patient outcomes by instructing medical residents about unique patient care that has occurred. The faculty-facilitated event is generally open to anyone involved in the case that has relevant information to offer. During the M&MC, the case is presented by someone involved in the patient's care. A timeline of events is established, and the clinical event that resulted in the poor outcome or harm to the patient is discussed. During the M&MC, any relevant evidenced-based literature is presented, and take home lessons are discussed. The type of cases discussed may include a poor patient outcome, a complex case, or a near-miss event. Frequently, these conferences discuss an unusual case rather than discussing problems and their prevention (Hamby, 2000).

*Challenges with M&MC in Healthcare.* Although individuals who seek feedback can discover opportunities for skill improvement and obtain information about the team (Crommelinck, 2013), research concludes that M&MCs frequently become a game of deflection and blame (Berenholtz, 2009). Because it is difficult for people to hear their faults, blame does not promote learning and has been identified as a barrier to effective M&MC because people are hesitant to take part in the process for fear of being singled out (Berenholtz, 2009).

Although it can be a powerful tool, the merit of the M&MC has been called into question because it can be uncomfortable to discuss failings in front of colleagues, and it is not always perceived as a safe learning environment (Orlander, 2002). A 2005 study of more than 1,700 healthcare professionals found that confronting people about uncomfortable issues, like discussing responsibility for error, was rated difficult to impossible (Banja, 2010). Lui (2005) reported that a survey of internal medicine house staff found that 76% did not discuss their most significant medical mistakes with the patient or family, and only 50% actually informed the supervising physician of the error (Liu, 2005). Learning effectiveness is reduced when a safe environment for open dialogue, free from blame, is not promoted. It is often difficult to ensure that conversations are based on the facts surrounding the case and are not biased by the opinions of what one person thinks may have contributed to the error.

Recent interest has expanded M&MC to include the use of a process known as Plan, Do, Check, Adjust (PDCA). PDCA is a continuous loop method of implementing change into an organization. This includes planning the change, making or doing the change, checking the impact of the change, and then adjusting the planned change as needed. Integration of a PDCA cycle within an M&MC was found to decrease failure rates and improve quality of patient care in some settings (Vogel, 2011). Although this has demonstrated success, only 10% of teaching hospitals surveyed stated that error discussion occurred during their M&MC (Pierluissi, 2003). In addition, a John Hopkins study found that the primary goal of M&MC was for medical management (75%),

teaching (58%), and finally patient safety and quality improvement (42%) (Aboumatar, 2007). This further demonstrates that the M&MC is not having the impact on the understanding of sentinel events for which it was originally designed.

### **Root Cause Analysis (RCA)**

RCA is defined as a problem-solving method to determine the underlying causal factor or factors associated with an event (Williams, 2001). Compared to FMEA, which uses a qualitative approach to assessment of potential risk, RCA is a quantitative approach that addresses the cause after the failure (Linkin, 2015). RCA is a retrospective analysis of the adverse event. RCA was originally designed as an organizational learning tool to re-establish organizational confidence and legitimacy after an adverse event (Nicolini, 2011). RCA offers a systematic review of events that may have contributed to the poor outcome (Lammers, 2012), and it is one way to get people to the table to discuss an event (Dekker, p.148). RCA is based upon the principle that every effect has a cause. In fact, in up to 77% of cases reviewed, a chain of errors was documented (Woolf, 2004). Root cause is constructed through the questions that are asked and the responses received through the process (Dekker, p.148). Similar to how a puzzle takes shape, an RCA utilizes additional layers of questioning to dig deeper into the event to determine what contributing factors impacted the sentinel event.

Aren (2006) determined that team dynamics are important to the success of the RCA session. The skill to cooperate across disciplines was seen as the most crucial skill set for organizational improvement. Those involved must be seen as partners and not

subordinates (Carroll, 2006). Without the proper team members involved in RCA, understanding what changes need to occur to prevent future errors may be difficult. It is important that the actual team members that were involved in the case be made available by the organization to take part in the RCA, because they provide insight to the thought process and understanding of the events that occurred. To promote patient safety and develop successful learning related to medical errors, involved staff from every discipline should be expected to contribute, a structured framework should be deployed to facilitate the process, and specific staff should be assigned responsibility to investigate the implementation of recommendations (Berenholtz, 2009).

The use of medical simulation during RCA should concentrate on the actual events without introducing other scenarios that could happen or may have happened (Alinier, 2007). Although staff members need appropriate training to conduct an RCA session, without organizational commitment from the leadership, the RCA program will not demonstrate success. Regardless of the background knowledge or degree of commitment the organization has displayed, all staff should receive education and training on conducting an RCA (Sweitzer, 2005). Aren (2006) also found that failure is certain without team ownership for development of countermeasures to prevent future error and without administrative support to remove roadblocks to the project.

Although RCA is a requirement of The Joint Commission, limited research demonstrates its effectiveness in increasing safety in healthcare (Percarpio, 2008). However, Bader (2003) was able to show improved quality of care by including PDCA

within the RCA to evaluate outcomes of patients with traumatic brain injury. Over a several year period, multiple adjustments were made to patient care that resulted in changes in medication administration, blood pressure control, fluid management, and other specific therapies, based upon the continual evaluation of data. Researchers concluded that the multi-disciplinary team evolved, became more synergistic, and impacted patient outcomes positively in the severely brain injured patient because of the on-going evaluation using the PDCA model (Bader, 2003). Additional research conducted by Bowie (2013) demonstrated that of 82% of respondents taking part in an RCA, at least part of their recommendations had been implemented, which speaks to the opportunities to impact change using RCA.

*Challenges with RCA in Healthcare.* Challenges associated with RCA in healthcare include the complete development of the case, insufficient methods to control for variables, and bias introduced by team members (Percarpio, 2008). Additional concerns identified with RCA include forming the assessment team, ensuring proper leadership of the team, gathering the proper documentation to complete the RCA, and, finally, implementing the findings of the RCA to prevent a future issue similar to the one being investigated (Nicolini, 2011).

Research conducted by Bowie (2013), found the three biggest barriers to success in RCA was lack of time (54.6%), unwillingness of colleagues to take part (34%), and inter-professional differences (31%). Supporting this research was an anonymous questionnaire sent to 252 health professionals about the barriers they experienced with

the use of simulation in RCA, in which 75% responded that a lack of time was the biggest hurdle, 45% cited inadequate resources, and lack of feedback was noted by 38.3% (Braithwaite, 2006). The beliefs and attitudes of those taking part in the causal analysis simulation can create an RCA environment that is destined to fail; moreover, research identifies that staff members who participate in the casual analysis can be a barrier to a successful simulation session (Bowie, 2013). These identified struggles lead to failure to get acceptance for the process from those involved; therefore, in many cases, nothing changes despite the best of intentions (Berenholtz, 2009).

An RCA of a sentinel event should occur as soon as possible after the event has occurred and should focus on the “what and why” of the event, rather than “who” (Williams, 2001). Failure to focus on the “what and why” can lead to tension between clinicians who are unable to discuss the case without blaming the error on a person. This prevents the progression of the conversation toward the formation of solutions to the problems presented (Aren, 2006).

Although there are many challenges, simulation education may provide an opportunity to enhance RCA. Since RCA is a discussion of the events, the questions asked might lead to false assumptions about the contributing factors (Dekker, p.151). Simulation may enhance the traditional RCA by including a mechanism to re-create the events with actual hands-on participation from those involved (Hunt, 2006). Making the RCA process more of a continuous quality improvement (CQI) project and making the process data-driven can offer deeper understanding for the participants (Quraishi, 2011).

Simulation offers the environment to make the learning visual and realistic to promote understanding and enhance the CQI process (Ziv, 2005). In many cases, the parameters documented in the patient medical record can be built into the simulation scenario to provide an accurate and realistic casual analysis. The simulation session is performed over the same timeline in which it actually occurred during the sentinel event and can be repeated multiple times, if needed, to gather further information (Hunt, 2006).

*Medical Simulation Impact on RCA.* A series of small research projects has explored the use of medical simulation in causal analysis and the understanding of error, but the overall research is insufficient to claim that there is consensus on whether it can be impactful (Hunt, 2007; Quraishi, 2011; Cheng, 2014). As an example, thirty medical anesthesiology residents took part in a research study to assess the effectiveness of medical simulation in root cause analysis. They were randomized into two groups. The first group was given a lesson on RCA and then placed into a simulation session, whereas the second group was given a lecture on RCA only. Participants completed a survey before and after the intervention and six months after the intervention to evaluate their attitudes and understanding of RCA. The group receiving the RCA only was found to be considerably more skeptical of using simulation to complete an RCA, and at six months they retained less information compared to the first group that had completed RCA with a simulation exercise included. They concluded that medical simulation, used in conjunction with focused didactics, is an effective way of teaching RCA and promotes greater knowledge retention (Quraishi, 2011).



Another study by researchers at Tulane University used medical simulation in sentinel events. They examined 460 closed claims that were linked to an error in surgical technique and had an RCA conducted. The researchers reviewed adverse events over a twelve-month period and then completed six simulation sessions on one case involving a missed post-procedural preoperative hemorrhage, which resulted in death. The initial analysis determined that the presumed cause was the lack of appropriate monitoring and inattention to signs of bleeding. A simulation was then built from the documented medical record. In 2 of 6 simulations, they were able to replicate the adverse event. After completing and debriefing the scenario, they identified more system errors and revealed the challenges imposed by complex decision-making. The researchers concluded that the use of simulation for investigation of adverse surgical outcomes is feasible, and any additional information obtained may facilitate the implementation of corrective measures and improve patient safety (Slakey, 2014; Simms, 2012). They determined that simulation can enhance traditional RCA, and they asserted that not only is it feasible, but it can also contribute to systematic changes (Slakey, 2014; Korndorffer, 2015). Upon closer assessment of the literature review, it should be noted that it appears that this same specific research has been cited in a minimum of six different journal articles or poster presentations since 2011 with different titles and, in many cases, different lead authors. This is evidence of how little research has actually been completed on simulation in RCA, although it could appear to someone that considerable research is available on this

topic. The research that does exist appears limited, repeated in many cases, and includes small sample sizes.

Hunt (2006) concluded that medical simulation could be a key component within a health care industry that worked to optimize patient safety and quality. Her contributions theorized that it may be valuable to reenact the entire situation in a simulated setting in order to determine what factors contribute to mistakes, such as ineffective communication, poorly designed equipment, improperly used equipment, and poor medical judgment (Hunt, 2006). Although Hunt did not specifically address RCA, her work did address the core concepts of RCA in healthcare.

### **Conclusion**

In summary, patient injury due to the failures of health care providers is a national concern. Research has shown that medical simulation can enhance patient safety by removing human patients from the students' learning. Several methods are in place to identify risks or causes of failure. The current standard in medicine is to conduct an M&MC to manage sentinel events. In addition, The Joint Commission encourages the use of two tools to use with medical simulation to reduce risk to patients, FMEA and RCA. While both produce benefits, FMEA is a prospective method to reduce the risks involved to patient care before the event occurs, whereas RCA is a retrospective method of investigation of the cause and effect after the event of harm to the patient has occurred. In either setting, it is important to determine what the risk is to the patient, how the risk

can be eliminated, who is assigned the follow up task to assure the countermeasure is implemented, and how outcomes are measured (Linkin, 2015).

Despite all of the risk-reducing methods that have been developed, sentinel events in healthcare continue to receive national attention. Levy (2008 p.8) stated, “Health care does not meet the quality standards we expect from other industry. It does not meet the quality standards from which health care goods and services are purchased.” New methods of research are needed to improve methodologies for identifying, and mitigating, potential system failures (Davis, 2008). Checklists have helped reduce risk of error in patient care, but they are dependent upon the human factor to use them correctly (Ely, 2011).

Some evidence indicates that RCAs can be completed with medical simulation, and that it increases safety in healthcare (Bagian, 2002). However, the literature is scarce, leading to the conclusion that additional research in the area is warranted. The literature identified that simulation offers the environment to reduce occurrences of real life error by reducing variation and providing patient care givers with the skills to deliver competent care and improve critical thinking (Ziv, 2005).

This literature review demonstrates a gap in how medical simulation contributes to the understanding of sentinel events in health care. Although simulation has been shown to have value in the re-creation of accidents in the aviation industry, simulation has primarily been used for education and training in health care. Only small studies are available on the use of simulation in RCA and the use of current debriefing techniques to

better understand the contributing factors to sentinel events. This presents an opportunity to increase patient safety through the understanding of root causes of sentinel events.

This literature review notes that there is little empirical research that addresses whether medical simulation can be used in conjunction with other risk reduction strategies to enhance patient safety. The use of medical simulation in causal analysis remains an area lacking rigorous research and provides an opportunity for additional investigation.

## **Chapter Three**

### **Methods**

This chapter describes how the research for this dissertation was designed and how the data was collected and analyzed to answer the research question outlined in Chapter 1. The literature cited in Chapter 2 discusses the main methods that healthcare employs to complete a causal analysis of sentinel events. Although methods such as the M&MC have been used with some success, today they are considered outdated because they fail to address all underlying causes attributed to poor patient outcomes (Percaprio, 2008). The working assumption for my research was that medical simulation offered the opportunity to better understand the contributing factors to sentinel events in healthcare. Although evidence supports the use of medical simulation to enhance learning and the promotion of patient safety, the literature reviewed provides only limited scientific evidence of the use of medical simulation to complete a causal analysis (Issenberg, 2011; Lammers, 2012; Simms, 2012).

The research question addressed in this project is: How can medical simulation play a role in the understanding of sentinel events in healthcare? Utilizing a qualitative approach, this project conducted simulations on three sentinel events cases. Through semi-structured debriefing of the simulations, information was collected on the additional learning opportunities and contributing factors to each sentinel event. In addition, the thoughts and experiences of the research participants were collected to assist in answering the research question and provided the main data for this research.

### **Definitions of Key Terms**

The following definitions will serve as a guide to the research focus of this project:

**Causal Analysis** – Process of determining the true underlying reason that events occur (Bagian, 2002).

**Failure Mode Effects Analysis (FMEA)** – A prospective approach to identify potential failure points in a process or procedure before they occur (The Joint Commission, Failure modes and effects analysis in healthcare: proactive risk reduction, 2005).

**High Fidelity Medical Simulation (HFMS)** – The use of technology to create a learning environment as life-like as possible through enhanced computer mannequins on which patient care procedures can be completed (Fatimah, 2010; Maran, 2003).

**Morbidity and Mortality Conference (M&MC)** – Peer reviewed recurring conferences that attempt to educate physicians and other medical providers by using actual case studies in which complications and errors occurred during patient care within the institution (Berenholtz, 2009).

**RAD-57** – A non-invasive method of measuring the suspected level of carboxyhemoglobin in a patient that has been exposed to the by-products of combustion (Hampson, 2012).

**Root Cause** – An initial factor that causes an event or events to occur that lead to a specific outcome (Williams, 2001).

**Root Cause Analysis (RCA)** – A problem solving method to determine the underlying causal factor or factors associated with an event (Williams, 2001).

**Sentinel Event** – An unexpected occurrence involving death or serious injury to a patient either physically or emotionally (The Joint Commission, 2001).

**Vivid-Trac** – A trade name for a device used to visualize the anatomy of a patient to place a tube into the airway for ventilation purposes. The device has a video screen, making all participants able to see what is occurring during the use of the equipment (VividMed, 2015).

### **Rationale for Qualitative Research Design**

Healthcare is a complex system that is dependent upon many interactive components and experiences. Therefore, a holistic approach is required to effectively conduct rigorous research, making a qualitative research methodology appropriate (Miles, 2014). Moreover, since the research involves complex interdependencies and system dynamics that are not straight forward or cannot be reduced to a few variables, qualitative research methodologies are well suited to the task (Patton, 2002). For the reasons stated above, this study used a qualitative research design.

The researcher identified three sentinel event cases from the continuous quality assurance office of the EMS agency in which the research was conducted. The format of the study consisted of conducting a traditional debriefing with the crew involved in the sentinel event, which is a standard procedure for the EMS agency. After the initial debriefing session, a simulation session was re-created from the patient care record and

initial debriefing of the sentinel event case. The first simulation involved the providers who were actually involved in the sentinel event case. After the first simulation, the crew was debriefed for the second time to determine what additional learning points and contributing factors they identified. After the initial team completed the simulation session and debriefing, a second team of paramedics went through the same simulation. The second team was then debriefed after the simulation session. Finally, a third simulation scenario was completed using a team of instructors from the EMS agency that provide education to the paramedics of the EMS agency. The instructors were also debriefed after the completion of the simulation session.

The research used observations and debriefings as the main methods of data collection. The use of multiple methods promotes triangulation of the data, offering a more robust understanding of the issues being investigated and reducing the risk of research bias (Fielding, 1986, Maxwell, 2013. p.102). Triangulation facilitates validation through a process of cross verification from two or more sources. The multiple points of data obtained through observing simulation sessions and debriefings made the data more robust than a single source of data.

### **Simulation Group**

By conducting simulation sessions and debriefings, I expected to be able to identify additional contributing factors and learning opportunities beyond what was identified through the traditional methods of investigation. The simulation sessions provided an opportunity to observe the engagement and interaction of the participants as



well as uncover additional issues involved in the sentinel event. Following the simulation sessions, a debriefing was completed to gain additional insight from the participants. The linkage between running a simulation experience and conducting a post simulation debriefing with the simulation group provided an opportunity to validate the information from the simulations (Miles, 2014). It also allowed each study participant to offer additional insight on the process of using medical simulation in causal analysis. The researcher hopes that the feedback received can be used for future development of a casual analysis program using medical simulation.

#### *Debriefing Interviews*

Through the debriefings, I sought to understand the thoughts and experiences of the research participants. Everyone is an expert from their own experiences (Ravitch, 2015), so the goal of the simulations and debriefings was to explore participants' experiences in this simulated environment and to determine if additional insights were gained during the debriefing that were not included in the original debriefing. Debriefings provided deep rich data that was important in this qualitative research by providing focused insight into the individual experience (Ravitch, 2015). Since this project was observational, it made this project highly appropriate for a qualitative study (Patton, 2002).

Prior to the initial simulation session with the team that was involved in the sentinel event; a debriefing was conducted similar to a traditional M&MC. The debriefing was conducted in a conference room and lasted an average of one hour in each

case. The case was reviewed, and discussion between the quality assurance coordinator, medical director, and participants helped establish a better understanding of the factors surrounding each case. New points of learning, contributing factors, and additional training opportunities were determined prior to the end of the session.

After the completion of the initial debriefing, the simulation session was completed. After completion of the simulation session, each team was debriefed in a group format. The debriefing occurred immediately after the simulation session in the setting that the simulation had been conducted. The debriefing session opened with the researcher describing the purpose and rules for the debriefing. The debriefings occurred in a semi-structure format. A copy of the protocols can be found in Appendices B, C, and D.

### **Setting**

This dissertation research was set within a large urban emergency medical service agency that will be identified as the “EMS agency.” This agency was chosen because it has a robust quality assurance program, engaged medical direction and leadership, a strong hospital support network, and active participation in research. The EMS agency responds to approximately 130,000 EMS calls annually. The chief executive agreed to allow the research to be conducted within the organization after being presented with the facts of the research request. I currently serve in the position of Assistant Chief of the EMS agency.

### **Sample**

Three distinct groups served as the sample for this research. This included a purposive sampling of paramedics and supervisors from the EMS agency that were involved in sentinel event cases within the EMS agency. Instructors of EMS education from the EMS agency were also used to investigate how the paramedic's education, knowledge, or the application of that knowledge may contribute to errors in patient care delivery. Additional study participants assisted in the second and third simulation and debriefing sessions that were recruited within the EMS agency. The criteria for inclusion in the research for each group included:

1. The original team which experienced the sentinel event.
2. A group of participants with identical qualifications and job responsibilities as the original sentinel event team that volunteered to take part in the simulation.
3. A group of instructors that provide initial and continuing medical education to the paramedics of the EMS agency.

### **Research Method**

Three sentinel event cases studied as part of this dissertation. Although a greater number of sample cases increases confidence in the findings of research through replication, (Miles, 2014) time and resource constraints limited this study. The researcher identified these three sentinel event cases through the quality assurance process of the EMS agency. Participant selection was based upon the criteria that was established and agreed upon by the institutional review board (IRB), dissertation chair, and committee.

This included three sentinel events that were recreated with three different teams. All participation within the debriefings and simulation sessions was voluntary, and no compensation was provided for this project, as noted in Appendix A. Each of the three sentinel event cases studied as part of this research were investigated using the same process which included identification of the sentinel event, simulations, and debriefing sessions.

### **Identification of Sentinel Event**

Sample participants were identified through the quality assurance office of the EMS agency. Sentinel event cases were identified through the quality assurance office of the EMS agency. This included any EMS run that involved harm or risk of harm to a patient. Once the sentinel event case was identified through the CQI process, all of the supporting documentation, which included the EMS medical record, computer aided dispatch information, hospital follow up, and notes from the CQI staff was collected. All protected health information was redacted from the case information. After a CQI review of all supporting documentation was completed, an initial debriefing session was scheduled with the crew involved in the sentinel event case. Participants included the crew members of the sentinel event case, medical director, and quality assurance officers. This initial debriefing session included a review of the sentinel event, a review of the case in its entirety, discussion with each member about their individual role, team dynamics, as well as a review of the medical protocol established for this patient care situation. This is consistent with the M&MC process and would have occurred with the case

regardless of this research project. During the introduction of the initial debriefing, the participants were approached about being part of this research project. The purpose and intent of the project was identified to the participants, who then signed consent forms. At this point, the initial debriefing continued and was conducted similar to a hospital M&MC conference as described in Chapter 2.

