

Capacity to Rescue: Nurse Behaviors that Rescue Patients

by

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## Dedication

This dissertation is dedicated to all of the people in my life who have made this possible. To my husband Eric, who has always encouraged me to pursue my dreams and who has worked tirelessly to support me through the process. To my children Cassandra and Lucas, who are the pride and joy in my life. To my parents William and Betty who provide encouragement and understanding. To my grandmother, Clara, who will always be with me. To my colleagues and friends who are always supportive and helpful.

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## ABSTRACT

Capacity to Rescue: Nurse Behaviors that Rescue Patients

By

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Chair: Richard W. Redman

Nurses play a large role in preventing or minimizing errors in the health care system including crisis intervention and managing unexpected events daily. The actions and behaviors of the nurse in a deteriorating clinical situation can have an immediate impact on the patient and may be the key to understanding why some patients do well and others experience complications during the course of their care.

Capacity to rescue is a new concept in nursing. Capacity to rescue is defined as the enactment of behaviors which allow for the optimization of patient outcomes, prevention of adverse events or reduction in the impact of an adverse event through early identification and timely interventions.

The capacity to rescue conceptual model was developed and its components (work environment, nurse characteristics, nurse competencies) and their relationships were then defined. The Capacity to Rescue Instrument (CRI) was developed. It is a 22

item instrument used with a clinical simulation scenario to measure the nurse's capacity to rescue. The clinical simulation measured the patient's outcome in the specific condition used in the simulation scenario. The CRI instrument underwent validity and reliability testing. Factor analysis reduced the instrument from 36 to 22 items. Construct validity demonstrated a significant and positive relationship between capacity to rescue and outcomes ( $r=.772$ ,  $p<.01$ ) and the reliability coefficient was  $\alpha=.69$ .

In addition to the CRI measure, several other measures were used as well. These included the Psychological Empowerment Instrument (1995), the Error Orientation Questionnaire (1999) and the Watson Glaser Critical Thinking Appraisal (2006). Data were gathered on 78 critical care nurses.

Hypotheses testing on the conceptual model showed mixed results. No significant relationships were found between the predictors (empowerment, error orientation, critical thinking) and capacity to rescue. A significant relationship was found between capacity to rescue and patient outcomes related to the condition ( $p < .01$ ) and the regression analysis showed the predictor variables (capacity to rescue, risk taking, critical thinking) explained 60% of the variance.

Although findings did not show significant relationships between all predictor variables and capacity to rescue, the relationship between capacity to rescue and patient outcomes holds promise.

## Chapter 1

### Statement of the Problem

#### *Background*

Approximately 44,000 to 98,000 people die each year as a result of medical errors. These numbers are based on two large studies conducted in Colorado and Utah as well as New York. When the rate of adverse events that lead to death is extrapolated to the entire number of patient admissions to U.S. hospitals the results imply at least 44,000 people will die and as many as 98,000 people could die. This exceeds the number of deaths due to motor vehicle accidents, breast cancer and AIDS annually. While 6000 people die each year as a result of workplace injuries, 7000 people will die each year as a result of medication errors (Kohn, Corrigan, & Donaldson, 2000). Many of these deaths are preventable and nurses are a part of this health care dilemma.

Nurses are a vital part of the error and adverse event prevention activities through their role in surveillance. Nurse surveillance, a nursing monitoring activity, is an important mechanism for detecting errors and preventing adverse events. Surveillance detects changes in a patient's condition through the nurse's observations of the patient's physical or cognitive status (Page, 2004). The goal of nursing surveillance is the early detection of a downturn in patient status as well as the initiation of activities to "rescue" the patient. Rescuing patients generally consists of two phases: surveillance and timely identification of complications and mounting an effective rescue response. Good nursing

surveillance is consistently related to lower patient mortality and when nurse surveillance is not present, failure to rescue is said to occur (Clarke & Aiken, 2003).

Failure to rescue is a term that has been recently introduced and studied in health care. The term was first used to study outcomes in surgical patients (Silber, Williams, Krakauer, & Schwartz, 1992). Since its introduction it has undergone an evolution from the original goal, to examine hospital characteristics' effect on mortality, to the current expanded use, measuring the nursing interventions and outcomes through nursing practice (Manojlovich & Talsma, 2007). Failure to rescue rate is defined by the Agency for Healthcare Quality and Research (AHRQ, 2005, p. 19) as "deaths per 1000 patients having developed specified complications of care during hospitalization." These specific complications generally include: pneumonia, deep vein thrombosis/pulmonary embolus, sepsis, acute renal failure, shock/cardiac arrest, or gastrointestinal hemorrhage/acute ulcer. Although most studies using failure to rescue define it as a rate of death from complications, failure to rescue can be more broadly defined to include failing to prevent those adverse events from occurring at all. Adverse events are injuries caused by clinical intervention as opposed to a health condition of the patient. A failure to rescue occurs when the patient experiences preventable adverse events. Preventable adverse events are those adverse events that are the result of an error (Page, 2004). This wide variation in the definition of failure to rescue can lead to difficulties in interpreting results of the research studies on this topic.

Most of the studies using failure to rescue as an outcome are linked to the absence of nurses or to the commission of errors by nurses (Clarke, 2004). Failure to rescue is a concept that is very helpful in determining the effects of the absence of nurses

which can lead to the conclusion that nursing presence is linked to the avoidance of failure to rescue. However, studying failure to rescue from a positive perspective offers the potential for avoiding some of the consequences that can be associated with studying negative outcomes, although it may require a different approach. When studying failure to rescue, it is difficult for nurses to evaluate objectively poor patient outcomes without feeling victimized or fearing repercussions for their apparent faulty actions (Clarke, 2004). Additionally, the study of failure to rescue has been focused primarily at the unit or hospital level, not the individual level.

A systems approach to the study of patient safety can overcome barriers to patient safety by moving away from the blame and shame approach that has dominated the health care culture in the past (Kalisch & Aebersold, 2006). This approach has many advantages when fixing problems in the health system which can lead to errors. However, understanding the individual role in error prevention is also important. Airline pilots undergo two types of training, crew resource management to help them learn teamwork behaviors that cause system failures of communication and individual training to improve their own skills in managing the plane during a crisis. Health care traditionally has focused just on individual clinicians in the past.

Few studies look at the individual nurse and his or her direct role in rescuing patients. The ability to study the individual nurse's role in rescue would add to the research on failure to rescue. A need exists to bring a positive research perspective to the frontline, at the bedside with the individuals caring for the patients: the nurses. This is a first step in an overall approach to patient safety that would combine individual and system interventions to improve patient outcomes. Both are necessary to improve patient

safety. Developing and studying a model of the individual nurse's contribution to the rescue of patients and testing that model to determine its validity would lead to a proactive and positive approach to studying failure to rescue.

### *Statement of the Problem*

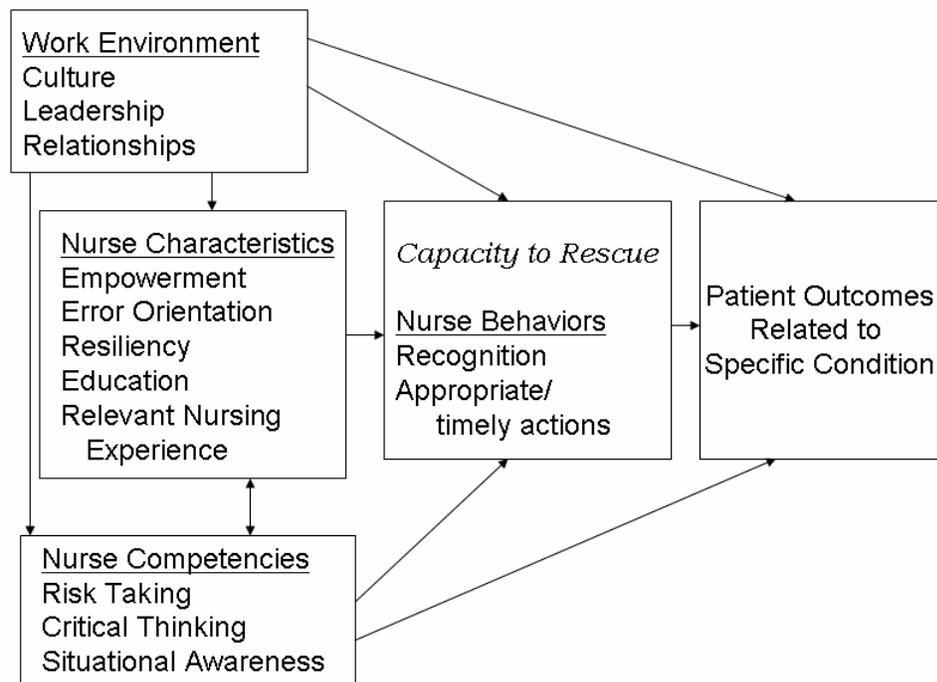
Nurses play a large role in preventing or minimizing errors in a very complex and unpredictable health care system including crisis intervention and managing unexpected events daily. The role of the nurse is critical in managing the new drugs and treatments that are increasingly available and the new and complex equipment that is part of the normal work environment. Nurses need to be flexible and yet maintain a professional dedication to patients and families. Often, the nurse at the bedside or at the frontline of care makes the difference between a positive outcome for the patient and failure to rescue. The actions and behaviors of the nurse in a deteriorating clinical situation can have an immediate impact on the patient. This set of nurse behaviors may be the key to understanding why some patients do well and others experience complications during the course of their care. Nursing vigilance can protect patients from errors. A study of medication errors in two hospitals found nurses intercepted 86% of all medication errors made by physicians, pharmacists and others before the error reached the patient (Leape et al., 1995).

The study of individual nurse behaviors is critical, but has been a challenge in the past due to the expense and difficulty of direct observations of clinicians (Seago, Williamson, & Atwood, 2006). However, the study of nurses who perform well may identify the characteristics and competencies those nurses possess that lead to the specific behaviors that rescue patients. Research in this area can lead to interventions designed to

improve upon those competencies and create environments that support these characteristics and behaviors and reduce preventable adverse events and improve health care for all patients.

To undertake this approach to improve patient safety a new concept, *capacity to rescue*, was developed. The concept, capacity to rescue, describes and defines the elements needed to prevent a failure to rescue. Capacity to rescue is defined as the enactment of behaviors which allow for the optimization of patient outcomes, prevention of adverse events or reduction in the impact of an adverse event through early identification and timely interventions. The overall model identifies all of the elements needed to create a high degree of capacity to rescue (Figure 1.1).

**Figure 1.1 Capacity to Rescue Conceptual Model**



The concept of capacity to rescue takes a more proactive approach in addressing patient safety concerns and errors. The set of behaviors in capacity to rescue includes: early recognition of problems, timely response to the problems and appropriate actions taken by the nurse. Additionally capacity to rescue leads to positive patient outcomes. In this conceptual model patient outcomes are defined as those outcomes related to the specific patient condition being evaluated. These outcomes can include avoiding complications, correcting adverse events and maximizing patient outcomes. This new concept is focused on prevention of failure to rescue, prevention of adverse events and/or dealing effectively with complications when they occur.

The research reported here addressed four research questions:

Q1: What are the nurse behaviors associated with capacity to rescue?

Q2: Are there certain nurse characteristics that are associated with capacity to rescue?

Q3: Are there certain nurse competencies that are associated with capacity to rescue?

Q4: Is capacity to rescue associated with positive patient outcomes specific to the condition being measured?

Q5: Are there certain nurse competencies associated with positive patient outcomes specific to the condition being measured?

### *Purpose*

The purpose of this study was to develop and describe the concept capacity to rescue and then to examine the characteristics and competencies of the nurse needed for capacity to rescue behaviors to occur. The study focused on individual nurse variables.

Variables associated with work environment were not addressed at this time due to their systems nature. This study focuses on individual variables first to provide insight on the proposed elements of capacity to rescue. Healthcare leaders who can identify those behaviors are in the best position to hire and train nurses who will provide optimal patient outcomes. While it is admirable to do root cause analysis on what went wrong and to change systems to prevent systemic problems from contributing to errors, in the end it is the nurse at the bedside who may be the only barrier between an error and the patient. In addition to investing health care dollars on systems, it is also necessary to invest dollars on workforce training. There are many factors that contribute to the success of patient care. The number of deaths per year from adverse events is at a critical point. The only way to improve this is for healthcare organizations and government agencies to focus on an overall approach to improve safety. This approach will require many changes in the health care system. Those changes need to be based on research evidence to determine the best practices for improving the death rate from preventable adverse events.

This dissertation is divided into five chapters which represent three separate papers developed to address the research questions along with an introductory chapter and a chapter for summary and conclusions. Chapter Two addresses the research question: what are the nurse behaviors associated with capacity to rescue? This chapter presents a conceptual development and analysis of the concept capacity to rescue and the conceptual model associated with it. Chapter Three addresses question one by describing the scenario and instrument development process used to measure capacity to rescue and patient related outcomes. Chapter Four addresses questions two, three, four and five: are there certain nurse characteristics that are associated with capacity to rescue and are there

certain nurse competencies that are associated with capacity to rescue? Also, are there certain nurse competencies associated with positive patient outcomes? Finally, is capacity to rescue associated with positive patient outcomes? This chapter presents the methodology and results from the testing of the conceptual model, capacity to rescue. The variables tested included: empowerment, error orientation, critical thinking skills, risk taking and capacity to rescue. The following hypotheses were tested and are presented in chapter four:

H1: Levels of capacity to rescue are influenced by empowerment, error orientation, and critical thinking.

H2: Patient outcomes related to specific condition are influenced by capacity to rescue.

H3: Patient outcomes related to specific condition are influenced by critical thinking, error risk taking, and capacity to rescue.

The final chapter presents a synthesis of the three previous chapters and includes implications for further research in nursing practice and health policy.