### **Simulation Group Session**

The participants involved in the sentinel event case were placed into a simulated patient care scenario as a group. Groups that focus on an issue together can generate more critical comments than interviews alone, as the discussion is more open ended, and the individual experience can be considered and reflected upon (Erickson & Kovalainen, 2008). The simulation re-created the circumstances that had been discussed in the traditional debriefing. The participants worked through the simulated scenario at the same rate of time in which the original events unfolded. Observations were recorded by the researcher in a research journal. Information included the positions of the crew members, the treatment being administered, and the methodology used by the participants to work through the case. The paramedics are accustomed to using simulation in EMS education for both initial and continuing education. Paramedics in the simulation were able to provide expertise to the research, because they are “people who are uniquely able to be informative because they are experts in an area or were privileged witnesses to an event” (Maxwell, 2013; Weis, 1994). The researcher utilized an assistant to help observe the simulation and debriefings, because it is difficult for one person to capture everything

that happens. Two forms of documentation occurred during the observation of the simulations. One part was the EMS medical protocol, which provides a standard set of instructions for a specific patient care scenario. The paramedics of the EMS agency are expected to follow these protocols while providing patient care. The actions of the teams in simulation were compared to the medical protocol to determine specific gaps in patient care. During all of the simulations and debriefings, the researcher used detailed note taking for use in the coding of themes and subthemes. Although no specific categories were established prior to the data collection, the impact of equipment, technology, EMS provider positions, and the interaction of the crew members were observed.

Three groups enacted each sentinel event scenario. Each simulation was conducted in a standardized way to reduce variation in the data collection. The use of an interview protocol (Appendix A, B, C) assisted in standardizing the simulation sessions and the debriefings. Each group had approximately five to six members, which is the standard team size that typically is involved in these types of EMS incidents. The simulated cases included an airway mishap involving a missed esophageal intubation and two cases that were considered failed airways because the patient was unable to be intubated or ventilated to provide airway support. The primary purpose of the simulation sessions and debriefing sessions was to compare the points raised in the initial debriefing to the points raised during the simulation and subsequent debriefing. The goal was to determine if additional contributing factors or learning points could be identified. Additionally, the simulation allowed for the observation of how the group interacted, how

they questioned each other in the debriefing, how they responded to the researcher's questions, and how they responded to others points of view. However, it was also important to observe what was not specifically stated in conversation, including the expression, body language, and silences observed by the researcher (Eriksson & Kovalainen, 2008). The goal was to determine whether it is practical to use medical simulation to re-create the event and how simulation influences the process of root cause analysis in sentinel events.

### **Debriefing Interviews**

After the simulation scenario, the researcher debriefed each team to assure that the simulation groups had time to reflect upon their individual as well as group experience (Ericksson, 2008). A debriefing protocol was written in advance of the debriefing to assist with the flow of events and can be found in Appendices B, C, and D. The debriefings were conducted in a group setting immediately after the simulation sessions and occurred in the location that the simulation had been completed. The debriefing asked a series of questions about the experience and the decision-making processes involved in the simulated experience. The use of an interview protocol assisted in providing a standard data collection method and technique that increased reliability. The semi-structured format for the debriefing allowed the participants to respond more openly and allowed the interviewees to guide the conversation in whatever direction they believed they needed to in order to answer the question (Patton, 2002). Semi-structured debriefing interviews allow the researcher to follow up on a particular interest or

comment that was revealing (Maxwell, 2013). The debriefing was observed by the research assistant to enable the researcher to have more interaction with the simulation group while not failing to gain key thoughts or themes.

A research journal was kept to assure adequate research and observational notes were memorialized throughout the project. A research journal is important in qualitative research (Ravitch, 2015 p. 124). The research journal serves several purposes, including keeping valuable references, formulating ideas about the research, developing additional questions, and guiding the discussion (Ravitch, 2015 p. 124). The journal was used as part of the data in the final writing of the project primarily in the discussion phase. An inductive process was then used to complete a thematic analysis of the data to help identify the themes and sub themes identified in the observational data. The thematic analysis was verified by giving the themes and sub themes to the colleague who served as the research assistant and asking him to review and comment on the findings. This helped increase reliability through checking the observational data with another researcher.

A second patient simulation experience was then scheduled with a crew of paramedics that had volunteered for the project. The team make up had identical certifications as the crew configuration of the initial event. The team was briefed on the scope and purpose of the project, and consents were signed after all questions were addressed. The team was presented with the identical parameters of the case and then asked to progress through the case using the same timelines of the original event. The



team dynamics and patient care was recorded, and the team was debriefed after the event. The debriefing focused on how team the managed the patient care scenario and what the team learned from being part of the simulation.

A third simulation scenario was conducted using a team of instructors from the paramedic education program of the EMS agency that volunteered to be included in the project. The teams of instructors were briefed on the scope and purpose of the project. After addressing any questions that the instructors had, they signed consents to participate in the project (Appendix A). The team of instructors had identical paramedic certifications to the previous teams. In addition, they all had been certified to teach paramedic education. This made their contribution unique. The instructors were presented with the identical parameters of the case and progressed through the case using the same timelines and events recorded from the initial case. Team dynamics were recorded, and the teams of instructors were debriefed after the event concluded. The debriefing was identical to the previous two simulation experiences and focused on how the team interacted and handled the case that they were presented with during the simulation. After the three simulations and four debriefings, the findings were compared. The findings were placed into a spreadsheet to determine what additional contributing factors were discussed during the debriefings. Additionally, a thematic analysis was completed to determine themes and subthemes. The analysis looked for patterns in the data that demonstrated similar behaviors, different approaches to patient care, statements,

and experiences within the crews as well as observations, behaviors, or statements unique to each scenario that may have had an impact on the sentinel event or the case outcome.

### **Limitations**

One of the limitations of this research is the small sample size and limited number of simulations that were conducted. Although a larger sample size may have made the data more robust, the findings of the research were consistent throughout the three cases. The simulation group participants' responses may be influenced by the comments and actions of others in the group. The specific experiences and beliefs of the group may influence their understanding or interest in this research and may contribute to response bias. This could include previous sentinel event investigations in which they have been involved, their current understanding of RCA purposes and techniques, or concern of potential discipline arising from additional contributing factors. This was evident in the initial discussion with the labor organization that represents the paramedics of the EMS agency. In addition, because they are a purposeful sample, the paramedics within the EMS agency provided a timely and inexpensive method for data collection. However, the sample size and the fact that it was a convenience sample mean it may not be generalizable.

### **Biases**

All training may be vulnerable to bias (Park, 2014). It was important that I recognize bias, because no researcher is without some form of bias. My personal bias was that I believed simulation could be used to perform causal analysis of sentinel events.

Since I am the main researcher, I accounted for this by making sure that I used semi-structured questions in the debriefing. I did not lead the respondents to give responses that may purposely contribute to my belief, and I asked the research assistant to observe my interactions with the participants for this form of bias. I also used a research assistant to observe my interactions with the group involved to help eliminate leading questions or other forms of bias. With a graduate education in process improvement and operational excellence, as well as a Black-Belt Six Sigma background, there is a chance of introducing bias into the study related to my previous understanding of defining, measuring, analyzing, and attempting to improve problems. I controlled for this potential bias by assuring that I was mindful of my graduate education and how others may not have the same level of understanding of RCA process. I spoke to each group of participants prior to the debriefing and explained that if I used phrases or words that did not make sense to ask for clarification.

Confirmation or hindsight bias occurs when the researcher chooses subjects based upon certain criteria. There is a chance of confirmation bias because the groups identified in the sentinel event had already experienced the case scenario in real time. The crew involved in the sentinel event had already been through a debriefing and had a better understanding of what occurred. It is possible that the crews involved would approach the simulation session from the view of what they now know or understand about the sentinel event case rather than what they were experiencing at the time they were managing the case.

Through the use of triangulation, I attempted to control for any bias by using consistent methods to answer the research question. The completion of the two additional simulation sessions and debriefings helped to control for this bias as well. I created a research memo and assured that I was taking adequate research notes in my research journal. This was helpful when I wanted to confirm that I accurately captured points observed or stated during the simulations and debriefings. These included observations such as the frustration of the crews in case number two with the uncooperative paramedic as well as the different protocol violations that were identified throughout each case. This gave me the opportunity to reflect on the research and account for any bias that I or the research participants may have had during this research.

There was also the risk of bias because I conducted all of the simulations and debriefings. There was the chance that I did not push as hard on one group compared to another. It is also possible that once I obtained information that I thought confirmed my findings, I stopped exploring other opportunities for additional contributing factors or learning points. I accounted for this by involving a research assistant that observed all simulations and debriefings. He was given the themes and sub-themes to cross check the findings of this research. His review of the findings helped validate the research.

Another potential bias involved the fact that I am affiliated with the EMS agency within which the research was conducted. Because I am in an administrative position within the EMS agency, there is the chance for bias based upon the position of authority that I hold in the organization. Although all participants signed consents to participate

that included a statement that they were not required to participate, it is possible that some of the participants felt obligated to take part due to my status in the organization. I attempted to account for this by having a research assistant present during the simulations and debriefings. In addition, prior to beginning the sessions, I made sure to address the scope and purpose of the research and assure the participants that they were not required to take part in the research and there would not be retaliation if they chose not to take part. I also spoke to the labor organization that represents the participants; I briefed them on the project and asked them to contact me if any concerns were raised. This will be discussed further in the findings section.

### **Conclusion**

This dissertation used an exploratory qualitative methodology to examine the usefulness of medical simulation sessions and debriefings. The purpose was to gather data to determine whether these methods can be used to conduct a causal analysis of sentinel events in healthcare. The dissertation study included three sentinel event cases. For each case, three groups were involved in the simulation: the original crew of the sentinel event, a crew with the same qualifications as the original crew that had no part in the sentinel event, and a crew of instructors with the same qualifications as the original crew. All three crews participated in the same simulation with the same parameters, and each crew participated in a debriefing session after the simulation. In addition, the original crew participated in a debriefing session similar to an M&MC before the simulation to help identify case parameters that should be included in the simulation.

During the simulation and debriefing, the researcher and a research assistant took extensive notes about the events and discussion that occurred.

## **Chapter 4**

### **Findings**

This chapter will present the findings of the data collection. The focus of the research was on the use of medical simulation in causal analysis of sentinel events in health care. I attempted to determine whether additional contributing factors to the sentinel events could be found by running simulated patient care sessions that recreated the specific circumstances of a case. This research used information from the medical record, continuous quality improvement (CQI), and initial debriefing of the crews involved in the patient encounter. I compared the simulation sessions and subsequent debriefing sessions with the original debriefing to determine whether additional contributing factors or learning opportunities were gleaned from the experiences. There were three sentinel event cases studied as part of this dissertation. Four total debriefings and three simulations were completed for each sentinel event for a total of 12 debriefings and nine simulation sessions run over a period from March 2016 to June 2016. The research was conducted an average of 7.6 days (3-9 days) after the sentinel event occurred.

### **Participant Demographics**

A total of 16 people participated in the project. As a matter of coincidence, all of the participants involved in this research were male. The average paramedic (EMT-P, LT) involved in the simulations had 16.1 years of experience in the division of fire (2 yrs.–30 yrs.) and 13.6 years of experience as a paramedic (3 yrs.–26 yrs.). The average

instructors (Inst) involved in the simulations had 10 years of experience as an instructor (8 yrs.–12 yrs.) and 14 years of experience as a paramedic (12 yrs.–18 yrs.). To maintain confidentiality of the participants, each paramedic was identified as P1 through P16.

(Table 1)

*Table 1*

*Paramedic years of experience*

EMTP	Position	Years in Org.	Years as Paramedic	Years as Instructor
P1	EMTP	24	6	N/A
P2	EMTP	19	15	N/A
P3	EMTP	26	18	N/A
P4	EMTP	29	20	N/A
P5	EMTP	16	9	N/A
P6	EMTP	16	10	N/A
P7	EMTP	8	3	N/A
P8	EMTP	29	26	N/A
P9	EMTP	11	7	N/A
P10	EMTP	12	9	N/A
P11	EMTP	13	9	N/A
P12	Super	18	18	N/A
P13	Super	30	25	N/A
P14	Inst	3	12	10
P15	Inst	2	13	8
P16	Inst	2.5	18	12
<b>Total</b>	12	258.5	218	30
<b>Average</b>		16.1	13.6	10

EMT-P = Paramedic - Super = EMS Supervisor - Inst = EMS Instructor

### Description of the Sentinel Event Cases

The continuous quality improvement (CQI) office of the EMS agency is housed within the training bureau and is tasked with managing the performance and protocol compliance of the agency paramedics. The goal of CQI is to assure that the paramedics



are performing at a level that is consistent and safe. CQI has been established as a process to promote a culture of continual improvement by ascertaining what occurred, what should have occurred, and how it can be improved (Joint Commission, 2011). The cases included in this project were identified through the CQI office of a large urban EMS system, identified as the “EMS agency” for this research. Each of the cases were reviewed by the researcher prior to the data collection to determine the significance of the events and the appropriateness of the case for inclusion in this research. The criteria used for inclusion in this research included risk or harm to a patient, an identified CQI concern, and a case that could be re-created and studied within the timeline of this research. The electronic medical record (EMR) was reviewed and compared to the patient care follow-up obtained from the receiving health care facility prior to the initial debriefing. After the initial CQI review, a debriefing was set up with the paramedic crews involved in the case. The debriefing began with the researcher explaining the purpose of the research, the methods, and then obtaining permission to use the data obtained from the crews for the completion of the project. Participants were assured that the process would not result in any disciplinary action.

When the crews involved in the sentinel event agreed to participate in the simulation experience, the parameters of the case were built into a simulated environment, which included a high fidelity mannequin. The environment in which the events occurred, such as an ambulance or bed room scenario, were obtained and set up. The equipment prepared for each case was identical to equipment that the crews used

during the patient care scenario. Each participating crew was briefed with the information from which the scenario was re-created as close to the actual events, parameters, and environments as possible. The crew was instructed to manage the patient care as they would as if they were in the actual scenario. The crew was instructed to be prepared to address any issues that they identified during the patient care experience. When the simulation experience was completed, a semi-structured debriefing occurred immediately with the crew involved in the simulation experience. The researcher led the debriefing, which focused on the contributing factors and learning opportunities that were observed during the simulation.

The information found during each simulation and debriefing was assessed to determine the impact each finding had on the sentinel event and placed into a classification based upon the coding category. Factors that were classified as contributing to the sentinel event case were identified in bold text. All additional findings were considered learning opportunities that did not contribute to the sentinel event. Throughout each simulation and debriefing, additional learning opportunities and contributing factors were either added or affirmed to be important in the case investigation. Thematic analysis was conducted on each researcher observation, learning opportunity, and finding to determine where similarities existed, such as protocol violations, and training issues. The researcher classified all data into six emerging themes. The classification and descriptions are described in Table 2.

Table 2

*Definitions of classifications*

Code	Classification	Description
C	Contributing	Identified as directly contributing to the sentinel event
E	Equipment	Identified equipment issue identified as impacting a case
O	Observation	Identified as an observation to be noted by the researcher
P	Protocol	Identified as a violation of EMS protocol
S	Sustaining	Helps to confirm impact of previous learning point
T	Training	Identifies additional training opportunity

**Case Number One**

The continuous quality improvement office (CQI) of the EMS system received a patient quality improvement concern regarding a pediatric airway involving a four-year-old that had been removed by firefighters from a house fire at 0100 hours. The child was in cardiac arrest with burns noted to his body. Advanced life support was initiated while transporting to the pediatric emergency department. The CQI follow up stated that the placement of the endotracheal tube (ET) was in the esophagus rather than the trachea upon arrival in the emergency department. An endotracheal tube is a breathing tube that is the preferred method for long term airway management in patients that require assisted ventilation. Placement requires a skilled provider to pass the ET tube through the vocal cords to secure the airway. This case was determined to be a sentinel event because the patient expired, and improperly placed ET tubes have been determined to be a critical event in health care. This is due to the poor patient outcomes and high litigation risk associated from the failure to detect the positioning of the ventilation tube (Bair, 2005).

Upon receipt of the CQI concern, all supporting documentation was collected, which included the EMS medical report and heart monitor information. A CQI review was completed, a chronologic timeline was established based upon the EMS report, and the heart monitor summary was embedded within the established timeline. It was determined that positive waveform capnography was present with a numeric value and a graphical waveform for approximately one minute after placing the endotracheal tube. Waveform capnography is technology that monitors airway gas exchange during ventilation and provides a graphical waveform during ventilation. It has been considered the gold standard for assuring airway patency in the prehospital setting (Bair, 2005). The waveform became flat at the same time that the medic was determined to be arriving at the emergency department from information obtained from the computer aided dispatch (CAD) system. This indicated a problem with either the equipment or the ventilation tube placement (Bair, 2005). The medical crew members entered the emergency department and explained the situation to the emergency department staff. During the emergency department assessment, the ventilation tube was found to be outside of the trachea, which is the proper position to adequately secure the patient's airway and ventilate the patient. The patient ultimately expired in the emergency department.

#### *EMS Crew Traditional Debriefing*

A CQI meeting was set up to include the medical director, deputy medical director, CQI coordinator, the paramedics involved in the case, and the researcher nine days after the event. The timeline was dependent upon the schedules of the medical

crews involved, and this was the earliest that all parties were available for debriefing. The meeting was opened with the medical director describing the purpose of the meeting. The CQI Captain reviewed the case and the concerns presented from the receiving hospital. The traditional debriefing included a discussion about the circumstances of the run, the patient care decisions, thought processes used in the crew member's management of this event, and specifically the confirmation and maintenance of the child's airway. The debriefing lasted approximately one hour.

The paramedic crew described initial confusion as this situation developed. The EMS crew described the rapidly developing situation in which a child was pulled from the home by firefighters and brought to the back of the ambulance, where the paramedics initiated care. The EMS supervisor stated that when he arrived at the ambulance, he determined the child "was in cardiac arrest" with chest compressions being administered (P4, personal communication, March 9, 2016). The EMS supervisor is expected to oversee patient care provided by the paramedics and also carries equipment that is not used often enough to provide to all the ambulances due to cost. This equipment is considered low frequency, expensive equipment that is of value when needed in certain patient care situations such as this case presents. Included in this equipment is a drill capable of placing a needle into the bone of a patient to provide access for medication and fluid used in resuscitation. During the course of this patient's care, treatment protocol states that the patient's airway should be managed, intravenous/interosseous access is obtained for medication administration, and the heart monitor is applied. The

heart monitor has the ability to measure the patient's carboxyhemoglobin level (RAD-57), which would be expected to be elevated in fire victims trapped within a closed space environment. The EMS supervisor also carried medication to counter the effects of cyanide toxicity—a by-product from a closed space fire that impacts the ability to exchange oxygen and carbon dioxide during ventilation. Although the heart monitor was utilized, neither the RAD-57 monitor nor the medication Sodium Thiosulfate was part of this patient's care administered during treatment. When asked, the paramedics felt that they did not have time to do this due to the short distance to the hospital.

A recent addition to the equipment carried by the EMS supervisor is video equipment used for direct visualization of the airway structures required for proper breathing tube placement. This equipment is used to enhance the success rate of completing the intubation procedure. The equipment that the EMS supervisor carries was not available during this case. The EMS supervisor stated, "I parked in the back in the alley and decided not to waste the time going back to get the equipment for such a short trip (to the hospital), I won't do that again" (personal communication, P4, March 9, 2016). The supervisor did not have this equipment with him and decided to not return to his vehicle to get it prior to leaving for the hospital. He stated, "I didn't want to delay transport to go back and get it" (personal communication, P4, March 9, 2016). The supervisor and the crew admitted that this hampered their patient care; the supervisor stated, "I should have had that equipment; next time I will not leave without it" (personal communication, P4, March 9, 2016). Additionally, the crew reflected upon the patient's

airway that was full of soot from the by-products of combustion. “I never completely saw the cords; the airway had edema and was full of soot” (personal communication, P3, March 9, 2016). All of this care occurred in the back of the ambulance while transporting. The EMS supervisor did not ride in the back of the ambulance to the hospital; rather, he drove the ambulance to the hospital, making him unavailable to direct patient care as expected by the policies of the EMS agency.

The child was ventilated with bag valve mask ventilation (BVM), which is the standard way of providing basic airway support in the non-breathing patient. It consists of a face mask and a manually squeezed bag that is attached to oxygen to provide respiratory support. During the initial attempt to intubate the child, a light bulb failure occurred on the blade used to visualize the airway structure. It was later determined that the light bulb was not tightened in the blade and was flickering during use, making the device impractical to use. The first intubation attempt had to be abandoned and the child re-ventilated. During the next attempt, a breathing tube passed into his trachea to secure the airway and provide oxygenation without directly visualizing the airway structures. The crew stated, “I confirmed airway presence by listening to the patient’s breath sounds and placing capnography in-line” (personal communication, P2, March 9, 2016). Capnography confirms gas exchange during ventilation and is considered the gold standard for assuring continued airway presence during ventilation and was noted to have a positive tracing upon review, indicating proper placement to ventilate the patient (Grmec, 2002).

The crew stated that when they were arriving at the emergency department and exiting the vehicle, they noticed the waveform tracing had gone flat. The lack of a continual waveform is an indication that the endotracheal tube may have become dislodged from the proper position and requires immediate attention on the part of the care provider (Mort, 2005). The crew described considering the causes for this sudden change in the waveform presence; they concluded that it may be a clogged filter line tube due to the soot in the patient's airway. The paramedic that initially saw the tracing stated, "I assumed it was clogged" (personal communication, P3, March 9, 2016). Since they were at the doors to the emergency department, they decided to proceed into the hospital and address the concerns with the staff at the bedside. It was at this point the tube was confirmed out of the trachea, and the patient was re-intubated. "I should have pulled the tube in hindsight" (personal communication, P2, March 9, 2016) was a comment from one of the participants that was unanimously agreed to by the others.