### *Significance*

Health care is in a crisis that came to the public attention in 1992 and continues today. Errors are the cause of that crisis and the battle to prevent them continues on with limited success overall. Health care systems are error prone and patients are vulnerable. The nurse is in the middle of this dilemma, as the caregiver that spends the most time with the patient and has the most to gain or lose in the battle to decrease or prevent errors. Many organizations, such as The Joint Commission (TJC), The Agency for Health Care and Quality (AHRQ) and the Institute for Health Care Improvement (IHI) are committing

large resources to the battle against errors and preventable adverse events. Research in this area of error prevention is timely and necessary to ensure the high quality of care that patients deserve. The nurse is a key player in this and can be the only barrier between an error waiting to happen and the patient. It is critical that research be undertaken to understand what assists the nurse in error prevention. Research on failure to rescue was just the beginning of this and now the focus needs to be not only on preventing failure to rescue, but increasing capacity to rescue. This research proposes to increase the knowledge about how the individual nurse rescues patients. This will also be a first step in analyzing a conceptual model of capacity to rescue by understanding what competencies and characteristics are present in the nurse that support rescue behaviors. This understanding will lay the groundwork for further development of capacity to rescue and inclusion of the work environment variables.

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## Chapter 2

### Concept Analysis of Capacity to Rescue

Capacity to rescue is a new concept in nursing that will potentially change how the relationship between nurses and patient safety is viewed. Capacity to rescue is a concept that builds on the positive role of the nurse in patient safety and is a more proactive way to describe that role. The concept, capacity to rescue, describes and defines the elements needed to prevent a failure to rescue, currently defined as death of a patient from a preventable cause (Page, 2004).

Capacity to rescue is defined as the enactment of nursing behaviors which allows for the optimization of patient outcomes, prevention of adverse events or reduction in the impact of an adverse event through early identification and timely interventions. This definition takes a more proactive approach to addressing patient safety concerns and errors. Capacity to rescue is a new phenomenon in health care and has not previously been defined or studied. This new concept is focused on prevention of failure to rescue, prevention of adverse events and/or dealing effectively with complications when they occur. The set of behaviors in capacity to rescue includes: early recognition of clinical problems, timely response to the problems and appropriate actions taken by the nurse.

Nurses are at the front line of the health care system when they are providing care to patients. During their assessments and delivery of therapeutic interventions and education they are often the first to detect any patient problems and prevent complications. This vigilance by the front line workers is essential in detecting threats to

safety before they become patient errors (Roberts, 1990; Roberts & Bea, 2001). Capacity to rescue is based on this concept of error prevention and/or rescue if complications do occur. The newly defined concept of capacity to rescue provides a different way to view the problem of error detection and prevention. The purpose of this paper is to introduce the concept of capacity to rescue and describe how it was developed using Norris' (1982) approach to concept development. This will address the research question: What are the nurse behaviors associated with capacity to rescue?

### *Background*

Much has been written in the last twenty years on safety in health care. Beginning with the seminal report, *To Err is Human*, (Kohn, Corrigan & Donaldson, 2000) healthcare has undergone a revolution transforming our view of errors from something that is a consequence of hospitalization to something that is preventable. Adverse events to patients have been categorized as those that are preventable in contrast to those events that are a natural complication of the disease process (Silber, Williams, Krakauer, & Schwartz, 1992). In the midst of all this is the nurse who is inseparably linked to patient safety. Nurses are also at the forefront of care in the acute care setting. Every patient who is admitted to a hospital receives much of their care from nurses. In addition, nurses generally coordinate the care during an inpatient episode. A distinguished physician summarized eloquently the role of the nurse at the time of his death in his book, *The Youngest Scientist: Notes of a Medicine Watcher*:

One thing the nurses do is to hold the place together. It is an astonishment, which every patient feels from time to time, observing the affairs of a large, complex hospital from the vantage point of his bed, that the whole institution doesn't fly to pieces. A hospital operates by the constant interplay of powerful forces pulling away at each other in different directions, each force essential for getting

necessary things done, but always at odds with each other....My discovery, as a patient... is that the institution is held together, *glued* together, enable to function as an organism, by the nurses and by nobody else. (Thomas, 1983, p.66-67).

Registered nurses comprise 23% of the entire health care workforce and nursing staff (licensed nurses and unlicensed nursing staff) account for 54% of the health care workforce in the U.S. (Page, 2004). Every day, nurses play a significant role in preventing or minimizing errors, including surveillance, crisis intervention and management of the unexpected events, in a very complex and unpredictable health care system. Nursing surveillance was one of three organizational variables related to lower mortality (Mitchell & Shortell, 1997). Nurses function at the front line of the health care system while they are performing assessments and interventions. This role is essential in promoting patient safety but only if the nurse is vigilant in detecting downturns in patient's health status. The role of the nurse is critical in managing the new drugs and treatments that are increasingly available and the new and complex equipment that is part of the normal work environment (Page, 2004).

The actions and behaviors of the nurse in various patient care situations can have an immediate impact on the patient. Understanding nurse behaviors and actions is critical to understanding why some patients do well and others experience complications during the course of their care. Studying individual nurse behaviors is critical, but has been a challenge in the past due to the expense and difficulty of direct observations of clinicians (Seago, Williamson, & Atwood, 2006).

Failure to rescue has limitations to its usefulness as a concept due to its negative framing. Therefore, a more proactive approach to studying this phenomenon of rescue is needed to further the research on patient safety and patient outcomes. Currently the

concept of failure to rescue is being studied extensively in the patient safety literature as a way to understand how we can decrease errors and improve patient outcomes. Failure to rescue is the failure of the staff to prevent the death of a patient after an adverse event occurs (Clarke & Aiken, 2003). Studies conducted on patient safety usually measure a failure to rescue rate, with a retrospective comparison of failure to rescue rates and hospital work environment characteristics. In 1992, Silber et al. described adverse occurrences and failure to rescue. The study looked at both hospital and patient characteristics and their associated relationship to adverse occurrences and failure to rescue. Rescue was defined as preventing a death after an adverse occurrence. The premise of the study was to propose an alternative way to evaluate hospitals. At the time the most common outcome measurement in hospitals was death rate. Although this number was adjusted for case mix and severity of illness, it may not directly link to quality of patient care. The assumption behind death rate is that hospitals with a lower mortality or death rate are superior at preventing complications and rescuing a patient after complications occur.

Silber, et al., (1992) proposed using this failure rate as the alternative measure to mortality. They hypothesized that the factors that prevent adverse occurrences are different than those that allow rescue after a complication. They believed that while patient characteristics are the primary causes of complications after surgery, the response to those complications varies among hospitals. A hospital with a low complication rate but a high failure to rescue rate can still have a lower death rate than another hospital with a high complication rate and a low failure to rescue rate. The complication rate is influenced by patient co-morbidities while the failure to rescue rate is influenced by

hospital characteristics. The findings of their study did indicate the presence of hospital characteristics that did not influence complication rates but did influence failure to rescue rates.

Failure to rescue rates have also been used in studies linking nurse staffing levels to quality of patient care (Needleman, Buerhaus, Mattke, Stewart, & Zelevinsky, 2002). One of the measurements used in this study was failure to rescue. The definition used for failure to rescue was death from pneumonia, shock or cardiac arrest, upper gastrointestinal bleeding, sepsis, or deep venous thrombosis. The study showed a link between lower failure to rescue rates and higher portion of registered nurse (RN) hours of care.

The influence of hospital characteristics on inpatient mortality rates has also been published in the nursing literature (Servellen & Schultz, 1999). In their review they found several studies which demonstrated an association between higher ratios of RNs and lower hospital mortality rates. The authors suggest that RN presence accounts for this lower mortality rate. In hospitals known for good nursing care and lower mortality rates, certain organizational characteristics exist. These include greater professional autonomy, more control over practice environments, and better relationships with physicians. When caring for patients with unstable conditions these characteristics assist in the early detection and prompt intervention critical to rescuing patients who are at risk for multiple organ failure.