#### *Initial Debriefing Summary*

In summary, there were equipment, patient care protocol, and supervision issues that contributed to this sentinel event. The identified equipment issues could be related to human error and could have been resolved prior to the event during equipment checks at the beginning of the assigned shift. Based upon the discussions a total of eight learning points and five factors that contributed to this sentinel event were identified (Table 3).



Table 3

*Case One Initial Debriefing Learning Points*

No.	Major Learnings Points	Contribution	Standard Debrief
1	<b>EMS supervisor vehicle location</b>	C	X
2	EMS crew proximity to each other during initial event	O	X
3	<b>EMS supervisor drove and failed to provide oversight</b>	C	X
4	<b>There was no airway checklist used</b>	C,O,P,S	X
5	<b>They did not pull the ET tube and use a BVM</b>	C,O,P,T	X
6	They failed to use the RAD-57	P,O	X
7	The laryngoscope bulb was flickering	E	X
8	<b>There was no pulse oximetry applied during care</b>	C,P,S	X
<b>Note: Bold print identifies contributing factors and regular print identifies additional learning opportunities</b>			
<b>C-Contributing E-Equipment O-Observation P-Protocol S-Sustaining T-Training</b>			

*Initial Crew Simulation Experience*

The same crew that was involved in the sentinel event and the traditional debriefing session agreed to take part in the simulation for this research. The crew was briefed on the purpose of the simulation experience. The vehicle and equipment were identical to the unit on the night of the event. The simulation experience began with the firefighters arriving at the back of the medic unit with the pulseless and apneic (non-breathing) child. The simulation was run over the same time period as reported on the EMS report. During the running of the simulation, the crew was asked to place themselves in the same positions in the medic that they were during the event. There were a total of four people in the simulation, including three paramedics and a paramedic supervisor. The simulation session began with the initial evaluation and resuscitation of the simulated patient. The patient was placed in the middle of the transport cot, which is secured to the floor of the vehicle. The small size of the patient (40 lbs.) made the patient

care a challenge in the back of the ambulance. The supervisor made initial contact and asked what the crew needed. They stated “we just need a driver” (personal communication, P2, March 9, 2016). The EMS supervisor closed the rear doors and proceeded to climb into the driver’s seat of the vehicle. The EMS supervisor remained in the front of the vehicle for the remainder of the simulation. As the patient care continued, attempts at airway management were made by one of the paramedics at the head of the patient. The patient remained in the middle of the cot and forced the paramedic to lean forward to gain access to the patient while the vehicle traveled down the street. There was never a time delay observed in attempting patient care procedures. It was noted by the researcher that there was little conversation between crew members. As an example, the paramedic managing the patient’s airway worked individually on the procedure without assistance from the other crew members and never asked for assistance when difficulties occurred. The simulation ended upon arrival in the emergency department, and patient care was transferred as reported from the initial debriefing.

#### *Initial Crew Simulation Debriefing*

During the semi-structured debriefing, crew members were given the opportunity to explain their thought process and involvement in their respective areas of responsibility. The debriefing discussion occurred in the back of the ambulance so the crew could visualize what they were discussing. As an example, the researcher asked why the child was left in the middle of the cot and not moved up on the cot closer to the paramedic who was responsible for the airway. After the question was asked, the paramedic reached

down and pulled the simulated patient closer to the head of the cot and stated, “I guess that would have worked better, it was just everyone was working and I didn’t think about it” (personal communication, P3, March 9, 2016). There were four additional learning points that were identified during the simulation scenario that were undetected during the initial debriefing. They included:

1. The position of the patient on the cot. Recalling that the patient was four years old and about 40 pounds, it was noted that the crew placed the patient in the middle of the cot and not at the head. Therefore, the paramedic had to reach further to manipulate the airway, and it forced him to lean forward in the back of a moving vehicle. This is not the ideal position to attempt this procedure.
2. The position of the paramedic. The paramedic manipulating the airway was in a position on the floor of the truck that was awkward, and it was difficult to get in the ideal position to control the airway even with bag valve ventilation. There was not an attempt to lift the patient by elevating the head of the bed to make the angle and positioning more manageable.
3. Lack of help. Once the truck left the scene, they only had three people available in the back for help. With one doing CPR, one attempting to gain intravenous access and administer medication, that left one paramedic to manage the airway. It appears that additional hands were required to enhance success in this situation.
4. Communication. There was a lack of discussion going on between the crew members during the travel time and patient care. Each was concentrating on their

assigned task. Better communication could have refocused the crew to the basic life support needs of chest compressions and ventilations.

Three additional learning points were identified from the same crew involved in this sentinel event. There were also three additional contributing factors identified. They are numbers 9-12 in Table 4 and include:

1. The lack of discussion and interaction among the crew members. Each crew member was observed to be working by themselves, and there was a lack of discussion noted.
2. Position of the paramedic during the intubation attempt. The paramedic was initially sitting in the chair at the head of the cot and well above the patient that was on the cot. This was observed to be a difficult position for him to successfully complete the procedure. During the debriefing, this issue was raised with the participants and all agreed that getting lower to the patient's level may have provided a better chance of success.
3. Only one person was managing the airway. It was also noted that there was only one paramedic managing the airway. This was observed to not be an ideal situation, as the paramedic was responsible for setting up the equipment, ventilating the patient, and then trying to complete the intubation procedure. During debriefing, it was noted that due to the limited help in the back of the truck, the paramedic did not feel there was another option.

Table 4

*Case One Simulation One Debriefing Learning Points*

No.	Major Learnings Points	Contribution	Standard Debrief	Simulation 1
1	<b>EMS supervisor vehicle location</b>	C	X	X
2	EMS crew proximity to each other during initial event	O	X	X
3	<b>EMS supervisor drove and failed to provide oversight</b>	C	X	X
4	<b>There was no airway checklist used</b>	C,O,P,S	X	X
5	<b>They did not pull the ET tube and use a BVM</b>	C,O,P,T	X	X
6	They failed to use the RAD-57	P,O	X	X
7	The laryngoscope bulb was flickering	E	X	X
8	<b>There was no pulse oximetry applied during care</b>	C,P,S	X	X
9	<b>Lack of discussion among crew members</b>	C,O,S		X
10	<b>Position of paramedic/patient during intubation</b>	C,O,S		X
11	Failed to use oral airway for effective ventilation	P,O		X
12	<b>Only one person managing the airway</b>	C,O,S		X
<b>Note: Bold print identifies contributing factors and regular print identifies additional learning opportunities</b>				
<b>C-Contributing E-Equipment O-Observation P-Protocol S-Sustaining T-Training</b>				

*Second Crew Simulation Experience*

A second crew was recruited to complete the same scenario. The team's make up reflected the same number that was in the back of the medic unit during transport. They were briefed on the specific scenario, which included the same type and size ambulance that was used in the original scenario. In addition, the equipment was identical to what was available during the initial event. The instructions to the participants included, "You are dispatched to a working fire at a residence, four minutes after your arrival firefighters meet you at the back of your medic unit with a four-year old in cardiac arrest that was removed from the structure." This is where the scenario began for the second simulation. These crew members went through the simulation and were presented the same situations encountered during the actual event. The EMS supervisor in this scenario remained in the back of the vehicle and directed patient care after assigning another firefighter to

drive to the hospital. It was noted that the crew approached the scenario differently in several areas. Although each approach has some validity and made sense to the crews involved, it demonstrates a lack of a standard approach to patient care even though each crew is operating from the same medical direction and protocol. Additionally, pulse oximetry to measure oxygenation status and a carboxyhemoglobin detector (RAD-57) were used in this scenario. Although the merits of pulse oximetry accuracy can be questioned in this case, they also used the RAD-57 to determine the amount of interference with the gas exchange in the lungs from the by-products of combustion that resulted from the fire. The use of this device was appropriate and should have been included in the care delivered. In addition, it was observed that there was enhanced crew coordination and communication during this simulation than in the previous simulation. This was evidenced by the airway paramedic in simulation session number two requesting help in the management of the airway, "I need some help here" was specifically stated during the simulation (personal communication, P8, March 12, 2016).

#### *Second Crew Simulation Debriefing*

After the second simulation, the crew was explained the events of the case and what made this a sentinel event. There was additional conversation among the participants about the management of the airway and the confirmation of the ET tube placement. It was stated by one participant that "I could see that happening to me. The filter line can get fouled up and I would think the same thing" (personal communication, P7, March 12, 2016).

There were seven additional learning factors identified compared to the previous debriefing. There were also two additional contributing factors identified. They are numbers 13-19 (Table 5) and include:

1. Equipment. This crew used additional equipment that was available to the initial crew but was not utilized during the actual event. This included the use of a Gum Elastic Bougie. This is a tool used to assist in the placement of an airway in a difficult airway scenario specifically when it is difficult to visualize the anatomical structures. Additional equipment was also used, such as the pulse oximeter and carboxyhemoglobin detector.
2. Communication. Enhanced communication included the request for assistance to manage the airway. The paramedic at the head stated, “Stop what you are doing there, I need help” (personal communication, P6, March 12, 2016). The outcome was different from the initial debrief related to the fact that the first crew member just managed the airway alone. The paramedic was a veteran with greater than eighteen years as a paramedic. When asked about why he did not ask for additional help, he stated, “everyone was busy, I felt like I had it handled” (personal communication, P4, March 12, 2016).

Table 5

*Case One Simulation Two Debriefing Learning Points*

No.	Major Learnings Points	Contribution	Standard Debrief	Simulation 1	Simulation 2
<b>1</b>	<b>EMS supervisor vehicle location</b>	C	X	X	X
<b>2</b>	<b>EMS crew proximity to each other during initial event</b>	O	X	X	X
<b>3</b>	<b>EMS supervisor drove and failed to provide oversight</b>	C	X	X	X
<b>4</b>	<b>There was no airway checklist used</b>	C,O,P,S	X	X	X
<b>5</b>	<b>They did not pull the ET tube and use a BVM</b>	C,O,P,T	X	X	X
<b>6</b>	<b>They failed to use the RAD-57</b>	P,O	X	X	X
<b>7</b>	<b>The laryngoscope bulb was flickering</b>	E	X	X	X
<b>8</b>	<b>There was no pulse oximetry applied during care</b>	C,P,S	X	X	X
<b>9</b>	<b>Lack of discussion among crew members</b>	C,O,S		X	X
<b>10</b>	<b>Position of paramedic/patient during intubation</b>	C,O,S		X	X
<b>11</b>	<b>Failed to use oral airway for effective ventilation</b>	P,O		X	X
<b>12</b>	<b>Only one person managing the airway</b>	C,O,S		X	X
<b>13</b>	<b>Crew pulled the ET tube and used BVM</b>	O,P,S			X
<b>14</b>	<b>Used the pulse oximetry correctly</b>	O,P,S			X
<b>15</b>	<b>Used the RAD-57 correctly</b>	O,P,S			X
<b>16</b>	<b>There was good crew communication during the care</b>	O,S			X
<b>17</b>	<b>Two people focused on controlling the airway</b>	O,C,S			X
<b>18</b>	<b>The crew used a Gum Elastic Bougie to pass ET tube</b>	O,S			X
<b>19</b>	<b>Failed to use airway checklist</b>	C,O,P			X

**Note: Bold print identifies contributing factors and regular print identifies additional learning opportunities**  
**C-Contributing E-Equipment O-Observation P-Protocol S-Sustaining T-Training**

*Instructor Simulation Experience*

A third simulation was run using state-certified instructors from the EMS agency's training bureau. The instructors teach initial and continuing education to the paramedics of the EMS agency. The instructors were recruited and briefed on the purpose of the project. They were given the same instructions that were given to the second team. The simulation was conducted with the same size and type ambulance, the same equipment, and over the same timeline that the previous simulations had been conducted. During the simulation, the EMS supervisor remained in the back of the vehicle and directed patient care. Researcher observations reflected continual discussions among the participants about the course of treatment. When the crew was arriving at the emergency department, the participants were presented with the tracing from the heart



monitor with a flat capnography tracing. When the airway was determined to be in question, the crew immediately pulled the ET tube and began bag valve ventilation, then proceeded into the emergency department. The instructor at the head remained in control of the events as they unfolded and actually raised his voice to stop the premature movement during unloading of the cot from the ambulance.

#### *Instructor Simulation Debriefing*

After the simulation, the crew was debriefed on their experiences and what had occurred in the sentinel event that they were asked to recreate. There was enthusiasm noted by each participant about the value of this experience. Each member felt that the simulation was interesting, realistic, and agreed that the simulation experience elicited feelings of stress. One member commented, “I could feel my heart rate amp up as you provided additional information during the case” (personal communication, P14, March 14, 2016). Another participant commented, “Did you see him? He was sweating like crazy” (personal communication, P15, March 14, 2016). This is consistent with Fraser (2014) who determined that emotions experienced during simulation training may affect cognitive learning, specifically in situations where the simulated patient died.

During debriefing, the instructors were briefed on the events surrounding the sentinel event. One instructor stated that he believed that the fact that it was a child contributed to the issues. He stated “everyone gets excited cause it is a kid, that’s where errors can occur because not everyone is comfortable” (personal communication, P15, March 14, 2016). The outcome of this simulation debriefing included a discussion and agreement

among the participants that the placement of the airway tube was initially in a good position to ventilate the patient. There was an assumption among those involved that migration of the tube occurred during movement from the back of the ambulance to the emergency department. The instructors discussed this case from a teaching perspective as well. “Is there something that we need to teach differently” (personal communication, P15, March 14, 2016). Their simulation experience demonstrated several of the same issues that were raised in the two previous simulations. However, they also identified an additional two contributing factors to the sentinel event. They are identified as 20-28 and include:

1. Coordinated movement to secure airway. Strong leadership and communication was observed from one designated in-charge person that was not demonstrated in the prior two simulations. The instructors noted that they frequently see this failure of communication in continuing education and have tried to ensure that scenario-based learning occurs. An example of leadership direction is that one instructor halted the movement of the patient from the vehicle when he noted a flat capnography. The paramedic instructor in control of the ET tube maintained it during patient movement by holding it with two fingers as they exited the vehicle and spoke to the other members about his intentions and the need for them to remove the patient slowly from the vehicle. This was demonstrated by one instructor commanding the group to “stop, hold on” when he did not feel he was ready to move the patient (personal communication, P14, March 14, 2016).

2. Education. The leader went through a mnemonic DOPE, which stands for dislodged, obstructed, pneumothorax, and equipment. This is taught to assist in the understanding of what is happening during a specific situation related to airway management. The instructors were the only group that used this thought process to problem solve the situation.

#### *Final Case Summary*

There was a total of 28 points of learning that occurred during the sentinel event simulations and debriefings (Table 6). The initial debrief identified five contributing factors. The simulation sessions identified an additional seven contributing factors for a total of twelve factors that contributed to this event, or a 58% increase over the initial debriefing. Many learning points were repeated, but new observations were also apparent in each simulation, adding evidence that simulation contributes more understanding.

Table 6

*Case One Simulation Three Debriefing Learning Points*

No.	Major Learnings Points	Contribution	Standard Debrief	Simulation 1	Simulation 2	Simulation 3
1	<b>EMS supervisor vehicle location</b>	C	X	X	X	X
2	EMS crew proximity to each other during initial event	O	X	X	X	X
3	<b>EMS supervisor drove and failed to provide oversight</b>	C	X	X	X	X
4	<b>There was no airway checklist used</b>	C,O,P,S	X	X	X	X
5	<b>They did not pull the ET tube and use a BVM</b>	C,O,P,T	X	X	X	X
6	They failed to use the RAD-57	P,O	X	X	X	X
7	The laryngoscope bulb was flickering	E	X	X	X	X
8	<b>There was no pulse oximetry applied during care</b>	C,P,S	X	X	X	X
9	<b>Lack of discussion among crew members</b>	C,O,S		X	X	X
10	<b>Position of paramedic/patient during intubation</b>	C,O,S		X	X	X
11	Failed to use oral airway for effective ventilation	P,O		X	X	X
12	<b>Only one person managing the airway</b>	C,O,S		X	X	X
13	Crew pulled the ET tube and used BVM	O,P,S			X	X
14	Used the pulse oximetry correctly	O,P,S			X	X
15	Used the RAD-57 correctly	O,P,S			X	X
16	<b>There was good crew communication during the care</b>	O,S			X	X
17	Two people focused on controlling the airway	O,C,S			X	X
18	<b>The crew used a Gum Elastic Bougie to pass ET tube</b>	O,S			X	X
19	Failed to use airway checklist	C,O,P			X	X
20	Aggressive leadership by the instructors	S				X
21	Airway paramedic was in command throughout	S				X
22	Used RAD-57	S				X
23	Pulled the ET tube and used BVM	S				X
24	Requested EMS supervisor to back of truck	S				X
25	<b>The crew used a Gum Elastic Bougie to pass ET tube</b>	C,O,S				X
26	<b>Used the DOPE assessment to troubleshoot</b>	P,T,C				X
27	<b>Moved child holding ET tube</b>	O,T,C				X
28	Considered Sodium Thiosulphate medication	P,T				X

**Note: Bold print identifies contributing factors and regular print identifies additional learning opportunities**  
**C-Contributing E-Equipment O-Observation P-Protocol S-Sustaining T-Training**

*Summary of Case Themes and Researcher Observations*

The primary contributing factor to this case was identified as the failure of the crew to immediately address the change in waveform capnography which was an indication of a problem with the placement of the breathing tube (Mort, 2005). Although this was identified as the primary factor involved, there were several additional observations and factors noted by the researcher during these simulations that impacted the patient care in this case and outlined in Table 7.

Table 7

*Case One Simulation Themes and Researcher Observations*

Case Number 1				
Traditional Debriefing	First Crew Simulation	Second Crew Simulation	Instructor Simulation	
Crew away from each other	EMS Supervisor in rear of house	No airway checklist	Asked for Sodium Thios	
<b>EMS Supervisor in rear of house</b>	Crew away from each other	Used pulse ox	Used Rad 57	
<b>EMS supervisor drove to ED</b>	EMS supervisor drove to ED	Used Rad 57	Pulled the tube and bagged	
<b>No airway checklist</b>	No airway checklist	Good communication	Kept supervisor in back of truck	
<b>Did not pull tube and bag</b>	<i>One person managing airway</i>	<b>Two people managing airway</b>	Bougie used for ET tube	
<b>No Rad 57</b>	<b>Did not pull tube and bag</b>	<b>Used Bougie</b>	<b>Used DOPE numonic to troubleshoot</b>	
<b>Blade flickering</b>	<i>No discussion</i>	<b>Pulled the tube and bagged</b>	<b>Moved child holding tube</b>	
<b>No pulse ox</b>	<b>Airway position to intubate</b>		<b>Aggressive leadership</b>	
	<b>No oral airway with BVM</b>		<b>Airway person commanded when to move</b>	
Researcher notes				
Each crew approached airway in a different position				
No checklist was used				
Checklist not even available in medic vehicle				
EMS officer failed to have Sodium Thiosulfate, Easy IO Drill, and Vivid Trac video laryngoscopy				

A demonstrated lack of standardization of care in the approach to this patient was observed. As an example, each of the paramedics that addressed the patient's airway did so in a completely different manner. One laid flat on the floor of the truck next to the patient, another sat in the seat at the head of the patient. This position put the paramedic well above the patient's head and he had to bend down to try and address the issues of the patient's airway. Aside from the initial event, none of the EMS supervisors in the simulations left the paramedics alone in the back of the ambulance. Protocol violations were identified that were addressed with the initial crew through the continuous quality improvement but were not considered contributing factors to the sentinel event. (Table 8)

*Table 8**Identified Protocol Violations*

Protocol Violation	Impact
Lack of pulse oximetry use	Inability to measure oxygenation
Lack of RAD-57 use	Inability to measure carboxyhemoglobin
Lack of use of intubation checklist	Lack of standardized airway confirmation

In each of the scenarios, the approach to the management of the patient's airway was different. In addition, none of the crews actually involved used the intubation checklist in these scenarios, and the checklist was not even available in the medic vehicle in which the sentinel event occurred. All of the participants know about the checklist but could not explain why it was not being used. "It's pretty new, and I just didn't think about it" (personal communication, P5) was one remark; yet another dismissed it as unnecessary, "I have been doing this a long time, I know how to confirm placement" (personal communication, P3). Additionally, despite policy and previous education, there was a hesitation and delay in pulling the ET tube in two of the three scenarios.

The impact of the EMS supervisor vehicle being inaccessible in the initial stages of the incident is hard to measure. The EMS supervisor equipment could have placed the paramedics at a greater advantage to provide optimal care to this patient, and it was responsible for at least one of the protocol violations found during this case. Therefore, it was determined to be a contributing factor. Although I consider this a contributing

factor, the lack of this equipment likely was not a factor that contributed to the poor outcome of this critically injured patient.