Most of the studies in failure to rescue focus on prevention strategies such as surveillance, which is a primary activity performed by nurses in acute care settings. Surveillance includes assessment of patients, monitoring, attending to cues, and

recognizing complications (Page, 2004; Clarke & Aiken, 2003). This ongoing surveillance function allows the nurse to detect potential adverse events by observing changes in the patient's physical or cognitive status. This requires attention, knowledge and responsiveness by the nurse and often leads to rescue of patients.

Mitchell and Shortell (1997) posit nursing surveillance as one of three organizational process variables consistently associated with lower mortality. While engaging in surveillance, nurses are functioning at the front line of the health care system because they are linked to the patient at the bedside (Reason, 2000). The goal of nursing surveillance is the early detection of changes in patient's condition to allow for the early initiation of activities to rescue patients. Studies have documented the role of nursing surveillance in medication errors. According to a study by Leape et al. (1995), nurses intercepted 86% of all medication errors made by other members of the team.

Although most studies using failure to rescue define it as a rate of death from complications, failure to rescue can be more broadly defined to include failing to prevent those adverse events from occurring at all. Adverse events are injuries caused by medical intervention as opposed to a health condition of the patient. A failure to rescue occurs when the patient experiences a preventable adverse event which occurs as the result of an error (Page, 2004).

The studies conclude that nursing surveillance is the key to preventing failure to rescue. Since nursing surveillance is associated with lower failure to rescue rates, it is important to understand what makes up good nursing surveillance skills and to study how those skills will prevent failure to rescue. The concept, capacity to rescue, will allow an

examination of those individual nurse behaviors that make surveillance and rescue happen.

### *Concept Development Process*

Concept development is a critical approach to theory development in nursing. The development of concepts is important to the expansion of nursing knowledge (Rodgers, 2000). Concepts are the classification of phenomena by using words that bring worth to mental pictures of things (Fawcett, 2004). Concepts can be considered the building blocks of theory and are the symbols for the objective elements in the world. Concept development is needed when there are few or no concepts available in the theorist's focal area of interest. In this case the theorist must obtain or invent concepts that are relevant to the phenomenon to be studied (Walker & Avant, 1995).

Conceptual models refer to global ideas about individuals, groups, situations or events that are of interest to science. They are not theories but are a set of concepts that have relationships. Concepts in a conceptual model are usually highly abstract and therefore not directly measurable in the real world. A conceptual model provides a perspective for scientists, allowing them to describe relationships and provide the basis for testing them which is the first step in theory formation (Fawcett, 2004). There are several methods available to researchers in the area of concept development and concept analysis.

One approach to concept clarification that can be used by nurse researchers to clarify phenomena important to the development of nursing knowledge was identified by Norris (1982). The components of concept clarification can then be used as variables in research studies. Norris (1982) used a five step approach: identifying the concept and

observe and describe it, systematizing the observations and descriptions, deriving an operation definition, producing a model and formulating hypotheses.

The first step in the process is to observe and describe phenomena. The step begins when the researcher identifies a concept of interest. The researcher then observes this concept in a variety of settings and describes the sequence and context of events and the antecedents and consequences involved in the phenomenon. The researcher can also look to other disciplines to see if the phenomenon occurs elsewhere. The researcher may want to discuss this with others in that field or even observe the phenomenon outside of nursing. Then the researcher conducts a thorough review of the literature to obtain information about the phenomenon of interest (Lackey, 2000).

The second step in the process involves systematizing the observations and descriptions. This can involve grouping observations into categories and/or hierarchies based on the components or elements of the observations. In step three, deriving an operational definition, the researcher needs to create a definition that will allow for measurement of the concept. Waltz, Strickland and Lenz (2005) advise researchers to be thoughtful in this process of developing an operational definition to ensure the ability to accurately measure it in future research.

The fourth step in Norris's (1982) process is to produce a model of the concept that includes all of its component parts. The model will enable researchers to re-examine the categories and hierarchies that were previously described and will help facilitate the identification of relationships between components. The fifth and final step involves hypothesis formation to predict relationships between the variables in the model for

empirical testing. The Norris (1982) method was used to define and clarify the concept capacity to rescue, to enable the research on rescue to move in a more proactive direction.

*Observational Data (step 1)*

The phenomenon of interest to be studied was how nurses engage in the care of their patients and how they use rescue behaviors in their practice. Nurses who practice at an expert level have certain behaviors that they engage in regularly when they provide care for their patients. Benner, Tanner and Chesla (1996) describe the clinical judgment used by experienced nurses as an engaged, practical reasoning process, not a purely theoretical reasoning process. They use the term clinical judgment to refer to the ways nurses understand the problems and concerns of patients and attend to salient information. These nurses often engage in individualized prevention activities aimed at the patient's unique needs. For example, if a patient is admitted post-operatively, the nurse engages in activities to prevent post-operative complications. These activities are given a high priority and are consistently and routinely done. The nurse uses evidence-based practice guidelines to deliver the care and is knowledgeable about the literature in his/her area of practice, e.g., neuroscience or pediatric cardiology.

The nurse also engages in surveillance activities which require accurate, timely and relevant assessment skills. The nurse must know what to assess and then be able to accurately conduct that assessment. The nurse regularly assesses the patient for changes in condition and has an understanding of potential patient complications. "A good clinician is always interpreting the present clinical situation in terms of the immediate past condition of the patient" (Benner, Hooper-Kyriakidis, & Stannard, 1999, p. 10). They are able to quickly and accurately recognize when there is a change in the patient's

condition based on their assessment. Benner et al (1996) describe this behavior in their work; nurses studied describe an intuitive feeling in which they anticipated a decline in a patient's condition before there was any objective evidence. The nurses use pattern recognition based on their experiences to detect these subtle warning signs.

Additionally, the nurse is able to respond correctly to the changes in the patient's condition and also responds in an appropriate timeframe. This is done through pattern recognition and relying on their experience in working with similar types of patients (Benner et al.,1996). If this situation is urgent, the nurse does not hesitate to take the appropriate actions, which include a variety of nursing interventions aimed at improving the patient situation. Actions can also include informing the physician of the patient's current condition and providing advice and suggestions on how to treat the patient's condition if it begins to deteriorate. Benner et al (1996) studied nurses as they prepared to make a case to a physician for a different course of treatment. They found that nurses want to assure themselves that their grasp of the situation is accurate so they test out other understandings of the situation by considering the relevancy and adequacy of their past experiences and the possible consequences if their intuition is wrong. These appropriate nurse behaviors can also improve with experience and knowledge acquisition (Benner et al., 1999).

Behaviors, such as recognition, timely response, and appropriate actions, are present in nurses who provide excellent care to their patients and whose patients have better outcomes. There are many examples of these behaviors in nursing in a wide variety of settings. During the care of a post-operative patient, the nurse will ensure physician orders are carried out as appropriate. In addition, the nurse will ensure appropriate post-

operative care is also performed even if it had not been ordered. The nurse will write nursing orders or care plans to identify the needed care if the care is within the scope of nursing practice. The care could include ambulation of the patient, hourly incentive spirometry, making sure anti-deep vein thrombosis measures such as sequential compression devices are on and functioning, and making sure the patient is receiving adequate nutrition. If there is care required that is outside the scope of the nursing role then the nurse will contact the appropriate physician to obtain the order.