### **Case Number Two**

This case involved a cardiac arrest on a male patient that occurred just after midnight. A fire engine first responder with a paramedic on the vehicle was the first to arrive, followed three minutes later by the transport ambulance. The EMS supervisor arrived an additional five minutes later. A total of seven crew members took place in the resuscitation. The crews were met at the door of the house by the spouse, who led them to a bedroom. The patient was pulseless and apneic upon arrival of the first arriving crews. The patient was found in a small 10 x 12 bedroom. The cardiac event was witnessed by the wife, who remained present in the room upon the paramedics' arrival and remained for the entirety of the event. Bystander resuscitation was not attempted prior to the arrival of the EMS crew. The paramedics had a difficult time completing an intubation, which places a breathing tube into the patient's lungs. What made this case a sentinel event was that the patient had multiple failed airway attempts as well as a failed rescue airway placement. Rescue airways provide a secondary method to provide oxygenation and assisted ventilation when intubation is unsuccessful. Although the patient received continual bag valve ventilation, it was discovered through quality assurance that during the attempt to manage the airway, the patient went three minutes and thirty-one seconds without being ventilated, further identifying this as a sentinel event. Patients should not go more than thirty seconds without receiving assisted

ventilations during these situations. This was discovered during the CQI office review of the case after the video airway footage was obtained. The patient ultimately expired in the emergency department of the receiving hospital.

#### *EMS Crew Traditional Debriefing*

A CQI meeting was set up with the crew involved in this case to include the CQI coordinator, crew members, deputy medical director, and the researcher. This occurred nine days after the event. The meeting opened with the CQI coordinator reviewing the specifics of the case and describing the purpose of the debriefing. During the initial crew debriefing, the crew described the bedroom as being small. They stated that there was a chair in the bedroom and that the spouse sat in the chair throughout the resuscitation. They noted that there was an initial unsuccessful attempt at intubation with a traditional laryngoscope blade used to visualize the vocal cords that the airway tube must pass through. Upon the second attempt, there was blood noted in the airway, and the crew was unable to visualize the anatomy needed for success of proper ET tube placement. The crew managed the patient's airway with a simple bag ventilation technique as described in case number one to provide oxygenation until additional help arrived from a supervisor, who brought additional equipment used for airway management that included video equipment for use in placement of the airway.

Upon the arrival of the EMS supervisor, the room was observed to be overly crowded due to the small size of the room, and providers were continuing resuscitation efforts. According to the supervisor, the video laryngoscopy equipment was passed through the



crowded room to a paramedic at the head of the patient, where an additional attempt to manage the patient's airway occurred. The supervisor determined that other paramedics in the room were in better positions to use the equipment and commented during the debriefing that "in hindsight, he should have pushed himself into the room and taken more of a leadership role" (personal communication, P6, April 2, 2016).

The participants involved also spoke about a frustration with one crew member that they had not previously worked with. This paramedic was working a trade from another area of the city and was not a routine member of the crew involved in this case. This paramedic was not present during the debriefing due to being on extended vacation and unavailable. The participants stated that the paramedic was dismissive in his attitude, and he did not appear to be working with them as a team. The EMS supervisor commented, "I had to call his name three times to get his attention and answer a question" (personal communication, P6, April 2, 2016). The EMS supervisor stated that the paramedic failed to initially plug the device into the video screen prior to attempting to use the device, further questioning his confidence in the paramedic, and he failed to respond when addressed about the use of the equipment. There were three occurrences identified as contributing factors to this event. They included:

1. Supervision/Leadership. The EMS supervisor and the most senior paramedic spoke about the frustration experienced with one crew member. However, the EMS supervisor did little to control the situation. This was evidenced by the fact that the EMS supervisor felt that the paramedic in the room was dismissive. The

EMS supervisor described having to raise his voice to get the paramedic's attention. He stated "I don't know if he was ignoring me or so engrossed in what he was doing that he tuned me out" (personal communication, P6, April 2, 2016). In addition, the patient was not ventilated for over three minutes during attempts to control the patient's airway. Failure of the EMS supervisor to assure the patient's airway status. Managing the patient's airway is a primary responsibility for the EMS providers when a patient is not breathing. Several techniques are taught to manage how the airway is controlled and to assure that attempts do not exceed thirty seconds without providing oxygenation.

2. Equipment training. The video of the airway management was reviewed. There were four issues identified on the video of the airway attempt. They included:
  - a. The video of the initial intubation attempt demonstrated that the endotracheal tube was not preloaded into the device as is recommended by the manufacturer. Preloading allows the tube to be guided directly into the trachea and helps prevent improper placement.
  - b. The EMS supervisor reported that the paramedic failed to initially plug the device into the video screen prior to attempting to use the device, preventing the device from being used properly and further questioning his confidence in the paramedic.
  - c. During the difficulty in the airway attempt, a Gum Elastic Bougie was used to place a small guide into the airway, which then allows the

endotracheal tube to pass over it. This was used successfully in the video; however, it was removed prior to attempting to pass the tube.

- d. The lack of oxygenation. Over three and a half minutes elapsed on the video during which attempts to visualize airway structures and pass the endotracheal tube were performed without stopping to ventilate and oxygenate the patient.

#### *EMS Crew Traditional Debriefing Summary*

The paramedic that was frustrating to the participants of this case was not included in this research due to being on extended leave from the EMS agency. This turned out to be a benefit, because it allowed the participants to speak more openly about the team dynamics and their struggles with communication. There were seven learning points identified through the debriefing, three of which were factors that contributed to the sentinel event.

*Table 9*

#### *Case Two Initial Debriefing Learning Points*

No.	Major Learnings Points	Contribution	Standard Debrief
1	Room extremely crowded	O	X
2	Wife maintained presence in the room	O	X
3	Crew member familiarization with each other	O	X
3	<b>Lack of paramedic response to EMS supervisor</b>	C	X
4	Position of the patient on the floor	C	X
5	<b>Aggressiveness of the EMS supervisor</b>	O	X
6	<b>Frustration of the crew members with each other</b>	C,O	X
7	Failed to preload the ET tube on the Vivid Trac	E,O	X
<b>Note: Bold print identifies contributing factors and regular print identifies additional learning opportunities</b>			
<b>C-Contributing E-Equipment O-Observation P-Protocol S-Sustaining T-Training</b>			

### *Crew One Simulation Experience*

After obtaining the agreement of the team to take part in the simulation experience, a room was set up in the EMS training area to replicate the room in which the event occurred. This included a 10' x 12' room with a bed along the back wall away from the door to the room. There was a reclining chair in the room as well as a nightstand table. The simulation started with the crew entering the bedroom; the crew consisted of seven people, including three paramedics, three emergency medical technicians, and a supervisor paramedic. The crew entered the room, and it was immediately evident through observation that the size of the obese provider was impacting the care being delivered. Although he was agile in getting onto the floor and assisting, his sheer body mass took up considerable area within the room and made other care being delivered, such as starting intravenous lines, difficult. The paramedic that attempted the airway management was the only one that attempted to control the patient's airway. When he struggled, he failed to ask for assistance, and the EMS supervisor did not request that they switch positions to allow someone else to attempt to complete the procedure. It was hard to re-create the impact of the team member that was frustrating to the crew; however, an assistant to the researcher played the role during the simulation so that it would be managed consistently through the three simulations. The EMS supervisor remained at the door and directed all patient care decisions from that position. The team proceeded through the scenario until they had removed the patient from the room.

### *Initial Crew Simulation Debriefing*

During the debriefing, the question was asked about the size of the room compared to the size of the providers. The obese paramedic stated, “I probably wasn’t the best one to be in here” (Personal communication P8, April 2, 2016). The EMS supervisor did not feel that he needed to be in the room; rather, he was able to observe the care being administered from the door and was out of the way. He stated “it was so tight that I was fine right where I was at. I could see everything” (personal communication, P6, April 2, 2016). As well, the EMS supervisor referenced the paramedic that they had struggles with during this case. He commented, “I sure know a lot more about (paramedic name) now and how he interacts with people” (personal communication, P6, April 2, 2016). This comment was in reference to the frustration that all participants spoke about regarding the lack of cooperation they felt this particular paramedic demonstrated during the patient care. When asked how they would handle that in the future, the supervisor commented, “I would push my way into the room and take better control” (personal communication, P6, April 2, 2016).

### *Crew One Simulation Summary*

The simulation session had to be stopped due to the participants explaining what they were doing at each step of the case instead of managing the case as if it were an actual event. The researcher re-explained the process of the simulation research, made sure there were no additional questions, and then re-started the scenario. From this point, there were no other issues in conducting the simulation. The crew members throughout

the debriefing continued to reference the frustration of the paramedic with which they had a bad experience. The video laryngoscopy equipment was improperly used by the crew and EMS supervisor in this simulation. Specifically, they failed to set the equipment up properly by preloading the endotracheal tube into the handle of the unit. Failure to preload the endotracheal tube was added as a contributing factor after the simulation session because it is very difficult to complete task correctly with the equipment set up incorrectly. While this was seen as a training issue in the initial debriefing session, the discussion during the simulation session demonstrated that it was impossible to pass the tube correctly without having it preloaded; therefore, it was added to the list of contributing factors. The debriefing also addressed the lack of oxygenation and the factors that contributed to the lack of continual ventilation. It appeared from the discussions that the frustration that the EMS supervisor was experiencing actually distracted his focus. There were eleven learning points that were identified from this simulation, and four were considered additional contributing factors to this event. Additional factors are listed as 8-11 and include:

1. The size of one of the paramedics. One paramedic is an obese male weighing over 300 lbs. The simulation session actually demonstrated that there was additional difficulty in managing the patient due to the size of the paramedic. His involvement in the small room made additional crew members' movement more difficult. This factor was discussed in debriefing when the paramedic stated, "I got down there to intubate him, but it was difficult, we probably should have

moved him” (personal communication, P8, April 2, 2016). This statement was in response to the conversation about attempting resuscitation in the bedroom and not moving the patient.

2. Failure to move the patient. There were too many people in the room for the size of the environment. This appeared to complicate the ability to adequately provide care. In addition, the spouse continuing to sit in the room and not be moved contributed to the difficulties. When asked, the only response was, “I just didn’t think about it” (personal communication, P6, April 2, 2016). None of the participants addressed the issue of the paramedic’s size and made him move out of the room to allow for additional room to manage the needs of this patient.
3. Crew resource management. There were different crews on this run that are not accustomed to working together. During the debriefing of the simulation experience, one participant stated that, “there is the expectation as an EMS supervisor that people are expected to perform at a certain level” (personal communication, P12, April 2, 2016). When asked to elaborate, he continued, “I don’t expect to have to always watch individual performance, I think that people should know what they are doing” (personal communication, P3, April 2, 2016). This reference was made related to the video equipment that had been improperly used during the simulation.

Table 10

*Case Two Simulation One Debriefing Learning Points*

No.	Major Learnings Points	Contribution	Standard Debrief	Simulation 1
1	Room extremely crowded	O	X	X
2	Wife maintained presence in the room	O	X	X
3	Crew member familiarization with each other	O	X	X
3	<b>Lack of paramedic response to EMS supervisor</b>	C	X	X
4	Position of the patient on the floor	C	X	X
5	<b>Aggressiveness of the EMS supervisor</b>	O	X	X
6	<b>Frustration of the crew members with each other</b>	C,O	X	X
7	Failed to preload the ET tube on the Vivid Trac	E,O	X	X
8	Fails to plug in the video equipment correctly	T,O		X
9	<b>Fails to preload ET tube on the Vivid Trac</b>	T,C,O		X
10	No stylet in the ET tube	T,O		X
11	<b>Obese male paramedic in room</b>	C,O		X
<b>Note: Bold print identifies contributing factors and regular print identifies additional learning opportunities</b>				
<b>C-Contributing E-Equipment O-Observation P-Protocol S-Sustaining T-Training</b>				

*Crew Two Simulation Experience*

A second crew was recruited to complete the same scenario. The crew configuration reflected the same quantity (seven) that were present in the room during the resuscitation, including a larger paramedic. This included one fire engine with four people, one being a paramedic; one ambulance with a crew of two paramedics; and one supervisor paramedic. The purpose of the research was described, and consent was obtained. The second simulation exercise was conducted with the same crew configuration (level of certification) as the original event. The simulation team was given the same equipment available during the sentinel event. In addition, a paramedic that was overweight played the role of the obese paramedic, and another paramedic was identified to be uncooperative. An observer was assigned to play the role of the spouse. The participants were instructed that as a crew, they were dispatched on a report of a cardiac



arrest at approximately midnight and that the medic vehicle is responding from another location and is not the medic assigned to your station. They will be five minutes behind you. When you arrive, you will be escorted to the second floor bedroom of a two story residence, where the wife who is played by our actor states she heard her husband fall out of bed. You are to work the patient care scenario presented as you would if it were an actual event. The crew was presented with the identical patient care scenario in the simulated bedroom. They went through the simulation and were debriefed after the event.

The simulation opened with the crew entering the room and completing an assessment of the patient. They moved the furniture in the room to gain better access to the patient. There were several observations made during this simulation that included:

- a) The participant that played the role of the uncooperative paramedic was moved out of the room after he struggled initially with the airway and then failed to use the video equipment correctly;
- b) The member in the role of the obese paramedic was given another job responsibility that contributed to the case by reducing the impact of his size in the room;
- c) The team communicated throughout the scenario, and the EMS supervisor took a position in the room at the head of the patient and maintained control of the situation throughout the case.

### *Crew Two Simulation Debriefing*

A debriefing session occurred immediately following the simulation in the room that the simulation session was conducted. The simulation team was briefed on the circumstances of the case and what made this a sentinel event case that was under investigation. During debriefing, these participants were briefed on how the case presented for the initial team, and what the thought processes of the initial team were as described from the previous debriefings. All parties involved agreed that the obese paramedic was a contributing factor and should have been moved to another area. They did not specifically have an issue with the EMS supervisor at the doorway but felt that the supervisor should have managed the uncooperative paramedic in a more aggressive manner, stating, “you have to control that better, and make sure that he does what you are telling him” (personal communication, P12, April 3, 2016). They also stated that when the airway became difficult, there should have been a switch in the personnel attempting the procedure. “That is what we are taught all the time, if I can’t get it, pass it off” (personal communication, P9, April 3, 2016).

### *Crew Two Simulation Summary*

There were positive observations noted about how this team managed this case as they completed it. Several observations noted during the simulation helped affirm the findings previously noted. This included the fact that this team removed both the obese paramedic and the uncooperative paramedic and reassigned them to other activities that still needed to be accomplished. Three additional learning points and two additional

contributing factors were identified that contributed to this event. They are listed as 12-21 (Table 11) and include:

1. Defined crew leadership. When the EMS supervisor arrived at the scenario, the question was immediately asked, “Who is in charge here?” This could also fall under crew resource management, but the fact that the leadership was identified and communicated to the team involved was evident. In addition, the EMS supervisor immediately addressed the uncooperative paramedic and controlled the circumstances as they developed.
2. Problem solving techniques. During the period when the airway difficulty was unfolding, the EMS supervisor used good communication techniques to work through and problem solve what was causing the inability to maintain the patient’s airway. Specifically, the supervisor talked out loud to the team in the room as a discussion starting with the comment, ‘OK, let’s go back to A’ which meant airway. “Can we bag him effectively? Does he have any medical history such as throat cancer, etc. that may cause this to be more difficult than normal?” (personal communication, P10, April 3, 2016). The supervisor spoke aloud, talking through the scenario using defined method to problem solve this situation.

Table 11

*Case Two Simulation Two Debriefing Learning Points*

No.	Major Learnings Points	Contribution	Standard Debrief	Simulation 1	Simulation 2
1	Room extremely crowded	O	X	X	X
2	Wife maintained presence in the room	O	X	X	X
3	Crew member familiarization with each other	O	X	X	X
3	<b>Lack of paramedic response to EMS supervisor</b>	C	X	X	X
4	Position of the patient on the floor	C	X	X	X
5	<b>Aggressiveness of the EMS supervisor</b>	O	X	X	X
6	<b>Frustration of the crew members with each other</b>	C,O	X	X	X
7	Failed to preload the ET tube on the Vivid Trac	E,O	X	X	X
8	Fails to plug in the video equipment correctly	T,O		X	X
9	<b>Fails to preload ET tube on the Vivid Trac</b>	T,C,O		X	X
10	No stylet in the ET tube	T,O		X	X
11	<b>Obese male paramedic in room</b>	C,O		X	X
12	Aggressiveness of the EMS supervisor	S			X
13	Frustration of the crew members with each other	S			X
14	<b>Obese paramedic removed</b>	C,S			X
15	<b>Arriving EMS supervisor specifically for I/C</b>	C,S			X
16	Assures the ET tube is preloaded	S			X
17	<b>Crew change when airway failure</b>	C			X
18	EMS supervisor aggressive in getting in room	S			X
19	Assesses for other airway issues such as cancer, etc.	T			X
20	EMS supervisor has an airway checklist and uses it	O			X
21	Moved patient out of confining environment	S			X
<b>Note: Bold print identifies contributing factors and regular print identifies additional learning opportunities</b>					
<b>C-Contributing E-Equipment O-Observation P-Protocol S-Sustaining T-Training</b>					

*Instructor Simulation Experience*

The instructors were recruited from within the EMS agency and briefed on the purpose of the project. Two of the instructors had participated in the previous simulation case, since the EMS agency employs only five instructors. The instructors were familiar with the purpose of the research and were given the same lead instructions that were given to the second team. The scenario began with the participants entering the room and completing the initial assessment of the situation. They immediately had an internal conversation about whether to move the patient or work him in the room they were in.

The decision was to start care and send someone to identify a better area. This was determined to be on the first floor of the house. For the purpose of the research, a larger room outside the simulation room was identified, and the patient was removed to that location. Care was continued, and the communication observed between crew members was better than the previous simulations. The participants kept a paramedic with the spouse and asked questions related to the difficult airway, such as any contributing factors such as cancer, etc.

When the EMS supervisor arrived at the scenario, he immediately asked, “who is in charge here and what do you have?” (personal communication, P16, April 3, 2016). The EMS supervisor moved himself to the head of the patient and produced an airway checklist to use. This was the only simulation during this case that the airway checklist was produced and used, and waveform capnography was included in the care. The EMS supervisor was also more aggressive in dealing with the problem paramedic by giving specific directions and tasks to be completed. The EMS supervisor moved into position and took over the video laryngoscopy equipment from the difficult paramedic when it was observed that he was uncomfortable with the procedure.

#### *Instructor Simulation Debriefing*

A debriefing session occurred immediately following the simulation. During debriefing, the participants discussed the size of the room and the participants’ decision to move the patient. When it was noted that the decision by the original crew was not to move the patient but rather to complete resuscitation in the small room, one participant

commented, “frequently it seems like the person on the scene with the strongest personality is the one others defer too” (personal communication, P15, April 3, 2016). This comment was found to be relevant, as it describes the personality of the obese paramedic as noted by the researcher throughout the case study. Another participant stated, “once you get started it’s hard to pick up and move, you might as well head to the truck” (personal communication P14, April 3, 2016).

The debriefing also discussed the decision to move the spouse and keep someone with her throughout the resuscitation. The participants thought that this was a simple solution to some of the issues with space in the room and provided an opportunity to obtain additional information from her as to what had happened to the patient and what medication, medical problems, etc. that the patient had. Six additional learning points were determined in the instructor simulation, including two contributing factors. They are listed as 22-27 (Table 12) and include:

1. The EMS instructor that was using the video laryngoscopy equipment set the unit up incorrectly and attempted to use the device without preloading the endotracheal tube. He also used the handle incorrectly. When debriefed, it was discovered that the instructor had been teaching these techniques incorrectly during continuing education to the paramedics. When asked, the instructor stated, “I guess I have been teaching that way. That was the way I was shown” (personal communication, P14, April 3, 2016). The fact that this instructor was teaching this procedure incorrectly has impact on the entire organization.

2. The EMS officer managed the difficult airway. The EMS officer pushed himself into the room when it became apparent the crew was struggling with completing the procedure. The supervisor used additional tools that were available, including:
  - a. Use of waveform capnography. This technology is used to confirm airway presence during intubation. Although this technology is required per the EMS agency medical protocol, it was observed that the crew in this case not only used this technology appropriately but appeared to have a better than average understanding in the interpretation of the information presented.
  - b. Lack of use of an intubation checklist. The CQI office of the Division of Fire has developed, trained on, and implemented an intubation checklist to reduce the impact of missed esophageal intubation, a catastrophic patient event. A copy of the checklist can be viewed in Appendix E. In this case, the supervisor pulled the checklist out of his pocket and used the checklist as part of his problem solving approach to manage this situation. Although the EMS supervisor in this scenario used the checklist correctly, it had not been used in the previous simulation sessions. The failure to use the checklist by the previous simulation teams was found to be an additional contributing factor at this point.

3. Communication. There was excellent crew communication and coordination observed during this simulation. This was evident throughout the simulation and was identified as a contributing factor after watching how the communication from this crew was observed to be much better than the other participants. There was continual discussion among the crew members. An example was the discussion with the EMS supervisor, who asked who was in charge, as well as the discussion about moving the patient out of the small room to a larger environment to have better access and provide additional care.