Another area where we can look to find behaviors that improve safety are in high reliability organizations (HROs). HROs are organizations that while inherently hazardous, such as nuclear submarines or aircraft carriers, have fewer accidents or adverse events than would be expected. These organizations are considered to possess a safety culture that allows them to maintain this high degree of safety despite very hazardous conditions. One of the behaviors of people who work in HROs is the ability to see the significant meaning in weak signals and to mount a strong response (Weick & Sutcliffe, 2001). An example of this in nursing is when the nurse who is caring for a patient detects subtle changes (weak signals) and may suspect something is wrong with the patient. It could be the patient's color has changed or the neurological status is slightly different than it was upon an earlier exam. Although the changes are subtle, the nurse mounts a strong response and notifies the physician to ensure that the patient gets help if needed. If the physician is resistant, the nurse must decide if it is worth the risk to pursue it, by getting another physician or an administrative nurse involved. This can be risky because of potential repercussions to the nurse depending on the environment in

which the nurse works. Some nurses work in environments where there is not sufficient support for independent judgment in these situations.

Expert nurses develop the ability to sense when something is not right with their patient. This is based on years of experience caring for patients in similar situations. The nurse learns to recognize patterns that indicate potential problems. This is often described as intuition which is characterized by the immediate apprehension of a clinical situation. The nurse uses contextual and relational cues from the patient to understand what is occurring. These cues allow for early warnings of a patient's potential demise before more obvious signs and symptoms are noticed (Benner et al., 1996).

Observations of nursing care at the bedside indicate that certain nursing staff consistently perform at more than just a competent level. Benner (1984) has studied individual nurses and how they function in caring for patients. She has discovered that nurses often progress through a series of five stages: novice, advanced beginner, competent, proficient, and expert. However, not every nurse advances beyond the competent level. Nurses who practice at a proficient or expert level demonstrate certain behaviors that make them successful at providing good patient outcomes.

Nurses engage in optimizing patient outcomes when they anticipate problems, act in ways to try to prevent problems from occurring, quickly identify when problems start to occur and take the appropriate actions to reduce the impact of the problem. This group of behaviors is a new concept in nursing called capacity to rescue that leads to rescue of patients. The most closely associated concepts that exist currently in the nursing and safety literature are surveillance and failure to rescue.

*Systematizing the Observations (step 2)*

Studies using failure to rescue as an outcome are linked to the absence of nurses or to the commission of errors by nurses (Clarke, 2004). Studying the effect of the absence of nurses does not support the perception that a strong nursing presence is associated with positive outcomes. Studying failure to rescue from a positive framework offers the potential for avoiding some of the consequences that can be associated with studying negative outcomes, but this research may require a different approach. A consequence found in studying failure to rescue, is the difficulty nurses have to objectively evaluate poor patient outcomes without feeling victimized or fearing repercussions for their apparent faulty actions (Clarke, 2004). The study of failure to rescue has been focused at the unit or hospital level, not the individual level. Few studies look at the individual nurse and his or her direct role in rescuing patients.

The surveillance function of nurses is linked to preventing failure to rescue, but what is it that enables the nurse to perform that surveillance function effectively? Observations of nursing care at the bedside indicate that certain nursing staff consistently perform at more than just a competent level. The observations indicate there are certain behaviors and actions the nurse takes that prevents a failure to rescue from occurring. This set of behaviors is the key to a new concept: capacity to rescue. These behaviors start with surveillance but go much further than just observing the patient. These behaviors can be categorized into three separate areas: recognition, timely response and appropriate actions.

### *Capacity to Rescue Defined (step 3)*

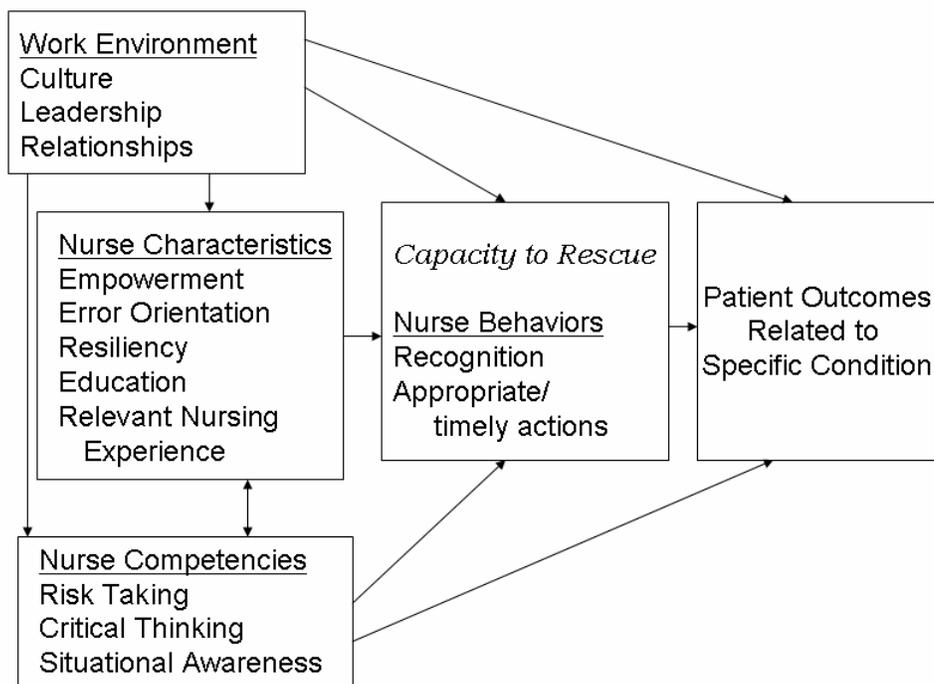
Capacity to rescue is defined as the enactment of behaviors which allow for the optimization of patient outcomes, prevention of adverse events or reduction in the impact of an adverse event through early identification and timely interventions. The specific behaviors of the nurse are: early recognition of problem, timely responses and appropriate actions. As stated earlier, this definition takes a more proactive approach in addressing patient safety concerns and errors based on this concept of error prevention and/or rescue if complications do occur.

### *Conceptual Model and Relationships (step 4 and 5)*

The fourth step in the process is to develop a model of the concept and its component parts. The fifth and final step in Norris' (1982) process involves hypotheses formation. This can be done by describing the relationships in the model from which the researcher can generate research questions and hypotheses to test. This section will describe the capacity rescue model and posit some initial hypotheses based on current knowledge.

The capacity to rescue model contains five essential components: work environment, nurse characteristics, nurse competencies, capacity to rescue behaviors and patient outcomes related to specific condition. The model can viewed in Figure 2.1.

**Figure 2.1 Capacity to Rescue Conceptual Model**



### *Work Environments*

The first component of the conceptual model, capacity to rescue, is the work environment. The environment in which the nurse practices is important for the nurse to enable capacity to rescue behaviors. It has been shown that characteristics in the work environment for nursing staff can affect job satisfaction and patient outcomes. Aiken, Clarke, Sloane, Sochalski, and Silber (2002) found that in hospitals with high nurse to patient ratios (a high number of patients per nurse), nurses were more likely to experience burnout and job dissatisfaction. Aiken, Havens, and Sloan (2000) found that at Magnet hospitals nurses had lower burnout rates, higher levels of job satisfaction and delivered high quality care. Magnet hospitals have been studied extensively because they have a low nursing turnover, high nurse satisfaction and good patient outcomes (McClure &

Hinshaw, 2002). Magnet hospitals had a 4.6% lower mortality rate. Aiken and Patricia (2000) found that autonomy was significantly related to control over practice and nurse-physicians relationships. Work environments are impacted by culture, leadership and relationships. A supportive environment will encourage capacity to rescue behaviors. A supportive environment is one which possesses a safety culture in which errors and near misses are looked upon as opportunities to learn and improve (Page, 2004; Weick & Sutcliffe, 2001). In a study by McGillis Hall, Doran and Pink (2008) unit characteristics can have an impact on nurse and patient outcomes. The study found that poor work environment was associated with nurses having a negative perception of their work and experiencing job stress. The study also found that having a higher proportion of RNs was linked to patients achieving a higher level of independence which can prevent adverse outcomes in patients related to mobility issues.

A systemic review and meta-analysis found that there is a statistically and clinically significant relationship between RN staffing and the adjusted odds ratio of hospital related mortality and failure to rescue (Kane, Shamliyan, Mueller, Duval, & Wilt, 2007). This may be related to the surveillance function of nurses in areas where additional staffing allow for more nursing time with the patient for surveillance functions.

Leadership, in particular transactional leadership, is a key element in a supportive work environment. Transactional leadership is a leadership style that focuses on raising others to a high level of motivation and morality (Kouzes & Posner, 2002). In the acute care environment, leadership is provided by the nurse manager of the unit or area. This person has the greatest influence on the nurse at the front line. A study by Aiken, Clarke,

and Sloane (2002) found that organizational and managerial support was essential to improving the quality of patient care.

Relationships are also an important component of the work environment, in particular nurse-physician relationships. In intensive care units, research has shown that positive nurse-physician relationships lead to improved patient care (Shortell, et al., 1994). Teamwork and commitment were also found to be related to nurse-physician collaboration in nurses working on medical-surgical units (Tschannen, 2004). Nurse-physician relationships have been discussed in the literature but few studies exist to date looking at the impact on patient care.

### *Hypotheses.*

The following hypotheses are presented to explain the relationship of work environment in the capacity to rescue model.

H1: Higher levels of capacity to rescue will be associated with a positive work environment.

H2: Higher levels of capacity to rescue will be associated with supportive leadership.

H3: Higher levels capacity to rescue will be associated with high levels of nurse-physician relationships.

H4: Positive patient outcomes will be associated with a positive work environment.

H5: Positive patient outcomes will be associated with supportive leadership.

H6: Positive patient outcomes will be associated with high levels of nurse-physician relationships.

### *Nurse Characteristics*

The next component of the model capacity to rescue is the characteristics of the nurse. Characteristic is defined as a trait, quality, or property or a group of them distinguishing an individual, group or type (*Websters, 2002*). The characteristics in capacity to rescue include: empowerment, error orientation, resiliency, education, and years of relevant nursing experience.

Psychological empowerment is "...a motivational construct manifested in four cognitions: meaning, competence, self-determination, and impact" (Spreitzer, 1995, p. 1444). Empowered nurses are intrinsically motivated (Thomas & Velthouse, 1990). They also find meaning in their work, are competent in their competencies, are self directed in their work and believe that they can make an impact (Spreitzer, 1995). Competence was related to higher levels of effectiveness (Spreitzer, Kizilos & Nason, 1997). Research by Laschinger and colleagues found that staff nurse empowerment impacts trust in management and influences job satisfaction and affective commitment. Laschinger, Finegan and Shamian (2001) found that nurse's work satisfaction and organizational commitment were related to workplace empowerment and trust. Laschinger and Finegan (2005) also found that staff nurse empowerment has an impact on their perceptions of fair management practices, feelings of being respected and trust in management. These ultimately influenced job satisfaction and commitment. Empowered nurses have higher levels of competence and the work by Benner (1984) and Benner et al. (1996, 1999) shows that nurses who function at a highly competent or expert level have better patient outcomes.

Error orientation is defined as how one copes with errors and how one thinks about errors at work (Rybowiak, Garst, Frese, & Batinic, 1999). Error management has been the focus of health care organizations and human factors engineers. Error management has two components: 1) decreasing the number of errors and 2) creating systems that are better able to tolerate errors and have measures in place to contain the adverse effects of human errors. High reliability organizations have found successful ways to decrease errors by improving how they manage them when they do occur. One of the key strategies used is a collective preoccupation with the possibility of failures. This creates an expectation in the organization that errors will happen and people need to know how to respond in that situation (Reason, 2000). To facilitate a successful error management strategy, it is important to have an intrapersonal perspective of errors from the workers on the front line. In health care that front line is the nurse at the bedside. The concept of error orientation can provide the ability to understand the intrapersonal perception of errors. A person with a positive error orientation would be more diligent about error avoidance and recover more quickly if an error does occur.

Resiliency is also called hardiness and refers to the ability to maintain a positive adjustment under challenging conditions. In organizational theory, resiliency refers to the capacity of individuals to absorb strain and preserve or improve functioning and to recover or bounce back from untoward events (Sutcliffe & Vogus, 2003). This can also describe the ability to bounce back from errors in health care. When individuals have experiences that allow them to encounter success and build self efficacy it motivates them to succeed in future endeavors (Sutcliffe & Vogus, 2003).

Educational preparation has been linked to positive patient outcomes (Aiken, Clarke, Cheung, Sloane, & Silber, 2003). Educational preparation in capacity to rescue is limited to the nursing degree that the individual nurse possesses. Nursing focused degrees would give the nurse additional knowledge and competencies to deliver better care.

Years of relevant experience are also important. Relevant experience is a better indicator than total experience alone, because a nurse needs to be experienced in caring for a particular patient population to become an expert in that care. If the nurse has experience in acute care but moves to intensive care they become a novice in that area (Benner et al., 1999). Years of relevant experience would include experience caring for the patient population in the setting that the nurse is currently practicing in, such as intensive care or acute care. This would lead to competency in practice. When higher levels of competent nurse staffing are present, failure to rescue rates are reduced (Clarke & Aiken, 2003).

### *Hypotheses.*

The nurse characteristics of the model will lead to the following hypotheses:

- H1: Higher capacity to rescue will be associated with high intrapersonal empowerment.
- H2: Higher capacity to rescue will be associated with high error orientation.
- H3: Higher capacity to rescue will be associated with high resiliency.
- H4: Higher capacity to rescue will be associated with a higher nursing degree.
- H5: Higher capacity to rescue will be associated with more years of relevant experience.

### *Nurse Competencies*

The next component of the model, capacity to rescue, is the nurse's competencies. Competency is defined as having sufficient knowledge, judgment, skill or strength for a particular duty (*Websters*, 2002). The competencies in capacity to rescue include risk taking ability, critical thinking, and situational awareness.