Table 12

## Case Two Simulation Three Debriefing Learning Points

No.	Major Learnings Points	Contribution	Standard Debrief	Simulation 1	Simulation 2	Simulation 3
1	Room extremely crowded	O	X	X	X	X
2	Wife maintained presence in the room	O	X	X	X	X
3	Crew member familiarization with each other	O	X	X	X	X
3	<b>Lack of paramedic response to EMS supervisor</b>	C	X	X	X	X
4	Position of the patient on the floor	C	X	X	X	X
5	<b>Aggressiveness of the EMS supervisor</b>	O	X	X	X	X
6	<b>Frustration of the crew members with each other</b>	C,O	X	X	X	X
7	Failed to preload the ET tube on the Vivid Trac	E,O	X	X	X	X
8	Fails to plug in the video equipment correctly	T,O		X	X	X
9	<b>Fails to preload ET tube on the Vivid Trac</b>	T,C,O		X	X	X
10	No stylet in the ET tube	T,O		X	X	X
11	<b>Obese male paramedic in room</b>	C,O		X	X	X
12	Aggressiveness of the EMS supervisor	S			X	X
13	Frustration of the crew members with each other	S			X	X
14	<b>Obese paramedic removed</b>	C,S			X	X
15	<b>Arriving EMS supervisor specifically for I/C</b>	C,S			X	X
16	Assures the ET tube is preloaded	S			X	X
17	<b>Crew change when airway failure</b>	C			X	X
18	EMS supervisor aggressive in getting in room	S			X	X
19	Assesses for other airway issues such as cancer, etc.	T			X	X
20	EMS supervisor has an airway checklist and uses it	O			X	X
21	Moved patient out of confining environment	S			X	X
22	Moved patient after initial resuscitation	S				X
23	Kept a crew member with spouse throughout care	O				X
24	One paramedic aggressive in lead roll	S				X
25	<b>Obese paramedic</b>	C,S				X
26	<b>Instructor uses video equipment incorrectly</b>	C				X
27	<b>Crew talks through the airway challenges as a team</b>	C				X
<b>Note: Bold print identifies contributing factors and regular print identifies additional learning opportunities</b>						
<b>C-Contributing E-Equipment O-Observation P-Protocol S-Sustaining T-Training</b>						

## Final Case Summary

A total of 27 points of learning occurred during this sentinel event review. The initial debrief identified three contributing factors. The simulation sessions identified an additional nine contributing factors for a total of eleven factors that contributed to this event, or a 75% increase over the initial debriefing. The instructor simulation experience demonstrated several of the same issues that were raised in the previous simulation sessions. However, it also identified an additional significant contributing factor, which is

also a learning opportunity, when it identified that the EMS instructor had been teaching use of the video laryngoscope incorrectly.

*Case Themes and Researcher Observations*

*Table 13*

*Case Two Themes and Researcher Observations*

Position of the patient on floor	Position of the patient on floor	<i>Changes crew for airway</i>	<i>Aggressive use of EtCO2</i>	
Aggressiveness of EMS supervisor	Aggressiveness of EMS supervisor	<i>EMS supervisor aggressive into room</i>	<i>Uses the video incorrectly</i>	
Frustration of crew members with on	Frustration of crew members with one m	<i>Assesses for other issues (throat CA) etc.</i>	<i>Talks through airway challenges with each other</i>	
Did not preload ET tube	<i>Fails to plug in the video equipment prop</i>	<i>Supervisor had an airway checklist</i>		
	<i>ET tube not preloaded</i>	<i>Moved patient to another position</i>		
	<i>No stylet into tube</i>			
	<i>Obese male paramedic</i>			
<b>Researcher observations</b>				
No crew approached case the same				
To many people in the room				
Environment of resuscitation adds to complexity				
Instructors do not recall receiving training on the video equipment				
First time crew used the checklist for airway				
When the crew identified the leader things went better				
Instructor used the video equipment incorrectly so what are they teaching				
Variety in the position people were in to complete airway attempts				
14 additional contributing factors identified				

Again in this case, there was a lack in standardization in the approach to the patient care scenario. Protocol violations were also noted that were addressed through continuous quality improvement but were not considered contributing factors to the sentinel event (Table 14). These included the lack of continued ventilation, the lack of use of the intubation checklist, as well as a medication error. Although the use of Sodium Bicarbonate is warranted in these types of patients, it should not be administered without a defined airway.

*Table 14**Case Two Protocol Violations*

Protocol Violation	Impact
Lack of continued ventilation	Inability to provide adequate oxygenation
Medication error – Sodium Bicarbonate	Given without airway established increases acidosis
Lack of use of intubation checklist	Lack of standardized airway confirmation

There was a difference in the management, communication, and aggressiveness of the care provided to the patient by each crew during the simulation scenarios. This included the observations that none of the simulations were managed in the same manner. One crew moved the patient into a bigger area, whereas the other crews managed the case in the environment that they were presented. Only one crew removed the patient's spouse from the room. In addition, the EMS supervisor in these simulation sessions managed the uncooperative paramedic and the obese paramedic in a more aggressive manner than the original EMS supervisor. This approach seemed to reduce unnecessary confusion throughout the simulations. Although the obese paramedic is a skilled experienced provider within the EMS agency, his involvement in this case appeared to hamper the care administered in such a small area where the resuscitation took place. Most notably in this case scenario was the instructor using the video equipment incorrectly and admitting that he had been teaching it that way.

### Case Number Three

This case involves a patient that could not be intubated and could not be ventilated. This failed airway involved a twenty-eight-year-old obese male (>350 lbs.) that was in a public fitness facility during a basketball game. This is a sentinel event because of the inability of the crew to adequately provide oxygen to the patient by any means that they attempted. This cardiac event was witnessed by others playing basketball. Cardio-pulmonary resuscitation (CPR) was initiated by by-standers prior to arrival of the paramedics. Upon arrival of the EMS crew, advanced life support was initiated. The paramedics were unable to place an endotracheal tube into the patient's trachea. The crew then attempted a rescue airway device that is placed without having to visualize the patient's anatomy, but it was indicated on the EMS report that they removed it because they were not able to confirm its placement. They did not attempt a crisis airway technique called cricothyrotomy that is in the protocol. A cricothyrotomy is considered an airway of last resort and involves a surgical penetration into the membrane cartilage of the neck to place a tube into the trachea for the purpose of providing oxygenation. The crew appears to have relied on bag valve ventilation during the resuscitation attempt, and according to the EMS report, this was difficult to maintain due to the size of the patient and having to move the patient for transport. The patient ultimately expired in the emergency department.

Quality assurance review indicated that the patient was intubated in the emergency department by the attending physician. It was initially suspected that the crew

had incorrectly used waveform capnography to confirm placement of the endotracheal tube according to the feedback from the emergency department. The patient arrived in the emergency room with a cannula in his nose that is traditionally used on a patient that is breathing. The physician comments stated that the likely reason the crew could not confirm placement with the rescue airway was that they had used the wrong type of tubing during their attempts to confirm placement.

#### *EMS Crew Traditional Debriefing*

A CQI meeting was set up with the crew involved in this case to include the CQI coordinator, crew members involved, deputy medical director, and the researcher. The meeting was conducted six days after the event and opened with the CQI coordinator reviewing the specifics of the case and describing the purpose of the debriefing. The two paramedics were presented with an obese male estimated at over 350 lbs. that had no pulse or respiration. Upon applying the heart monitor, they found the patient in an irregular unstable heart rhythm for which standard EMS system protocols advise to commence cardiac compressions and defibrillation, which is a procedure used to provide an electrical current to the heart muscle in an attempt to correct the unorganized heart rhythm. After completing this therapy, the attention turned to providing an airway for this patient. The crew spoke about the adipose (fat) tissue that the patient had around the neck and head area. During the debriefing, the crew denied using an assessment tool to anticipate a difficult airway because they felt the obvious appearance of the patient made this tool unnecessary. The crew ventilated the patient with a bag valve mask to provide

initial oxygenation to the patient. The initial attempt to control the airway with intubation was unsuccessful. The crew members asked for help to elevate the patient's shoulders with a blanket for a second attempt. They then pulled upward on the patient's arms to elevate the head and shoulders further in an attempt to promote better visualization of the patient's airway anatomy. After three failed attempts, they continued to bag valve ventilate this patient to maintain oxygenation saturation. The crew proceeded to the medic transport vehicle with the patient, where they were met by the EMS supervisor who had additional equipment for difficult airways, including video laryngoscopy equipment. The EMS supervisor failed to ride with the crew to the hospital; rather, he passed the airway equipment into the medic and then followed the crew to the emergency department. The crew stated in the debriefing that they were uncomfortable with the video intubation. One participant stated, "I have never used this and as a matter of fact this is the first time I have seen it" (personal communication, P11, May 3, 2016). The crew made two failed attempts with the video equipment and then attempted to use a rescue airway device to secure an airway. The crew described the difficulty in placing the rescue airway device. Despite using the largest size available, they described, "I couldn't get it to fit properly" (personal communication, P11, May 3, 2016), and they were unable to assure its proper placement with waveform capnography. The paramedic stated that "I decided to pull the device and continue to ventilate the patient with a simple bag valve technique" (personal communication, P13, May 3, 2016). The EMS supervisor was asked about why he did not ride to the hospital with the medic

crew. He stated that “they were all ready to go, and I didn’t want to hold them up” (personal communication, P13, May 3, 2016).

The additional issue of quality assurance that came from the receiving hospital was that the patient arrived with an inappropriate use of a nasal cannula for assuring ventilation, known as an end-tidal carbon dioxide (EtCO<sub>2</sub>) cannula. This QA concern was presented and discussed in the traditional debriefing. It was determined that the cannula is the type that allows for oxygen to be administered, and the crew placed this on the patient to allow for passive oxygenation of the patient during the airway attempts. There is considerable literature to support this technique, and after discussion it appeared to be a good use of this technology and was removed as a contributing factor or a quality assurance concern.

#### *Summary of Traditional Debriefing*

It was determined through debriefing that the follow two learning points contributed to the difficulties with this case (Table 15):

1. The lack of supervision. Per policy, the EMS supervisor has ultimate scene responsibility for patient care. The supervisor on this specific incident was not the regularly assigned supervisor. The supervisor chose to follow the crew to the hospital instead of riding in the ambulance and directing patient care activities, including airway management. When asked, the supervisor stated, “When I arrived, they told me they needed the video laryngoscope. They were ready to leave the scene and I didn’t

want to hold them up” (personal communication, P13, May 3, 2016). The failure of the supervisor to assure that the crew had used this equipment before and provide direct oversight of the patient care scenario was determined to be a contributing factor.

2. Lack of crew continuity. The fact that the EMS supervisor was not the regularly assigned supervisor for that crew was discussed as a contributing factor. The supervisor did not routinely work with these crew members, and there was hesitation in his decision to be aggressive by inserting himself into the patient care. The leadership and medical direction of the division of fire expects this of the EMS supervisors, and it is outlined in their job responsibilities that they are to direct operations at medical emergency scenes and assure that division protocols are followed.

*Table 15*

*Case Three Initial Debriefing Learning Points*

No.	Major Learnings Points	Contribution	Standard Debrief
1	Lack of EMS supervisor direction	C	X
2	Lack of crew continuity	C, O	X

*Crew One Simulation Experience*

The crew members involved agreed to be included in the research project, signed consents, and were placed into a simulated setting based on the criteria of the case as described in the EMS medical record and the debriefing. The case was run over the same time parameters as outlined in the EMS report. The simulation scenario focused on the



airway management of the patient, because that was specific to the sentinel event. During the simulation session, the paramedics involved attempted to sit the patient up to allow gravity to assist in the reducing the adipose (fat) tissue around the patient's head and neck. After they were unable to secure the airway, they attempted to move the patient to the vehicle, where the EMS supervisor gave them the video laryngoscopy unit. As CPR continued, both paramedics again attempted to intubate the patient but were observed to be using the equipment incorrectly. After the unsuccessful attempt with the video equipment, they discussed the use of a rescue airway device. The device was placed into the patient's mouth, and the cuff that allows air to flow into the lungs was inflated. The crew began ventilating the patient through this device and immediately were able to hear air escaping around the cuff. They tried to reset the airway and re-inflate the cuff. They continued to have problems with this airway and never did get a proper position. They then abandoned the attempts and continued to bag valve ventilate the patient until arrival in the emergency department. It was observed that the size of the patient made the management of this case more difficult.

#### *Crew One Simulation Debriefing*

After completion of the simulation session, a semi-structured debriefing immediately occurred. Since this case was slightly different than the previous cases, the debriefing initially asked the question whether they felt that the simulation accurately reflected the events as they occurred. One participant commented that "It did, I actually got a lot out of it. I was able to slow the events down in my mind a little" (personal communication,

P9, May 3, 2016). Each participant was asked to comment on additional factors that they felt were identified in addition to the original debrief. The crew members agreed that the case was frustrating to them, but they felt like they had given this situation their best attempts to provide good patient care. During the discussion about the difficulty with the rescue airway, it appeared as though they had attempted to use the rescue airway device correctly. Additional discussion occurred about what other options existed to get the patient's airway managed. All participants agreed that they did not feel comfortable with a surgical airway due to the patient's size and did not believe that it was an option due to the body mass of this patient.

During the debriefing, a discussion ensued about the rescue airway device that was used unsuccessfully to ventilate the patient. The paramedic that was involved was asked to demonstrate the technique that he used to place the device and confirm placement of the device. The procedure was completed on an airway mannequin successfully; however, it was observed that the paramedic did not demonstrate confidence in completing the procedure without the help of others on the team. The EMS supervisor explained that after seeing the scenario unfold in this simulation, he should have climbed in the back of the vehicle and assisted during transport to the hospital. He stated, "I really don't know these guys well, and they already had him loaded, they asked me for the Vivid-Trac and I just gave it to them" (personal communication P13, May 3, 2016).

### *Crew One Simulation Summary*

There were two additional learning opportunities and each contributed to the sentinel event. They are listed as three to four (Table 16) and include:

1. Lack of knowledge. Cognition is defined as the mental action or process of acquiring the knowledge and understanding through thought, experiences, and senses (Cognition, 2016). Both paramedics used the video equipment incorrectly. Although the paramedics were aware of the Vivid-Trac that the EMS supervisor carried, they were not trained on the use of the equipment; however, they both attempted to use it. During the traditional debriefing, it was determined that they were not using the equipment properly, nor had they been trained properly to use the equipment. Although the paramedic that was using the rescue airway did not complete the procedure improperly, he did demonstrate a lack of confidence during the procedure.
2. The second contributing factor was the lack of engagement and direction of the EMS supervisor that stayed out of the vehicle and passed the equipment into the ambulance. Although this was discussed in the initial debriefing, it was evident in the simulation that this was a contributing factor to the lack of securing an advanced airway in this situation. This is listed as two different findings due to the fact that the EMS supervisor has overall scene responsibility and was not present to provide oversight and direction during the patient care activities. Secondly, although all paramedics in the EMS agency are able to provide the

advanced airway technique defined within this case without direct oversight of the EMS supervisor, the EMS supervisor failed to assure that the video equipment was being used correctly.

*Table 16*

*Case Three Simulation One Debriefing Learning Points*

No.	Major Learnings Points	Contribution	Standard Debrief	Simulation 1
1	Lack of EMS supervisor direction	C	X	X
2	Lack of crew continuity	C, O	X	X
3	Lack of knowledge on using Vivid Trac	T,C		X
4	Lack of oversight from EMS supervisor in managing airway	C		X

*Crew Two Simulation Experience*

A second team of paramedics was recruited to take part in the second simulation. The second simulation exercise was conducted with the same crew configuration as the original event. They were briefed on the specifics of the research and signed consents to participate. The paramedics involved were given the specifics of the case that included the need to manage the airway of an obese male patient that was found unresponsive and not breathing at a fitness facility in the middle of the basketball court. The equipment used in this simulation was identical to the equipment available during the initial case. There was minimal need to set up a room, as the events of this case unfolded on the floor of a large basketball court. The paramedics approached the patient during the initial stages of the simulation and set up their equipment similar to the methods used by the initial team. After verifying cardiac arrest, they placed the patient on the heart monitor and began administration of advanced life support treatment. The participant at the head

initially began bag valve ventilation and asked for assistance with assuring proper ventilation. A member of the team attempted to place the airway in the patient and was told that that he was unable to see the airway structures to complete the procedure. The paramedic stopped the procedure, provided additional oxygenation, and then re-attempted the procedure. After being instructed of the second failed attempt, he asked for help from the other two paramedics present. They attempted to elevate the head of the patient by placing a pillow under the head and neck. When the participants were told that this attempt was also unsuccessful, they attempted a rescue airway. During the securing of the rescue airway, the participants were told that the airway could not be confirmed. Therefore, they removed it and then used the bag valve mask to continue ventilations and began moving to the ambulance for transport.

At this point in the scenario, the EMS supervisor arrived at the back of the ambulance, he climbed in the vehicle and asked that someone else drive his vehicle to the hospital. The EMS supervisor was observed to coordinate the care in the back of the ambulance during the simulated ride to the hospital. The patient continued to receive cardiac compressions, and his airway was managed with the video equipment by the EMS supervisor.

#### *Crew Two Simulation Debriefing*

During the semi-structured debriefing, the participants were told the circumstances of the case. They discussed the difficulties that an obese patient presents as well as having an audience watching their attempts to control the situation. This was

noted in one comment that stated, “and as it that isn’t enough, you have all his friends watching” (personal communication, P10, April 3, 2016). There was consensus among the participants that the video technology should be made available to all paramedics and that waiting for an EMS supervisor presented problems. There was also considerable discussion about why the rescue airway was not working properly. The patient’s size or incorrect techniques of the paramedic trying to complete the procedure were the only factors that this team could identify.

#### *Crew Two Simulation Summary*

Evidence indicated that there was a lack of standardization in the approach to patient care, as demonstrated by the approach to the airway management. The participants were observed to be managing the patient’s airway in a different manner than the previous crew. In addition, the lack of supervision by the EMS supervisor was not recreated in simulation. The supervisor in this simulation was engaged and directed the management of the case. He was observed to climb in to the back of the EMS vehicle and ride to the hospital with the patient. In this case, the EMS supervisor stayed with the patient and the medical crew after arriving on the scene. There were two additional learning points found in this simulation and one additional contributing factor that are listed as five and six (Table 17). This included a lack of standardization in the approach to the patient care compared across the two simulation sessions. The approach to patient care, the timeliness of medication administration, and completion of procedure varied among the two crews despite medical protocols that speak to the flow of the tasks.

Table 17

*Case Three Simulation Two Debriefing Learning Points*

No.	Major Learnings Points	Contribution	Standard Debrief	Simulation 1	Simulation 2
1	<b>Lack of supervision in managing the airway</b>	C	X	X	X
2	<b>Lack of crew continuity</b>	C, O	X	X	X
3	<b>Lack of knowledge on using Vivid Trac</b>	T,C		X	X
4	<b>Lack of oversight from EMS supervisor</b>	C		X	X
5	<b>Lack of standardized work from crews</b>	C,O,S			X
6	Oversight noted by EMS supervisor	S,O,S			X
<b>Note: Bold print identifies contributing factors and regular print identifies additional learning opportunities</b>					
<b>C-Contributing E-Equipment O-Observation P-Protocol S-Sustaining T-Training</b>					

*Instructor Simulation Experience*

The instructors were recruited and briefed on the purpose of the project. They were given the same instructions that were given to the second team. Two of the instructors had participated in the previous simulation cases and were familiar with the purpose of the research. The case started with the instructors completing an initial assessment of the situation and beginning bag valve ventilation. Good communication and thought processes were observed throughout the scenario as evidenced by the instructors questioning the cause of the cardiac arrest and whether other factors such as asthma were involved. This was evident when the supervisor asked, “Does he have asthma or a cancer that may make his airway more difficult?” (personal communication, P16, April 3, 2016). In addition, another paramedic involved asked, “do you need help with that, or want me to take a look?” (personal communication, P16, April 3, 2016). This was in reference to the difficulty in securing the patient’s airway. The instructors used a similar technique to raise the patient’s arms and pull them upwards and then pad under the patient’s shoulders in an attempt to gain better access to the airway. After this

attempt failed, they moved the patient to the transport cot and tried to slide the head further off the cot in an attempt to gain additional room for access to the airway. When they decided to use a rescue airway device, they appropriately used the largest available device. When they were told that the airway would not ventilate correctly, they attempted to reposition the tube and tried again. After this failed attempt, they made the decision to pull the airway and continue with bag valve ventilation and continue care and transport to the emergency department. When the EMS supervisor was brought into the case scenario, they crew asked for the Vivid-Trac. The instructors used the video laryngoscope equipment correctly during this session. The EMS supervisor in this simulation also climbed into the vehicle and rode with the crew members to the hospital. The patient care that the instructors provided was observed to be exceptional considering the circumstances of the case, as evidenced by strong communication and no protocol violations during the simulation session.

#### *Instructor Simulation Debriefing*

During debriefing, the participating instructors were briefed on what had occurred with the initial crew and the quality assurance feedback from the emergency department. They asked whether there was additional information on the cause of the cardiac arrest, which was unavailable. They were asked about how they approached the airway as a team. They stated that they frequently discussed this type of scenario during training. One instructor stated, “I am not sure what else we could have done, why didn’t the King LT work?” (personal communication, P14, May 15, 2016). There was continued



discussion on the failed airway and what other options existed. Finally, one of the observers made the comment that elevating the head of the cot might allow gravity to assist in the attempt. Using the cot to sit the head up placed the patient in a semi-sitting (fowlers) position, which allows gravity to pull the adipose tissue down. Afterward one instructor commented “I was embarrassed. I was looking at advanced procedures and then oh ya, we should sit him up. It was humbling” (personal communication, P15, May 15, 2016). There was general agreement that this option could have assisted in the scenario. Their simulation experience demonstrated several of the same issues that were raised in the two previous simulations; however, they also identified an additional one contributing factor to the sentinel event that turned out to be a significant discovery. This included:

1. Lack of structured approach to airway management. The EMS instructors took a more standard approach to the difficult airway than both of the crew simulations. This included working through an algorithm that is available for anticipation of a difficult airway that is included in the medical protocol of the EMS agency. The instructors were observed to have very good communication and discussion as they approach the management of the patient. Discussions that they had during the simulation demonstrated that they had an advanced skill set and knowledge base on what could be additional contributing factors to the underlying cause of this event. They included:

- a. Discussion with the researcher regarding other potential causes of this cardiac arrest, such as asthma.
- b. Discussion about trying a retrograde airway technique where a needle is passed into the patient's trachea and a guidewire is inserted to seek proper placement.
- c. Moving the head of the patient off the end of the cot to attempt a different position to facilitate success.
- d. Repositioning of the rescue airway device and checking again for compliance prior to pulling the rescue airway.
- e. Using diagnostic waveform capnography with the ventilation devices to assess compliance and adequacy of the attempts as described in case number one.