Risk taking refers to the nurse's willingness to take risks in a challenging situation. In particular, error risk taking refers to openness toward errors and willingness to take risks (Rybowiak et al, 1999). Research by Smith and Friedland (1998) examined the concept of the nurse manager's propensity to risk. This study used the conceptual framework developed by Sitkin and Pablo (1992) in which behavior is more risky when decisions are made in situations of greater outcome uncertainty, difficult goal achievement, and potential extreme negative or positive consequences. The study found: 1) nurse managers with stronger autonomy orientations had a higher propensity to take risks and 2) education accounted for a significant amount of the variance in risk propensity, with higher degrees taking more risk. This supports an earlier study by Grier and Schnitzler (1979) in which masters prepared nurses demonstrated a greater willingness to accept risk in order to achieve a desired gain.

Critical thinking is defined as the nurse's ability to use the cognitive skills of analysis, synthesis and evaluation in a challenging situation (Facione, Facione & Sanchez, 1994; O'Neill & Dluhy, 1997). Maynard (1996) examined the relationship between critical thinking skills and professional competencies. No evidence of a relationship between critical thinking ability and professional competence was found, but significant changes were found in critical thinking that occurred after a period of

professional nursing experience. O'Neill and Dluhy (1997) described critical thinking as one part of the skills needed for effective practice. Good critical thinking skills are usually associated with positive outcomes.

Another skill, situational awareness, is defined as the awareness of what is going on at the front line (Weick & Sutcliffe, 2001). This ability to comprehend all of the factors in the situation at hand is the skill the nurse possesses. Schon (1983) argues that expert practitioners often use a process called reflecting in action, where experts do not respond to a situation with linear, sequential thinking but rather with a 'feel' of the whole problem. Intuition was studied by Welsh & Lyons (2001). The ability to 'sense' when something is 'not as it appears to be' was examined in the decision making process of mental health practitioners. The study found that the use of research evidence, tacit knowledge, and advanced practitioner skills was evident in mental health nurse practitioner's decision making.

### *Hypotheses.*

The nurse competencies of the model will lead to the following hypotheses:

H1: Higher levels of capacity to rescue will be associated with higher levels of error risk taking.

H2: Higher levels of capacity to rescue will be associated with higher critical thinking skills.

H3: Higher levels of capacity to rescue will be associated with higher degrees of situational awareness.

### *Capacity to Rescue Nurse Behaviors*

The third component of the model is capacity to rescue which are the nurse behaviors of recognition, timely response and appropriate actions. These three behaviors define and describe capacity to rescue and are interrelated. Capacity to rescue occurs when the nurse recognizes a patient sign or symptom that could lead to a potential adverse event or less than optimal outcome. The nurse then takes the appropriate actions to prevent the adverse event or suboptimal outcome. Those actions must occur within an appropriate timeframe. An example of this is in the treatment of stroke. If a nurse caring for a patient recognizes signs of a stroke in the patient, then quick action must be taken to provide that patient with the optimal outcome. If the patient is having a stroke and could be eligible for treatment using tPA, that treatment must begin within three hours of symptom onset (“Tissue plasminogen activator,” 1995). If the nurse does not recognize the stroke symptoms or is slow to take action, the patient’s outcome will be less than optimal.

### *Hypothesis.*

Nurse behaviors will lead to the following hypothesis.

H1: Positive patient outcomes will be associated with high capacity to rescue behaviors.

### *Patient Outcomes*

The final component of the model is patient outcomes. Patient outcomes in the capacity to rescue model focus specifically on those patient outcomes related to the specific condition of the patient and are not meant to be generalized to all patient

outcomes. Capacity to rescue behaviors are focused on recognizing problems and taking action. Patient outcomes related to the capacity to rescue behaviors can include avoiding complications, correcting adverse events and maximizing patient outcomes. Linking patient outcomes to nurse behaviors is consistent with the Nursing Role Effectiveness Model (Irvine, Sidani, & McGillis Hall, 1998) which is based on Donabedian's (1980) model of structure, process and outcome. In this model nursing intervention is a process variable and is linked to patient outcomes. Nursing's impact on patient outcomes such as falls, pressure ulcers, nosocomial infections, and mortality has been well studied in the recent literature (White & McGillis Hall, 2003).

#### *Model Relationships*

The previously identified nurse characteristics and competencies are the foundation of the capacity to rescue behaviors: early recognition of problems or the potential for problems, timely response to the situation and appropriate actions taken to rescue the patient. Early recognition of problems or potential problems is achieved through the nursing surveillance function. Surveillance requires accurate, timely and relevant assessment skills. The nurse must know what to assess and then be able to accurately conduct that assessment. The appropriate actions taken by the nurse can include a variety of nursing interventions aimed at improving the patient situation. It can also include informing the physician of the patient's current condition and providing advice and suggestions on how to treat the patient's condition if it begins to deteriorate. These appropriate nurse behaviors can improve with experience and knowledge acquisition (Benner et al., 1999).

The relationship between nurse competencies and nurse characteristics are interdependent. Nurse competencies can be influenced by nurse characteristics and nurse characteristics can be influenced by nurse competencies. The relationship is continuous and cyclic. As the nursing skill level increases, empowerment increases because competency is a component of empowerment. For example, as empowerment increases, and the nurse understands the impact he/she makes on the patient, a desire to learn is present and her skill level will increase. As levels increase in competencies or characteristics there is a corresponding increase in the other areas. It is important to understand this interactive relationship between competencies and characteristics in addition to understanding how they each separately impact capacity to rescue behaviors and ultimately patient outcomes.

### *Conclusion*

Healthcare leaders who can identify capacity to rescue behaviors are in the best position to hire and train nurses who will provide optimal patient outcomes. While it is admirable to do root cause analysis on what went wrong and to change systems to prevent systemic problems from contributing to errors, in the end it is the nurse at the bedside who may be the only barrier between an error and the patient. In addition to investing health care dollars on systems, it is also necessary to invest dollars on workforce training. There are many factors that contribute to the success of patient care. The concept capacity to rescue can provide a mechanism to study individual nurses so that changes that can be made in the education and training of individual nurses at the front line of the health care system to promote better patient outcomes and safer patient care. This concept merits testing, as the next stage in validation and refinement.

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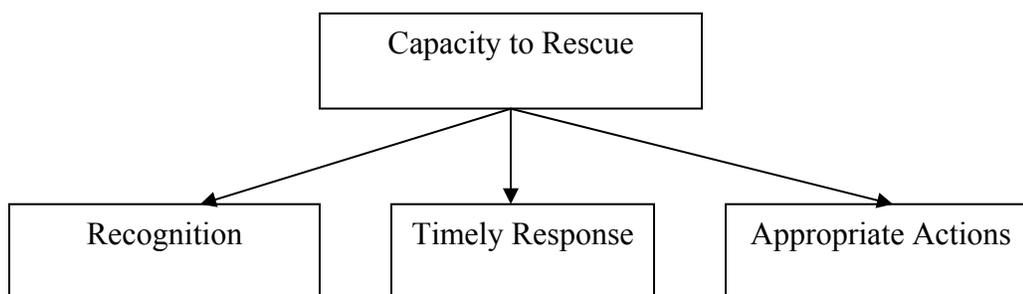
## Chapter 3

### Instrument Development for Capacity to Rescue

#### *Background*

Capacity to rescue is a new concept in nursing and currently an instrument is not available to measure it. Capacity to rescue is the enactment of behaviors which allow for the optimization of patient outcomes, prevention of adverse events or reduction in the impact of an adverse event through early identification and timely interventions. The set of behaviors in capacity to rescue includes three subscales: early recognition of problems, timely response to the problems and appropriate actions taken by the nurse (Figure 3.1).