*Table 18*

*Case Three Simulation Three Debriefing Learning Points*

No.	Major Learnings Points	Contribution	Standard Debrief	Simulation 1	Simulation 2	Simulation 3
1	<b>Lack of supervision in managing the airway</b>	C	X	X	X	X
2	<b>Lack of crew continuity</b>	C, O	X	X	X	X
3	<b>Lack of knowledge on using Vivid Trac</b>	T, C		X	X	X
4	<b>Lack of oversight from EMS supervisor</b>	C		X	X	X
5	<b>Lack of standardized work from crews</b>	C, O, S			X	X
6	Oversight noted by EMS supervisor	S, O, S			X	X
7	Lack of standard work noted	S				X
8	<b>There was aggressive focused leadership</b>	C				X
9	Strong communication	S				X
<b>Note: Bold print identifies contributing factors and regular print identifies additional learning opportunities</b>						
<b>C-Contributing E-Equipment O-Observation P-Protocol S-Sustaining T-Training</b>						

### *Final Case Summary*

There were three additional learning points and one additional contributing factor compared to the initial findings through traditional debriefing. Nine points of learning were identified during this sentinel event investigation. The initial debrief identified only two contributing factors. The simulation sessions identified an additional four contributing factors for a total of six factors that contributed to this event, or a 67% increase over the initial debriefing. Several of the learning points helped sustain the earlier contributing factors since they were repeated from earlier simulation sessions. The ability to reproduce the findings throughout the simulation experiences provides additional contributing evidence.

### *Case Themes and Researcher Observations*

*Table 19*

#### *Case Three Themes and Researcher Observations*

<b>Case Number 3</b>			
<b>Traditional Debriefing</b>	<b>First Crew Simulation</b>	<b>Second Crew Simulation</b>	<b>Instructor Simulation</b>
<b>Lack of cognition</b>	Lack of knowledge of Vivid Trac	<b>Lack of standardized work</b>	<b>Lack of standardized work</b>
<b>Lack of crew continuity</b>	<b>Lack of supervision from EMS Sup</b>		<b>Focused leadership</b>
<b>Researcher Observations</b>			
<b>EMS supervisor not engaged</b>			
<b>Lack of standard work</b>			
<b>Failure to use equipment correctly</b>			
<b>Lack of communication</b>			

It appeared through the discussion and observations of the simulations that the circumstances of this case presented challenges related to the patient's weight. Some of

the participants argued that it may not even rise to the level of a sentinel event, with one stating, “I am not sure what we could have done differently with what we were presented, we tried everything” (personal communication, P9, May 3, 2016). This was reaffirmed by one of the instructors that stated, “I am not sure you always need high fidelity” (personal communication, P14, May 18, 2016). However, the purpose of this research project is to determine if simulation can provide additional contributing factors to the case that were not found in traditional debriefing methods. In this specific case, the only area of assessment was the airway management. There were four additional contributing factors identified beyond the two identified in the traditional debriefing. There was no simulation session completed where the crew either discussed or attempted a surgical airway procedure during the simulation. Although this is within the scope of the protocol for a paramedic in the EMS agency, it was apparent that the crews were uncomfortable with the idea of trying this procedure in this case. During the debriefing periods, this was asked of each crew, and every one of the crews stated that they did not even consider it because of the size of the patient and the presumed difficulty in completing this task. It was not added as a protocol violation or contributing factor due to the size of this patient and the fact that this was not a feasible alternative in the prehospital care of this patient.

Observations of the researcher include the fact that the EMS supervisor did not appear to be engaged with the crew that was involved in the original case. During the debriefing, he stated, “I really didn’t know these guys that well” (personal communication, P13, May 18, 2016). Lack of engagement of the EMS supervisor could

place the patient at a disadvantage for quality patient care. There also was a lack of standard processes and work observed throughout each of the simulation sessions, as evidenced by each crew communicating in different ways during the simulations. One crew was observed to communicate extensively with each other, whereas the other two simulations exhibited less discussion among crew members. When questioned about this observation during debriefing, one member commented, “I knew there was no way we were going to get that guy intubated” (personal communication, P10, May 18, 2016). The obese patient provides a challenge for the paramedic to obtain and maintain an airway. The lack of a standard approach to patient care and communication as noted within the simulations appeared to complicate the success of this scenario.

### **Common Themes**

The nine simulations and twelve debriefing sessions completed during this study indicated that the use of medical simulation in sentinel events provided additional contributing factors that were not originally identified by traditional debriefing methods. In addition, four specific common themes were identified across the three simulation experiences, and 10 subthemes were identified. The four themes are (Table 20): 1) The impact of gaps in individual knowledge and preparedness to manage high risk patient encounters, 2) The impact of team dynamics and decision making during high risk patient care scenarios, 3) The impact of crew resource management (CRM) in organizational communication during high risk patient care events, and 4) The impact of debriefing on closure and understanding of contributing factors in sentinel events.

Table 20

*Themes and the Explanation for the Corresponding Theme*

Theme	Explanation
1. The impact of gaps in individual knowledge and preparedness to manage high risk patient encounters	Pertains to the individual and overall team knowledge during delivery of patient care to the critically ill and injured.
2. The impact of team dynamics and decision making during high risk patient care scenarios	Pertains to how the lack of strong communication and team interactions increase variability in patient care decision making that places patients at an increased risk of error.
3. The impact of crew resource management (CRM) in organizational communication during high risk patient care events	Pertains to how poor communication and lack of standard care impacts the comfort levels of the team and increases risk of error that leads to sentinel events.
4. The impact of debriefing on closure and understanding of contributing factors in sentinel events.	Pertains to how debriefing can provide a deeper understanding of the cognitive and thought processes of participants involved in sentinel event cases

**Theme 1.** The impact of gaps in individual knowledge and preparedness to manage high risk patient encounters.

The results identified gaps in knowledge of individual learning and preparedness as a contributing factor to the sentinel events. More specifically, 1a) issues with knowledge of the paramedics involved in the case, 1b) the failure of EMS crews to collectively recognize and problem solve an unfolding sentinel event, and 1c) the failure to assure that the equipment needed to manage the patient care was present and being used properly.

**Subtheme 1A.** Issues with knowledge or cognition of the paramedics involved in the case. In each of the sentinel event cases examined through this research, the knowledge

of either a member of the crew or the collective knowledge of the crew involved was defined as a contributing factor in the case. In some situations, such as with the video laryngoscopy equipment, the crew had defined knowledge gaps in how to use the equipment properly. This provides an opportunity to promote additional training and education to the paramedics and instructors during continuing education.

**Subtheme 1B.** The failure of individual crew members to collectively recognize and problem solve an unfolding sentinel event in a standard method. In the sentinel event cases examined, either a crew member or a set of crew members failed to identify and address an issue that may have prevented the sentinel event. As an example, the arrival in the emergency department with a misplaced endotracheal tube could have been avoided if the crew had understood and adhered to proper problem solving techniques. The failure to address this issue was identified as a contributing factor in this sentinel event case.

**Subtheme 1C.** The failure to assure that the equipment needed to manage the patient care was present and used properly. In each of the sentinel event cases, equipment that had recently been introduced to the organization was being used improperly or was not completely understood by the end user. Whether this is an issue with cognition of the paramedics involved in the case or a lack of proper initial training and roll out is uncertain. Several comments from those involved in the cases stated that this was the first time they had used the video laryngoscope device, as evidenced by the statement “I

have never used this and as a matter of fact this is the first time I have seen it” (personal communication, P11, May 3, 2016).

**Theme 2.** The impact of team dynamics during high risk patient care scenarios.

Theme 2 encapsulates the individual contribution to the team. Team dynamics include decision making, roles of each team member, and the impact of each team member and their performance within the group setting. Even though the EMS agency has a protocol-based system for providing medical care, there was a lack of standard approach to delivering that care. More specific was (2A) A lack of the use of the checklist for assuring proper airway placement, (2B) A range of aggressiveness in the delivery of care, and (2C) Lack of leadership direction and oversight from the EMS supervisors.

**Subtheme 2A.** A lack of the use of the checklist for assuring proper airway placement. Checklists have been shown to reduce the variation in a process that can lead to failure or complications in patient care (Joint Commission, 2011). The organization has developed a checklist for airway management. All nine of the simulation scenarios involved advanced airway management. The crews only used and followed the intubation checklist in one of nine simulations (11%). In one case, the checklist was not even available in the airway kit of the medic crew. When questioned about its whereabouts, none of the participants could recall.

**Subtheme 2B.** A range of aggressiveness in the delivery of care. The teams of paramedics, and more specifically each crew member within that team, had a different



level of comfort in what was occurring as the simulation events unfolded. There was not a standard approach in the care that was delivered. Some procedures were accomplished earlier in the patient care delivery by one simulation crew and considerably later in patient care by the other crews. Although considerable discussion occurred between members of the crew during the simulations, there was not a standard method that I could observe regarding how the crews approached the patient care scenario. This lack of standardization potentially created gaps in the patient's care that contributed additional factors to the sentinel event.

**Subtheme 2C.** Lack of leadership direction and oversight from the EMS supervisors. Throughout each simulation session, it became apparent that the EMS supervisors are not consistently providing direction and oversight of the care for which they are responsible. The lack of direction and leadership is different than crew resource management. Although they go hand in hand, direction and leadership is the immediate oversight provided to the crew during the resuscitation, whereas CRM is how the crew problem solves and interacts with each other (Lindquist, 2009). The EMS agency places the EMS supervisor in an oversight capacity to assure that the patient care is coordinated and meets the standard that the agency expects. It was apparent through the researcher's observations of the simulated sessions that there are considerable differences in the engagement of the EMS supervisors. This was observed through the level of each supervisor's participation in the patient care events. The frustration was apparent when

the statement was made during a debriefing, “we expect you as an EMS supervisor to take the lead in these situations” (personal communication, P12, May 3, 2016).

**Theme 3.** The impact of poor crew resource management in organizational communication during high risk patient care events.

Although it can be argued that Themes 2 and 3 are similar, Theme 3 relates to how a combination of individual performances within the team intersects the outcome of the event. The impact of crew resource management has been identified as a contributing factor to poor outcomes involving medicine, airlines, and military. (McConaughey, 2008). Simulation has had a successful role in the assessment, training, and enhancement of CRM (Shapiro, 2004). In these sentinel event cases, a lack of communication and CRM was determined to be a contributing factor in the cases. Specifically, in each of the cases, it was interesting to note that the EMS instructors’ communications and interactions with each other were more deliberate throughout the simulation. Their enhanced communication appeared to result in a better approach to the management of the patients that they encountered, even when the scenario was not turning out the way they envisioned. There were two subthemes that emerged including (3A) Lack of crew continuity, and (3B) Failure of leadership from the EMS supervisor.

**Subtheme 3A.** Lack of crew continuity. Staffing complexities of the EMS agency contributed to poor CRM. Due to the paramedic staffing demands of the EMS agency, it is a common practice to move paramedics around the city to cover open shifts. Although the policies and procedures are the same, the lack of crew continuity was determined to

be a theme throughout the course of the research. Through observation and reflection during debriefing, the lack of crew continuity appeared to contribute to a variation in the aggressiveness of patient care. In the second case as an example, the EMS supervisor and crew admitted frustration with the paramedic that was from another shift. They had never worked with him before and demonstrated their frustration during the debriefings. In the additional simulations, a paramedic commented, "I have been a paramedic a long time, but I haven't worked with these guys before" (personal communication, P4, May 3, 2016). The lack of crew continuity has been demonstrated to be a contributing factor to sentinel events in healthcare and was identified as a contributing factor in 11% of the 2572 sentinel event cases (Joint Commission, 2014).

**Subtheme 3B.** Failure of leadership from the EMS supervisor. The EMS supervisor continuously failed to assure that proper crew resource management occurred as the emergency developed by providing direction during the events. Within the EMS agency, the EMS supervisor is considered the quarterback and is responsible for assuring that the emergency is being handled in a proper manner that follows the established policies and protocols. Each sentinel event involved different crew members. The simulation sessions provided an opportunity to assess the involvement of the EMS supervisor as leader. The failure of the EMS supervisor was consistent over the three sentinel event scenarios. These failures include the lack of direct oversight of the events unfolding during the patient care. The expectation is that the supervisor will be present and at minimum oversee if not actively engage in providing direction regarding patient care. In

each of the scenarios, the EMS supervisor distanced himself from the events as the situation developed and left the paramedics to make decisions they were not prepared to make and use equipment they were not prepared to use.

**Theme 4.** The impact of debriefing on closure and understanding of contributing factors in sentinel events.

Debriefing has been found to reinforce experiential learning in adults (Dreifuerst, 2012). Although there were generally positive experiences with the debriefing after the simulation sessions, it became apparent that the EMS agency needs additional education on the purpose and process of debriefing to promote added value to learning.

Specifically, two subthemes from this study related to debriefing include: (4A) crews need to better understand the purpose and intent of debriefing and how it contributes to learning, and (4B) learning leaders need to be developed who understand how to successfully lead debriefing simulation scenarios.

**Subtheme 4A.** The understanding of the purpose and intent of debriefing and how it contributes to learning. It was apparent that the members taking part in the research enjoyed the semi-structured debriefing that occurred after the simulation scenarios. They appeared eager to begin discussing these simulation sessions. As an example, most debriefings occurred immediately following the simulation session in the location that the simulation had just occurred. This was found to work well, because the participants used the simulated setting to demonstrate some of their points in the debriefing. They spoke about what they had observed, asked questions, debated among themselves, and gave

their insight on the situation that had occurred. However, when asked about debriefing, most of the participants did not realize that a semi-structured format was an accepted form of learning.

**Subtheme 4B.** Learning leaders that are educated on how to lead debriefing simulation scenarios. Although the researcher had some education on conducting debriefings, there was a difference in how this debriefing was conducted. The debriefings occurred immediately following the simulation session. They were conducted in the location in which the simulation had occurred. As an example, the first case scenario debriefings occurred in the ambulance in which the simulation took place. This contributed additional information to the case, because the crews were able to discuss changes and then immediately make the change and see the impact of the change. In an attempt to limit the potential for researcher bias, the simulation teams were not briefed on the specifics of the sentinel event case until after their simulation session was completed.

### **Conclusion**

Three sentinel event cases were studied during this research over a three-month period. Sixteen paramedics participated in the research. Ten contributing factors and an average of 3.33 (2–5) contributing factors were found in each sentinel event through traditional debriefing. Three simulations were conducted and debriefed for each sentinel event case for a total of nine simulations. Nineteen additional contributing factors were identified through simulation with an average of 6.3 (4–7) additional contributing factors.

Simulation provided a 65.5% increase in causal factors of sentinel events compared to traditional debriefing. In addition, there were an additional fifty-eight points of learning that were identified through the simulations and debriefings.

*Table 21*

*Additional Contributing Factors per Case*

<b>Case</b>	<b>Initial Debrief</b>	<b>First Simulation</b>	<b>Second Simulation</b>	<b>Instructor Simulation</b>	<b>Total Additional</b>	<b>Total Overall</b>
One	5	3	2	2	7	12
Two	3	2	3	3	8	11
Three	2	2	1	1	4	6
Total	10	9	5	6	19	29

## Chapter 5

### **Discussion**

In this chapter, I summarize the major findings of this research, analyze these findings in depth, and provide implications for practice. I also discuss potential future research opportunities and present my concluding thoughts. Think for a moment about the next statement. Injury from adverse events during patient care is now the third leading cause of death in the United States (Makary, 2016). Consumers are far less likely to be injured or killed traveling the globe by aircraft than seeking medical care from providers that have a duty to protect them. There have been multiple attempts to reduce the risk of unintentional errors to patients.

This observational qualitative research study was conducted in a large urban single tiered advanced life support EMS system. The working theory associated with this project was that simulation could be used to gain additional insight into contributing factors of sentinel events. A limited number of small studies have been completed with the use of simulation in causal analysis using a retrospective re-creation of the events based off of closed claim cases (Slakey, 2014). There had not been a study completed where simulation has been added to the traditional methods of debriefing sentinel event cases to determine if additional factors could be identified during an active investigation. Therefore, this research attempted to expand the traditional understanding of simulation and its contribution to causal analysis of sentinel events. The research question therefore was: How can medical simulation play a role in the understanding of sentinel events in

healthcare? The goal of this dissertation was to bridge the gap identified in the research and determine if medical simulation could enhance the current methods of investigating sentinel events and promote a deeper understanding of contributing factors to sentinel events. The research participants for this project were associated with a large urban fire-based emergency medical service and were all paramedics.

The findings from this research indicated that the use of medical simulation can bring to light additional contributing factors and learning opportunities in sentinel events. The original debriefing sessions provided ten contributing factors to the sentinel events. Nine simulation sessions and their associated debriefings provided an additional nineteen contributing factors, increasing the understanding of causes of sentinel events by 65.5% over traditional methods of debriefing.

*Table 22*

*Additional Learning Points and Contributing Factors*

Case	Initial Contributing Factors	Additional Learning Points	Additional Contributing Factors	% Change
1	5	28	7	58%
2	3	21	8	72%
3	2	9	4	66%
<b>Total</b>	10	58	19	<b>65.00%</b>

This research demonstrates that the use of HFMS can help determine additional causal factors of sentinel events in healthcare. There were clearly additional contributing factors identified after the simulation sessions that were beyond the traditional debriefing and quality assurance review. This research further suggests that not all sentinel events



cases may require HFMS to be successful in understanding additional contributing factors; rather, low and medium fidelity simulation may be satisfactory.

### **Major Findings of the Study**

The major finding of this research was that simulation can be used to determine additional learning opportunities and contributing factors to sentinel events. Four common themes emerged during this dissertation research that had a direct relationship to the research question and the organization in which the research was conducted. The themes that were identified in this project would not have been identified through traditional quality improvement activities such as an M&MC without the introduction of simulation during the investigation of these events. The themes include: The impact of gaps in individual knowledge and preparedness, the impact of team dynamics and decision making during high risk patient care events, the impact of crew resource management (CRM) on organizational communication during high risk patient care encounters, and the impact of debriefing on closure and understanding of contributing factors in sentinel events.

#### **The impact of gaps in individual knowledge and preparedness.**

The findings demonstrate that there are issues that need to be addressed across the entire organization. These are related to individual knowledge gaps in certain areas of airway management, use of technology during patient care, and procedural skills. This research demonstrates that simulation can enhance cognitive task analysis of individuals related to their process of problem solving and decision making in managing the sentinel

events (Velmahos, 2004). The re-creation of the case parameters involved in the sentinel event provides an opportunity to observe each member's role within the team and how their actions contributed to the events. The addition of simulation within the investigation provides a visual description of each participant's actions. It can enhance the understanding of decision making, assess the participant's use of equipment, and demonstrate understanding and compliance with policies and procedures. Additional knowledge gaps such as failure to use the airway checklist, failure to properly use the video laryngoscope, and failure to follow established medical protocols of the EMS agency were identified during the simulation sessions of this research. It is unlikely that traditional methods of investigating sentinel events would have captured these additional findings.

### **The impact of team dynamics and decision making during high risk patient care events**

Lussier (2016) describes team dynamics as the process that emerges as individual components impacting behavior, human relations, and performance develop within a group. This finding describes the impact of an individual contribution based upon a role within the team compared to the overall team performance as a group described in theme three. In this EMS agency, there were additional observations made regarding the negative impact on patient care from the lack of crew continuity that affected the cohesiveness of the overall team. Several issues that were identified as an additional contributing factor were directly related to someone not taking charge of the situation or a

direct result of poor on-scene management. One specific quote that reflected upon the leadership and oversight during patient care encounters on this issue was, “frequently it seems like the person on the scene with the strongest personality is the one people defer too. That isn’t always the best thing” (personal communication, P15, April 3, 2016).

One comment highlighted the impact on crew continuity when a paramedic commented, “I have been a paramedic a long time, but I haven’t worked with these guys before” (personal communication, P4, May 3, 2016). In addition, even with standard medical protocols for the delivery of patient care, the specifics of how the patient care was administered demonstrated considerable variability during the observations of the simulated sessions. Further observations noted the need for more direction and leadership from the EMS supervisors. There was variation noted in the leadership and aggressiveness of each EMS supervisor. The EMS supervisors routinely failed to provide direct oversight of the crew members involved in the simulation sessions. Although these three factors were discussed in the traditional quality assurance debriefing, the impact that this had on the cases did not become apparent until the simulations were conducted. It is difficult to get people to admit that their actions or lack of action may have contributed to the sentinel event. Only through direct observation by the researcher and reflection with the participants in debriefing were these identified and discussed. Through direct observation, the participants were able to see the consequences of specific actions, such as the EMS supervisor not having the proper equipment or the EMS instructor not using the airway equipment correctly.

### **The impact of crew resource management (CRM) on organizational communication during high risk patient care encounters**

The impact of individual performances and behaviors contribute to the overall team performance. CRM addresses an all-inclusive team approach to reduce the variations in a process. These EMS teams are frequently self-managed and have to be able to resolve conflicts or unexpected situations that develop quickly in order to prevent delays in patient care. Standardization of work may offer ways to reduce the stress related to lack of crew continuity. However, lack of standardized approach to patient care treatment was identified in several simulations as a contributing factor to a sentinel event. As an example, although each simulation scenario was presented in the same manner to the teams involved, they were managed by the crews in different manners. There was a lack of consistency observed in how the cases were approached. This lack of consistency resulted in variation that impacted the decision making of the patient care. Variation in any process leads to inconsistency and could be a contributing factor to errors. Although it could be argued that this is part of Theme 2 regarding team dynamics, in the EMS agency, the EMS supervisor is supposed to be the lead in the team approach to assure that patient care is progressing as per protocol. This helps reduce the variations in the approach to the patient encounter. However, in this research, it was observed throughout multiple simulations that the lack of the EMS supervisor maintaining a presence with the paramedics providing patient care contributed to the sentinel events. The Joint Commission white paper on patient injury and liability from 2005 made several

recommendations that included the adoption of simulation for the support of teamwork development (Joint Commission, 2005). As an example, one EMS supervisor stayed in the doorway and failed to enter the room and take charge of a difficult situation involving an uncooperative crew member, whereas another chose to drive to the hospital and not remain in the patient care compartment of the ambulance during transport. It is further noted that it can be difficult to get a team to admit that communication was part of the problem or that the possibility exists that the team's poor interaction contributed to an adverse event. However, through the use of simulation, it became apparent as the case unfolded and was debriefed that a lack of good CRM and communication was a problem in each of these cases.

### **The impact of debriefing on closure and understanding of contributing factors in sentinel events**

Observations made during the simulation scenarios were discussed in depth after the simulation through semi-structured debriefings. The semi-structured debriefing was ideal for this research. It afforded the researcher the opportunity to share the experiences of the sentinel event with the participants and then elicit additional thoughts from them regarding how they managed the same issues as the case developed. It was interesting to hear the crews discuss amongst themselves the impact that the simulation sessions had for each of them personally. Specifically, comments included, "we were able to slow the situation down and re-create it" (personal communication, P9, May 3, 2016). An additional comment was, "it allowed us to ask additional questions and discuss possible

alternatives” (personal communication, P14, May 30, 2016). Because each sentinel event is different due to the events and complexities of the case, the inclusion of simulation sessions allows for investigation of how individuals as well as teams of paramedics impact the case. One participant commented, “I liked everyone having the opportunity to talk afterward. I learned a lot” (personal communication, P9, May 3, 2016). Simulation also makes the learning factors visual to the participants, affording the opportunity for a deeper discussion on the impact of positioning of personnel and equipment and how this may have contributed to the events. “We should do that more often. It is amazing how everyone felt the same way” (personal communication, P5, March 9, 2016). Making the learning visual through simulation affords the participants the chance to actually see the impact of different situations and discuss options that should have been considered. The participants can actually move people or equipment around the simulated scene to determine the impact the change may have on the scenario. This was evident when the paramedic managing the airway in case number one pulled the child further up on the cot during the debriefing discussion of simulation number one.

### **What is the Value of Medical Simulation in Causal Analysis?**

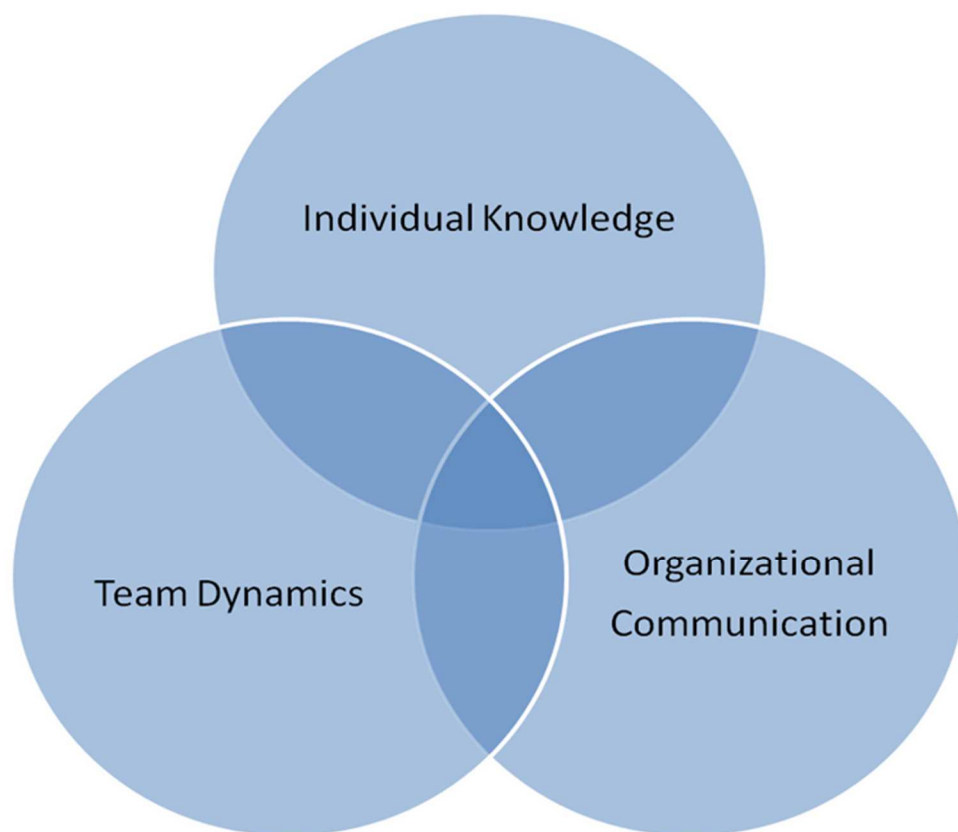
The use of simulation in causal analysis investigation can promote additional observational learning beyond current techniques that rely primarily on expert judgement of investigators and frequently lack structure (McDermott, 1996). Simulation sessions promote an opportunity to further identify contributing factors through group discussion by the participants after they re-create the case. This was demonstrated in this research

when a non-threatening environment was established early in the quality improvement process.

The results support the outline in figure 2 that medical simulation has a place in the investigation of sentinel events in healthcare, specifically in the understanding of how contributing factors can overlap the three areas of individual knowledge, team dynamics, and organizational communication. Although each one of these three areas can be investigated individually, completing a simulation of the case provides the investigators with an opportunity to see how the three areas intersect. Simulation can help provide a learning experience that is visual to those involved. The time and events of the case can be slowed down compared to the actual event, which offers a method to provide a deeper understanding of how the three areas overlap during patient care. It can help identify where failures occurred, identify risk for future failure, and offer additional organizational learning opportunities for organizational improvement. Simulation offers the investigator the opportunity to see how participants approach complex patient care issues and how they utilize the equipment they have available.

*Figure 2*

*Area of Opportunity or Medical Simulation in Casual Analysis*



### **Individual Knowledge**

An individual's acceptance of responsibility related to individual performance or knowledge gaps is often hard for health care providers to accept (Dekker, 2002).

Although the use of simulation provides a method of education and increases patient safety, the use of simulation to determine gaps in an individual's knowledge has not been explored during investigations of sentinel events. The findings of this research demonstrate that individual knowledge gaps can be identified and corrected with the use



of simulation beyond the typical debriefing or M&MC used in many causal analysis programs.

The findings concur with Jones (2015) that simulation offers an innovative approach to understand the cause of errors and improve competencies related to knowledge. Through the use of simulation as an adjunct to the learning process, the impact of individual performance, equipment placement, or interactions between team members can be established. Gaps in individual knowledge can be identified, and the need to redesign a process such as placement of equipment in an ambulance can be assessed. As an example, the introduction of video laryngoscopy was used incorrectly by multiple participants, and then the simulation process determined that one instructor was teaching the use of the equipment incorrectly. Only through observation of a simulation was this identified and corrected during the sentinel events investigation.

### **Team Dynamics**

Assessing team dynamics and its impact on individual performance is difficult to measure through traditional debriefing and M&MC. Each of the cases presented in this research identified unique challenges that required a team approach to successfully resolve the situation. Team dynamics and interactions became a specific area of additional contributing factors throughout this research. These findings also concurred with Maran (2003), who postulated that re-creating the working environment in which teams have to function is a powerful tool for enhancing the learning experience and promotes the opportunity to assess team dynamics as well as each member's role within

the team. I concur with the findings of Maran (2003) and this was evident when one EMS supervisor was frustrated with a paramedic with which he had not previously worked. His comment, “I now know a lot more about [paramedic name]” (personal communication, P6, March 12, 2016) was an example of the frustration that he experienced, and this frustration was re-lived in the simulation. Recalling this interaction during the simulation, I question whether this frustration would have been discussed had that paramedic been involved in the simulated setting, or if it did, what type of interaction would have occurred between the participants. Additionally, the findings are consistent with Slakey, (2014) that found that “marked variation in judgement of the test subjects” was considered an additional contributing factor above the original RCA finding of lack of communication. In debriefing after the simulation, the EMS supervisor was asked about the sense of frustration. His response included a comment that he should have “pushed his way into the room” (personal communication, P6, March 12, 2016), affirming that by being placed into a simulated environment within a controlled setting, he was able to visualize the development of the situation and reflect that he should have taken a greater leadership role in this case.

### **Organizational Communication**

The research findings were consistent with Woolf (2004) that a chain of factors contributes to sentinel event cases. In each case, the causal chain could have been broken at any point by an action of a participant or an interaction of the team. Simulation helped validate this by slowing the scenario down to make the opportunities visual to the

participants through debriefing. The use of simulation demonstrated significant communication gaps that contributed to the sentinel event cases and reduced the reliability in how the EMS agency handled these cases. Although Maran (2003) found that 80% of the errors in medical care were related to communication, 44% were determined to be a communication breakdown among colleagues such as what was experienced in this research. Examples of communication breakdown was evident in the first case in which the paramedic crew failed to communicate to the supervisor that his equipment was needed for the pediatric patient who had been removed from the house fire. During the debriefing, it was evident that the team found communication to be a challenge. The impact of communication was also evident in case number two between the crews and the supervisor in the bedroom scenario, as well as in case number three when the EMS supervisor arrived on the scene only to hand his equipment off to them without determining whether they were trained on the equipment.

### *Debriefing*

The impact of debriefing on the understanding of how simulation contributes to the RCA of sentinel events is evident. Debriefing of the events provided an opportunity for the participants to discuss and reflect upon the case. It allowed the connection of all points of learning and afforded a deeper understanding of additional contributing factors and learning opportunities. The findings also concur with Driefuerst (2012) that simulation promotes reflective learning. During this research, reflective learning occurred due to the situations being visual and due to the discussion and exploration of

the circumstances of the case evolving under less stressful conditions. Promoting a reflective approach to the problem solving process encouraged participants to step back from the immediate issue and examine their thinking process. This is particularly of interest in the emergency health care setting in which time resources are limited, time constraints apply, and in many cases shortcuts are sought for success (Croskerry, 2003).

### **Limitations**

There are several possible limitations that may have impacted the findings of this research. They include:

#### **Sample size**

This study is based upon a small sample size of three sentinel events involving nine simulations and twelve debriefing sessions.

#### **Lack of randomization**

This study was not randomized; rather, a convenience sample was used. Because this research was conducted to examine the use of medical simulation in sentinel events, I had to use sentinel event cases conducted within an urban fire-based EMS system. Lack of randomization may lead to a lack of generalizability of the results. However, since multiple simulations were run for each sentinel event, there is compelling evidence that these results are more than suggestive that simulation does have a place in causal analysis of sentinel events in healthcare.

### **Impact of fatigue**

The inability to account for fatigue in the findings is also a limitation. The fact that two of the three sentinel event scenarios occurred after midnight raises a question about the impact of fatigue on the decision making of the paramedics. The system that the research was conducted within is a busy system with over 130,000 responses annually. Although fatigue was discussed in the debriefing of the events, I was unable to account for the fatigue factor during the simulation scenarios. It should be noted that fatigue has been considered a contributing factor in other research associated with sentinel events in healthcare (Joint Commission, 2011). The paramedics of the EMS agency work a 24-hour shift every three days. Recurrent 24-hour shifts have been associated with a 36 percent increase in preventable adverse events (Landrigan, 2004).

### **Bias**

Hindsight and confirmation bias may play a role in the use of simulation in causal analysis. Because the parties have already had a shared experience in the event, there is an opportunity to introduce bias in the initial crew simulation scenario. Although this is hard to control for, it can be discussed during the simulation debriefing with each group of participants. Through the comparison of what was discussed in the traditional debriefing with what was observed in the simulation exercise, I attempted to control for this by ensuring that potential learning points and contributing factors were not exaggerated. This was accomplished by using a research assistant that observed the simulation sessions and then read the results of the coding of themes and subthemes.

### **Unexpected findings**

There were several unanticipated findings that occurred during this research. Included was the cooperation of the participants, the emotional involvement of some of the participants in the process, and the instructor error that was discovered. Each is explained in greater detail below.

#### **Cooperation of participants**

Although I anticipated that there would be cooperation among the participants in investigating these cases, the degree of cooperation received once the simulations began was unexpected. The paramedics and instructors that took part in the simulation experiences appeared to have a sense of interest and engagement that exceeded the researcher's expectations. The instructors who took part in the first sentinel event case actually asked to be part of the remaining cases. There appeared to be a high interest in what this research was trying to accomplish, and cooperation was noted. Once the purpose of the research was reviewed and the assurance of a non-disciplinary approach was discussed, no additional concerns were raised. All participants agreed willingly to take part in the research. This was evidenced by the comments of different participants, including "I felt like I got a lot out of it" (personal communication P14, March 14, 2016). In addition, one set of crew members that took part in the second scenario of case number one asked to be included in future research. In order to gain a strong understanding of the events, there must be a sense of trust in the process for those who are being asked to open themselves to additional scrutiny. A failure to discount the significance of this

concern could have been a barrier to this project. If the purpose of sentinel event investigation is to better understand the factors that contribute to error with a goal of preventing future mishaps, then a culture of continuous improvement must be established rather than a culture of discipline.

### **Emotional involvement of some participants**

Several people taking part in the research were found to become emotionally involved in the events of the case as evidenced by a rise in their voices or perspiration noticeable as the scenario played out. It has been questioned whether simulation can create a life-like environment for training that truly mimics real life stress. Mills (2014) studied first year paramedic students and concluded that early in a student's education, medical simulation can increase a student's heart rate task load index score. During the debriefing of the simulations, this question was asked of the participants, and the consensus was that the simulation did increase the stress levels of the paramedics as the sentinel event unfolded. One quote from a participant was, "I could sense my heart rate going up as my frustration increased, but I didn't realize I was sweating so much." (personal communication, P14, 2016). One member commented, "I could feel my heart rate amp up as you provided additional information during the case" (personal communication, P14, 2016). Another participant commented, "Did you see him? He was sweating like crazy" (personal communication, P15, March 14, 2016). This is supported in the literature, which has demonstrated that students placed in a simulated environment

have physiological responses such as elevated heart rates similar to live patient encounters (Hinchley, 2011).

### **Instructor error in teaching**

I did not expect to come across the fact that an instructor was teaching the video laryngoscopy equipment incorrectly. During the simulation scenario in case number two, it was observed that a paramedic had used the video equipment incorrectly. The video technology was introduced into the EMS agency early in 2016 in an attempt to increase intubation success rates. This technology requires a different approach for the user than traditional intubation methods. It also requires the tube that is placed into the patient's trachea to be preloaded into the blade on the handle prior to use.

During the instructor scenario, the instructor was witnessed to be using the video equipment incorrectly. His use of the handle was incorrect, and he did not have the tube preloaded. During debriefing, these observations were discussed, and the same instructor demonstrated the correct way to use the video equipment. He stated, "I guess I have been teaching it that way" (personal communication, P14, April 3, 2016). This finding is consistent with previous research that found simulation to be effective in identifying deficiencies in paramedics' resuscitation skills through the use of three manikin-based simulation sessions (Lammers, 2009).

In addition, during the obese patient airway in Case Three, a paramedic was asked to demonstrate how he inserted the rescue airway device. Although he completed the procedure correctly on the mannequin, he did not demonstrate a confidence in placing the



ventilation tube quickly and properly. The use of simulation allowed the team to observe his approach to this procedure. After the observations were noted, his technique was discussed. Other paramedics offered their insight on how they place the tube, including the way they hold it, place it, and confirm that it is set properly. Through this simulation session, a team approach to learning occurred.

This demonstrates the impact of the use of simulation in causal analysis. A typical M&MC likely would not have picked up on the paramedics using the equipment incorrectly, and without including the instructors in the next scenario, I would not have found that the instructor was teaching the use of the equipment incorrectly. This demonstrates the importance of completing multiple scenarios and including people in those scenarios that bring different perspectives to the case. After this simulation and debriefing, a clarification video was made to demonstrate the proper method of using the equipment. It was uploaded to the learning management system of the EMS agency, and all EMS supervisors were contacted with the correction on the method of use. The EMS agency has seen a 17% increase in success rate following the implementation of the correction.

### **Potential Future Research**

This dissertation has determined several future research opportunities. They include including a larger sample size to validate these findings, and a survey of participants regarding their experiences with this investigative model. In addition, future research offers an opportunity to determine how these findings translate to other health care

settings, how video technology can increase the impact of the simulation sessions, and the introduction of stress in learning through simulation impacts learning.

### **Larger sample size**

Since this was a small sample size, the recommendations for additional research include completing a large multi-centered research project. A larger sample size would increase the number of participants and give future researchers the opportunity to replicate the findings of this study. In addition, future research could also include a larger multi-center study in which additional sentinel event cases are included.

### **Pre/Post simulation survey**

As discussed above, it appeared that there was a sense of interest and engagement once the simulation exercises began. Including a post simulation survey from the participants may make the future use of medical simulation in causal analysis of sentinel events a richer experience. A participation survey could be completed prior to the simulation session being completed and then repeated after the simulation session and debriefing has concluded. The purpose for this type of study would provide a better understanding of a participant's opinions, expectations and/or understanding of the use of simulation in sentinel event investigation. After completion, a follow up survey could provide insight into the post simulation experiences of those taking part in the research.

### **Transfer of findings to other health care settings.**

This study was completed within a single tiered fire-based EMS system. The extent to which these findings transfer to other health care settings, such as the in hospital

environment, remain to be seen. This offers opportunity for additional research. Today, healthcare facilities have extensive simulation centers. Most centers still utilize the typical M&MC for determining root causes of sentinel events, and this research demonstrates that the introduction of simulation into the investigational process could yield additional contributing factors and learning points. This research could be replicated in other health care settings, such as hospital quality improvement practices, to determine if the findings can be reproduced in that environment.

### **The use of video technology**

Research could be conducted using video technology for each simulation and debriefing session. After review and thematic analysis of the findings, the videos could be reviewed by others involved in process improvement and sentinel event investigation. The purpose of this research would be to determine if the findings of one researcher are consistent with the findings of others and would provide richer data.

### **The impact of simulation on stress in learning.**

It was evident in the research that the simulated scenarios could elicit a feeling of stress on the participants. One member commented, “I could feel my heart rate amp up as you provided additional information during the case” (personal communication, P14, 2016). Another participant commented, “Did you see him? He was sweating like crazy” (personal communication, P15, March 14, 2016). There is an opportunity for further research in how a simulated learning environment impacts the physiological response to a

participant's blood pressure, heart rate, respiratory rate, and salivary cortisol level. These parameters may be able to capture an increased stress response in simulated learning.

### **Implications for Practice**

This dissertation has captured several implications to practice that support the use of simulation in causal analysis of sentinel events. This includes that simulation in causal analysis works to capture additional contributing factors and learning opportunities. Not all investigations warrant an investigation that involves simulation. The use of simulation can also help eliminate confirmation and hindsight bias that potentially clouds investigations. And finally, the use of checklists impacts variation in a process and reduces the risk of error.

**Simulation in causal analysis works.** It is possible to gain additional insight into contributing factors of sentinel events in health care through the re-creation of the events with medical simulation. It is possible to duplicate the events that led to the sentinel events. Therefore, the use of simulation can be used to increase understanding of additional contributing factors of sentinel events beyond what traditional debriefing and M&MC offer. This includes the ability to observe team interactions, individual cognition, and communication. One instructor noted, "Is it something that you can recreate or is it a freak occurrence?" He continued, "I like the idea of getting a different experience from others and getting them together and see where the errors occur" (personal communication, P15, March 16, 2106). Placing teams into a simulated environment offers an opportunity to slow the situation down, use experiential and

reflective learning to make visual the factors involved in the case, and gain additional insights into contributing factors of sentinel events that are beyond traditional RCA. This can be accomplished through a non-punitive approach in which the value comes in identifying learning opportunities from sentinel event cases to increase future risk reduction.

The use of simulation can enhance the current patient safety initiatives by examining each step in the process of patient care. Through the use of simulation, the investigator can examine how each process works, how a proposed change impacts the process, and where potential failure opportunities exist (FMEA). This could promote a safer approach to patient care, because a team can pilot potential changes in a controlled environment without impacting patient safety.

**Not every case needs simulation.** Not all sentinel event cases are ideal for using simulation. This research concurs with Dekker (2002) that investigating human error through the reconstruction of the events is not easy. One of the instructors brought up the question of the practicality of using HFMS in the re-creation of the third case. In some settings, it may be difficult to use HFMS because the mannequins are more complex and tied to a computer lab. As an example, in the third scenario, the cardiac arrest occurred on a basketball court in a fitness center. Although the case was able to be re-created in the gymnasium at the training complex, the use of HFMS was impractical. Druckman (1994) stated that the functional level of fidelity is more important than the type of fidelity. In this particular case, my findings were consistent with Druckman. The use of

a medium fidelity advanced life support mannequin was capable of re-creating the events of the difficult airway scenario without having to re-locate the entire HFMS system. The future use of simulation in causal analysis should include the type of simulation required to gain the best results. The type of cases that simulation appears to be most appropriate for include situations where team dynamics are questioned as a possibility, events where new procedures are considered a possible causal factor, or where multiple issues are occurring at the same time. In the third case, the sentinel event was primarily an isolated difficult airway without additional complex situations. This isolated event scenario may not require simulation scenarios to be completed by three different groups if standard work in the form of checklists is established.

**Checklists.** Checklists have been proven to work when used properly and followed by staff members. A 2011 study demonstrated that morbidity and mortality was reduced when checklists are used (Ely, 2011). Because crew continuity was a contributing factor to the cases presented within this research, it is important to point out the benefit of standard work and the use of checklists. Organizations that are expected to be highly reliable such as the EMS agency should look to adopt the concepts of CRM and checklists that have been used successfully in other industries such as the airlines (Levy, 2008). It has been noted that health care does not actually meet the same quality standards that are expected from other service industries (Levy, 2008). The airline industry and the EMS agency experience a similar situation of a high risk environment that places them at risk for failure. This includes the frequent variation in team members,

complex tasks, and the challenges associated with staffing. The airline industry has embraced the use of checklists as part of their CRM training to reduce the risks associated with variation in the workplace. Medicine has made strides in the acceptance and use of checklists, and as a patient and provider safety measure, the EMS agency should follow suit. The EMS agency has a checklist that was developed for confirming intubation that was only used in one simulation. Simulation can be used to develop checklists for high risk procedures, train employees on the use of checklists, and validate the effectiveness and functionality of checklists to enhance patient safety. The EMS agency should evaluate how the checklist increases patient safety and provide additional organizational support in the form of policies and education to further encourage the use of checklists.

**Avoidance of confirmation or hindsight bias.** The use of simulation can help avoid confirmation and hindsight bias during causal analysis of sentinel events. Those investigating sentinel events need to understand how bias can impact the way the scenario is set up and how questions are posed during the running or debriefing of the scenarios. This was evident in the comments of the EMS supervisor when he stated, “I learned something about (paramedic name) that night and I will never forget it” (personal communication P6, April 2, 2016). The EMS supervisor in this situation demonstrated a bias that the uncooperative paramedic was the problem with this event. Without the recreation of the case with simulation, the EMS supervisor would have remained focused on the attitude of the uncooperative paramedic being the root cause of the issues with this

case. Since other methods of investigation rely heavily on discussions, simulation forces active participation and engages all the participants in the investigation compared to sitting in a debriefing of the event.

**Organizational challenges.** It can be a challenge to complete the sentinel event simulation due to organizational barriers. As an example, one of the members involved in case number two was on vacation for ten days immediately after the event. Therefore, a delay occurred in getting the debriefing and the simulation event scheduled.

Additionally, there was approximately twenty hours of time in setting up, conducting and debriefing each scenario. That does not include time for coding and conducting thematic analysis. In addition, crew members or response ambulances have to be taken out of service for this type of investigation, potentially impacting the emergency response capabilities of the organization. Organizations also have to have the leadership to obtain the training and equipment to provide an effective environment for sentinel event investigation. This begins with a quality improvement mindset rather than a disciplinary or fault finding process. During this research, the issues described were addressed during the consent process for each participant. Any organization that uses medical simulation in the causal analysis process will have to have discussions within the leadership team, participants involved in the sentinel event, and legal counsel regarding how to conduct this investigation.

**Debriefing.** Debriefing the simulation provides an opportunity for participants to use reflection and group discussion to add to the understanding of factors that contributed to



the sentinel event. Debriefing helps to explore what occurred, to develop insights for future learning, and to connect the activities of the simulation to the real life opportunities or experiences (Fanning, 2007). The purpose of the debriefings in this research was to engage the participants in the process of learning through active experimentation and reflection. The additional insights gave the researcher a better understanding of some of the thought processes these paramedics used in the care they administered during the simulations. The participants all felt that the simulation presented conditions as close to life-like as possible. They demonstrated empathy for the paramedics that had experienced the cases with which they were assisting. When asked about the impact of the experience, one participant commented, “That’s the most appropriate way to do it. That way you can evaluate whether it’s a training issue, and equipment issues, or a system issue without having to discipline someone” (personal communication, August 1, 2016).

Debriefing is a critical part of overall simulation training because it provides a method of learning through reflection (Driefuerst, 2012). The post simulation debriefing experience was seen as a positive part of the experience by all involved in this research. Specifically, one instructor who took part in the simulation stated, “I knew that someone else had an issue. So I actually had that on my mind as I went through the scenario. I was looking for the obstacle that got them caught up” (personal communication, P14, March 14, 2016).

A benefit to the use of simulation is that the events are visual to the participants. Since the events are visual to the team involved in the case, immediate debriefing becomes more interactive. Through the debriefing process, I observed that everyone taking part in the simulation scenario began to discuss what the challenges were and how this became a sentinel event in a professional manner, without any argument or intimidation. Described as metacognition, this reflective group discussion approach to problem solving allows the participants to engage others and use reflection techniques to enhance understanding of the events. In the conversations during the debriefings after the simulations, I found it interesting that the participants began picking up equipment, looking at medication labels, and asking each other questions. The simulation environment was obviously less rushed and stressed than they had experienced during the handling of the actual case, so it became an unofficial learning environment. Each original crew member taking part was asked if they felt that this process had helped to bring closure to the experience. There was unanimous consensus in all three cases that this process helped provide some closure to the case. They stated that they appreciated the non-threatening approach and the opportunity to brainstorm as a group in reflection of the case. Even though the participants may have heard about the case from others within the EMS agency, it is important to make sure everyone involved understands that the purpose of the simulations are for continuous improvement rather than discipline. It is also important to assure that participants of the simulation experiences agree to keep the

discussions within the simulation groups confidential. Letting the sentinel event investigation team complete their simulation sessions and issue their report and recommendations without information being leaked from the teams involved in the case adds credibility to the process and reduces potential conflict or distrust within the organization.

### **Significance of Findings**

Traditionally, medical simulation has been proven to be effective in the training and education of medical providers. The findings and conclusions of this study are significant because they provide evidence that simulations can be used to contribute to Root Cause Analysis and should not just be seen as a training and education vehicle. These findings demonstrate that additional causal factors can be identified by including simulation in the investigation of sentinel events, provided the organization uses a focused approach to conduct their investigation. The significance of this research can be found in the 2015 Joint Commission sentinel event report, which reported that the top three factors identified in sentinel events were human factors that involved either leadership or communication problems and accounted for 70% of the root causes identified (Joint Commission, 2015). The findings of this research are consistent with the conclusions of the Joint Commission and provide additional research that demonstrates the need to provide additional leadership and CRM training. Additional findings include:

### **Crew Resource Management Training**

CRM training is a staple of airline industry safety programs and should be the foundation for the program developed (Lindquist, 2009). The findings of this research demonstrated the complexity of a large urban EMS system and the lack of crew continuity within the EMS agency. Based on these findings, the EMS agency should development a crew resource management program and conduct additional CRM education based on the use of simulation. Additionally, the program should be developed to enhance the organization's understanding of the causes of error in the workplace, how good CRM prevents errors from occurring, and what communication strategies can be used to reduce the risk of error. Because the research also indicates that the EMS agency is struggling with organizational understanding and compliance with the use of checklists, the purpose and benefits of including checklists within a CRM program should be included. This program should be taught in a hybrid method to include an in-line component prior to the classroom session to reduce the impact on organizational staffing.

### **Protocol for conducting simulation for causal analysis**

This research identified specific factors that are requirements for a successful causal analysis program using simulation. The findings demonstrate that not all sentinel events benefit from including simulation. Simulation should be considered when confounding variables are competing for priority in the decision tree of establishing fault in a sentinel event case. This includes situations where individual knowledge gaps may

exist, team dynamics are in question, or communication among the health care providers is of concern. The research also identified additional factors that promote success in using simulation in causal analysis (Table 23)

*Table 23*

*Success Factors in Sentinel Event Investigation with Simulation*

<b>Success factors in sentinel event investigation with simulation</b>	
Organizational commitment to gain deeper understanding	
Time commitment of members involved	
Adequate equipment to conduct root cause analysis	
Proper staff education in root cause analysis to conduct simulations	
Initial debriefing session of crews involved	
Additional simulation session to include those responsible for staff education	
Recognition that simulation is not appropriate for all investigations	
Recognition that sentinel event investigation is not a linear process rather a fluid one	

## Future State

Figure 3

### Proposed Method for Inclusion of Medical Simulation



Through this rigorous research project, I have identified how simulation can be used to enhance the understanding of contributing factors to sentinel events in healthcare. I propose including simulation in the future investigation of a sentinel event as outlined in Figure 2. Including medical simulation would not specifically be a requirement; rather, it would be available as a supplement to the current analysis methods if it is determined to be warranted.

The reporting and administrative review by department leadership and/or the quality improvement team would remain unchanged from what currently occurs. The purpose of this review is to determine the impact of the event on patient care and the

organization and to determine what emergency steps need to be implemented to protect patients and medical providers. If this review is unable to conclusively identify the specific issues that contributed to the sentinel event, then a meeting would be set up with the simulation team. The meeting would be a development and/or brainstorming meeting (**Plan**) for the simulation team to understand the objectives of the simulation. The team would identify what potential contributing factors need to be explored through simulation and any bias that may contribute to a successful simulation experience. After agreement that simulation may be of benefit, the simulation team would then build the scenario and arrange the simulation environment to be as consistent as possible with the environment in which the sentinel event occurred.

After the set-up is completed, the simulation would then be run (**Do**) by the simulation team and investigators of the sentinel event. A debriefing would occur by someone trained in debriefing techniques immediately following the simulation. Once the debriefing is completed, the simulation staff, administrative staff, and the quality improvement team would meet to discuss the findings and develop a report and recommendation (R&R). When the R&R is accepted by the organization, implementation of the countermeasures is the next step (**Check**). This would occur over an established timeline set by the team. It should be noted that the established timeline is important for the well-being of the team involved in the sentinel event. When the team is subjected to on-going discussions and review of the case events, it is difficult for the team to bring closure to the case, which can add to a team member's post-traumatic stress. It is

also during this phase that the final findings are presented to the initial team involved in the case. This provides an opportunity to close the loop on the investigation process and review additional contributing factors and learning opportunities with the initial team.

During the R&R development, short and long term goals can be established. These may include additional training, policy changes, additional equipment needs, or staffing changes. After the implementation phase, a follow up would occur at specific intervals such as 30 days, 90 days, and 180 days to determine how the implemented changes are functioning. At this point, any changes (**Adjust**) that need to be made can occur prior to beginning the PDCA loop again until the team is comfortable with closing the case.

### **Conclusion**

The success of simulation in learning is no longer in question. However, adverse patient events continue to plague the health care industry. The findings of this research provide empirical support for using simulation to understand additional contributing factors to sentinel events in health care beyond traditional debriefing methods. Although everyone realizes that there are many factors that can contribute to sentinel event, it is hard sometimes to admit that our own actions, interactions, or failures impacted the event. The use of simulation allows us to dig deeper into adverse events and make sense of the errors with a goal of reducing the future risks. This creates opportunities to promote learning, increase patient safety, and gain a deeper, more enriched learning experience. In the future, further research will hopefully continue to illustrate the



contributions that simulation can offer. Simulation can enhance traditional root cause understanding of sentinel events and should be included as an adjunct to current methods of investigation. In addition, simulation may provide an opportunity to study risk and failure opportunities in patient care during the development of procedures, and new patient care methods.

Although the field of simulation is still in its infancy, the technology continues to evolve. Currently, the advancement of the technology is out-pacing our ability to understand how and when to use simulation for learning. Although the technology can be expensive, simulation can be used for areas within health care beyond initial education and compliance training. To make full use of the opportunities that simulation offers in regard to our understanding of medical error, we need to remain focused on understanding the factors that contribute to patient injuries caused by those that provide their care. This research demonstrates that there are issues beyond human error which impact patient care. The use of simulation can help determine how multiple variables impact patient safety and sentinel events. Learning leaders need additional education on how to conduct root cause investigations and how the use of simulation can enhance the understanding of error in health care.

## Appendix A

### Consent to Participate in Research

Thank you for your involvement and assistance in this research project that is being conducted through the University of Pennsylvania Graduate School of Education (GSE). The purpose of this research is to determine if the use of high fidelity medical simulation can increase our understanding of causal factors that contribute to sentinel events in healthcare. This research is being conducted by James Davis as a partial fulfillment of degree requirements for a Doctorate in Education and is being overseen by Mr. Dana Kaminstein. Your participation is completely voluntary. The information collected during this project will be de-identified and used only by James Davis. Information will be used for the completion of this project only to complete the research. There will be no investigation or discipline arising from this research.

You will be immediately notified if there is any change to the conditions outlined above. You may withdraw your permission at any time by sending a written communication to the researcher. If you have additional questions or concerns, you may contact the researcher at [davisj@columbus.gov](mailto:davisj@columbus.gov) or by phone at (614) 774-3504. You can also contact Mr. Dana Kaminstein, the chair of Mr. Davis' dissertation committee, at [dkamin@sas.upenn.edu](mailto:dkamin@sas.upenn.edu) or by phone at (610) 664-0906.

I, \_\_\_\_\_, agree to take part in the research being conducted by James Davis. I understand that my participation is completely voluntary and that I can withdraw my consent at any time by making notification to the researcher in writing. I have received a copy of this agreement and have had all of my questions answered to my satisfaction.

Name: \_\_\_\_\_

Witness: \_\_\_\_\_

Date: \_\_\_\_\_

## Appendix B

### Case Number One

#### Background information

- Thank you for your agreement to take part in this simulation as part of my research.
- As I have stated, the purpose of this project is to investigate a case involving a group of paramedics and supervisors that involved a sentinel event.
- You have been asked to take part in this due to the fact that you have the same certifications and crew make-up as the crews involved in this case that we are investigating.
- I will give you a brief description of the situation and explain the case to give you enough information to proceed through the simulation.
- We will be observing you to see how you proceed through the case. I will attempt to answer any questions that arise during the case that is not evident in the simulation. I may make certain comments, such as “you are unable to pass the endotracheal tube.”
- I am asking that you proceed through this case as you would if it were an actual case.
- At the end, we will debrief this situation. I will explain more details then so that it does not impact your decision making during the simulation. We will have plenty of time to discuss the specifics of the case. I want to get your reflection and feedback on the events and how they impacted the case.
- Again, I want to assure you that this is a non-disciplinary process. I am trying to determine the impact of the use of simulation to better understand these events, and everything we find here will be used for training and education to attempt to prevent further incidents.
- Are there any questions?

#### Specific case information

You are dispatched on a report of a fire a 0400 hours. A full fire assignment is sent and you are the medic assigned to the run. Upon arrival, you find a house that is well involved in fire. About three minutes after arrival, you are requested back to the medic where a firefighter presents you with a four-year old male that is unconscious and floppy in the arms of the firefighter. You meet him at the back of the medic, and this is where we will begin this scenario. You will initially have three of you present.

I will tell you when the medic arrives with two additional paramedics, and I will let you know when the EMS supervisor arrives.

#### Debriefing

Now that we have completed the scenario, I want to talk to you about the case that unfolded during the event.

- Explain where the medic crew was
- Explain that the EMS supervisor drove to the ED
- Explain the ET tube was in question upon arrival
- Explain that the crew lost the waveform upon arrival in the ED squad bay

#### Questions

- How did you feel this simulation went as you progressed through it?
- Now that you know what happened in the sentinel event, what additional thoughts do you have?
- Did you find this simulation realistic?
- What would you have done differently if you did it again?
- What can you identify as a learning opportunity from this case?
- Do you have anything else to discuss or add?

## Appendix C

### Case Number Two

#### Background information

- Thank you for your agreement to take part in this simulation as part of my research.
- As I have stated, the purpose of this project is to investigate a case involving a group of paramedics and supervisors that involved a sentinel event.
- You have been asked to take part in this due to the fact that you have the same certifications and crew make-up as the crews involved in this case that we are investigating.
- I will give you a brief description of the situation and explain the case to give you enough information to proceed through the simulation.
- We will be observing you to see how you proceed through the case. I will attempt to answer any questions that arise during the case that is not evident in the simulation. I may make certain comments such as “you are unable to pass the endotracheal tube.”
- I am asking that you proceed through this case as you would if it were an actual case.
- At the end, we will debrief this situation. I will explain more details than so that it does not impact your decision making during the simulation. We will have plenty of time to discuss the specifics of the case. I want to get your reflection and feedback on the events and how they impacted the case.
- Again, I want to assure you that this is a non-disciplinary process. I am trying to determine the impact of the use of simulation to better understand these events, and everything we find here will be used for training and education to attempt to prevent further incidents.
- Are there any questions?

#### Specific case information

You are dispatched on a report of a cardiac arrest at about midnight. The engine is the closest firehouse, while the medic is coming from the next firehouse about five minutes further away. The paramedic on the fire engine is a trade and does not normally work this shift. Upon arrival, you have four people on the engine, one of which is a paramedic. The patient’s wife states that she heard him fall upstairs and you find him in a small bedroom that you will see.

Your initial examination finds him pulseless and apneic. The wife is sitting in a chair in the room and states that she called right away when she heard him. You are to assume that he has been down for about 6-8 minutes.

I will tell you when the medic arrives with two additional paramedics, and I will let you know when the EMS supervisor arrives.

The case will begin with you making entry into the mock-up of the bedroom. It is set up as close as possible as recalled by the original crew. You are asked to proceed through this case as you would in the event that it was an actual case.

#### Debriefing

Now that we have completed the scenario, I want to talk to you about the case that unfolded during the event.

- Explain what you found upon arrival
- Explain the care priorities as you established them
- Explain the EMS supervisor involvement in this case
- Explain the considerations in airway management

#### Questions

- How did you feel this simulation went as you progressed through it?
- Now that you know what happened in the sentinel event, what additional thoughts do you have?
- Did you find this simulation realistic?
- What would you have done differently if you did it again?
- What can you identify as a learning opportunity from this case?
- Do you have anything else to discuss or add?

## Appendix D

### Case Number Three

#### Background information

- Thank you for your agreement to take part in this simulation as part of my research.
- As I have stated, the purpose of this project is to investigate a case involving a group of paramedics and supervisors that involved a sentinel event.
- You have been asked to take part in this due to the fact that you have the same certifications and crew make-up as the crews involved in this case that we are investigating.
- I will give you a brief description of the situation and explain the case to give you enough information to proceed through the simulation.
- We will be observing you to see how you proceed through the case. I will attempt to answer any questions that arise during the case that is not evident in the simulation. I may make certain comments such as “you are unable to pass the endotracheal tube.”
- I am asking that you proceed through this case as you would if it were an actual case.
- At the end, we will debrief this situation. I will explain more details than so that it does not impact your decision making during the simulation. We will have plenty of time to discuss the specifics of the case. I want to get your reflection and feedback on the events and how they impacted the case.
- Again, I want to assure you that this is a non-disciplinary process. I am trying to determine the impact on the use of simulation to better understand these events, and everything we find here will be used for training and education to attempt to prevent further incidents.
- Are there any questions?

#### Specific case information

You are dispatched on a report of a cardiac arrest at a fitness facility. The patient was found unresponsive on the basketball court. He is an obese male that weighs about 350 lbs. Bystanders are doing CPR, and there is plenty of room to work.

During the scenario, we will move to the back of the medic vehicle to begin transport to the local hospital emergency department, and I will tell you when the time comes.

I will tell you when the medic arrives with two additional paramedics, and I will let you know when the EMS supervisor arrives.

#### Debriefing

Now that we have completed the scenario, I want to talk to you about the case that unfolded during the event.

- Explain what you found upon arrival
- Explain the care priorities as you established them
- Explain the EMS supervisor involvement in this case
- Explain the considerations in airway management

#### Questions

- How did you feel this simulation went as you progressed through it?
- Now that you know what happened in the sentinel event, what additional thoughts do you have?
- Did you find this simulation realistic?
- What would you have done differently if you did it again?
- What can you identify as a learning opportunity from this case?
- Do you have anything else to discuss or add?



## Appendix E

<b>Intubation Confirmation Checklist</b>				
PRIORITY	√	DESCRIPTION	You Want	STATUS
1		Did you witness the tube pass through the cords?	Yes	If yes go to 2
2		Do you have bilateral breath sounds?	Yes	If yes go to 3 If NO - assess why <i>Consider pull ET</i>
3		Are there gastric sounds present over the abdomen?	No	If no go to 4 <b>If YES - PULL ET</b>
4		Do you have chest rise? Can you ventilate? Do you have oxygen saturation greater than 93%? <b>Assess = Oxygen connected, pneumothorax, etc.</b>	Yes	If yes go to 5 If NO - assess why <i>Consider pull ET</i>
5		Is there a numeric value with capnography? Is there a waveform present with capnography?	Yes	If yes go to 6 <b>If NO - PULL ET</b>
6		Do you see fogging of the ET tube? <b>Assess = Perfusion status core temperature, etc.</b>	Yes	If yes go to 7 If NO - assess why
7		Is there any stomach distention?	No	If no go to 8 <b>If YES-go to 3</b>
8		Is there gastric content from the ET tube?	No	If no go to 9 <b>If YES - PULL ET</b>
9		Is the ET tube secured? Is the lip line location documented?	Yes	Continue to maintain airway assessment
<b>NOTE:</b>		It takes three to say go and one to say no. If at any point ALL are not comfortable with the airway <b>the ET tube is to be pulled</b> , the patient bag valve ventilated until re-assessment and airway decisions are made by the crew.		
Officer			Assignment	
				<b>Davis-NFA 2012</b>

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