**Figure 3.1 Capacity to Rescue Subscales**



Capacity to rescue is posited to be linked to safe and effective patient care, therefore, it is important to be able to measure this concept to permit researchers to determine if interventions aimed at increasing capacity to rescue are successful.

Instrument development is necessary when a researcher is studying a new phenomenon and no instrument exists to measure it. Researchers need a way to quantify new phenomena before they can conduct further research in the area (DeVellis, 2003).

The process of instrument development for capacity to rescue required several steps. The first step involved creating a clinical scenario which would require nurses to demonstrate capacity to rescue behaviors. The next step involved identifying the appropriate indicators to document capacity to rescue behaviors and patient outcomes. Additionally, it was important to determine patient outcomes related to the demonstrated capacity to rescue behaviors. Through data reduction strategies the final tool was reduced to 22 capacity to rescue indicators and five patient outcome indicators. This article describes the process used to develop the scenario and the capacity to rescue instrument and the psychometric testing of that instrument.

### *Capacity to Rescue*

The concept, capacity to rescue, describes and defines the elements needed to prevent a failure to rescue. This overall model identifies all of the elements needed to create a high degree of capacity to rescue. Capacity to rescue is defined as the enactment of behaviors which allow for the optimization of patient outcomes, prevention of adverse events, or reduction in the impact of an adverse event through early identification and timely interventions. This definition takes a more proactive approach than the currently used failure to rescue approach in addressing patient safety concerns and errors. The set of behaviors in capacity to rescue includes: early recognition of problems, timely response to the problems and appropriate actions taken by the nurse.

Capacity to rescue is a new phenomenon in health care and has not previously been defined or studied. This new concept is focused on prevention of failure to rescue, prevention of adverse events, and/or dealing effectively with complications when they occur. Nurses are at the front line of the health care system providing care to patients and during their assessments and delivery of therapeutic interventions and patient education they are in the best place to detect any patient problems and prevent complications. The constant vigilance by the front line workers is essential in detecting threats to safety before they become patient errors (Roberts, 1990; Roberts & Bea, 2001).

Capacity to rescue is based on this concept of error prevention and/or rescue if complications do occur. The newly defined concept of capacity to rescue provides a different way to view the problem of error detection and prevention. Capacity to rescue behaviors are linked to patient outcomes related to the specific patient condition being measured. These patient conditions can include septic shock, cardiogenic shock, and traumatic brain injury. The outcomes measured result from capacity to rescue behaviors that prevent failure to rescue, correct adverse events, and optimize patient outcomes.

Capacity to rescue is thought to be present not only in expert nurses but also to some degree in novice nurses. Capacity to rescue is influenced by a combination of nurse characteristics and competencies. Nurse characteristics are those characteristics of the individual nurse that have a direct impact on capacity to rescue. Nurse competencies are those individual competencies that each nurse possesses and that have a direct impact on capacity to rescue. Nurse characteristics and competencies also have some influence on each other.

These components along with work environment make up the capacity to rescue conceptual model that was detailed in chapter two. The three components of the model are work environment, nurse characteristics and nurse competencies. These characteristics include empowerment, error orientation, relevant nursing experience, education and resiliency. Empowerment is defined as the intrapersonal and motivational construct which has four components: meaning, competence, self-determination and impact (Spreitzer, 1995). Error orientation refers to how one thinks about errors (Rybowiak, Garst, Frese, & Batinic, 1999). Resiliency is the capacity of individuals to absorb strain and preserve or improve functioning and to recover or bounce back from untoward events (Sutcliffe & Vogus, 2003). Relevant nursing experience is the experience the nurse has in the setting that is relevant for the patient population and education refers to the nurse's highest nursing degree. The competencies component includes critical thinking, risk taking, and situational awareness. Critical thinking is the nurse's ability to use the cognitive skills of analysis, synthesis and evaluation in a challenging situation (Facione, Facione & Sanchez, 1994; O'Neill & Dluhy, 1997). Risk taking is defined as openness toward errors and willingness to take risks (Rybowiak et al., 1999) and situational awareness is the knowledge of what is going on at the front line or at the point where care is delivered (Weick & Sutcliffe, 2001).

Work environment includes culture, relationships and leadership. The capacity to rescue behaviors of the nurse are influenced by both individual and work environment factors. Capacity to rescue behaviors will be influenced directly by work environment but they will also be influenced by nurse characteristics and nurse competencies.

### *Clinical Scenario Development*

The use of simulators to provide education to nursing students and medical personnel has become more widespread. Simulation training has been used in the aviation industry and for anesthesia training. The technology used in simulation is well established in several disciplines and is used for pilots, astronauts, war games and training exercises for military personnel, management games for business executives and technical operations for nuclear power personnel (Salas & Cannon-Bowers, 2001). The use in the airline industry is aimed at improving pilot skills by approximating in-flight situations.

In the medical field, simulators can be used to provide standardized experiences for all trainees and can be reproduced accurately to train for both procedures and difficult management situations (Issenberg et al., 1999). Simulation is also used as part of the overall crisis management training of anesthesiologists. There are four categories of crises defined by the Institute for Crisis Management. These are: 1) acts of God, 2) mechanical problems, 3) human error, and 4) management decision/indecision (Vogt, 2004). Health care is impacted by all four.

“Simulation is a ‘technique’ and not a ‘technology.’ Simulation refers to the artificial replication of sufficient elements of a real-world domain to achieve a stated goal-and typically includes training of individuals and teams to deal with the domain, or testing the capacity of personnel to work in the domain” (Gaba, 2004, p. 7). There is currently no accepted classification scheme for patient simulators for use in medical education and the various classifications used have some overlap. Currently several types of simulation ‘devices’ are used. Mannequin-based patient simulators are most

commonly thought of when the word simulation is used. There are also computer-assisted instruction programs and training devices and partial-task trainers. Partial task trainers are a particular trainer used for a specific purpose such as a chest model for insertion of chest tubes.

The type of ‘patient’ simulator that is important for the research on capacity to rescue is mannequin-based with features and behaviors that respond as would a real patient’s physiology to clinical and drug interactions. This simulator is based in a recreated clinical work environment. This type of simulator is further defined by its fidelity, capabilities and control logic. Fidelity refers to how closely the simulation replicates the selected domain and the error between the elements and the real world. Capability refers to the features available on the simulator. Mannequin-based patient simulators also have outputs representing the patient’s physiologic responses, such as breath sounds, heart rate, palpable pulses, and airways that can change from normal to abnormal. Control logic is an essential feature which operates the changes in the mannequin based on pre-programmed inputs, responses to the inputs received by the mannequin or changes made by the controller or instructor running the scenario (Gaba, 2004).

Currently anesthesia training uses simulators such as the Medical Education Technologies (METI) simulator ([http://www.meti.com/hpsn\\_main.htm](http://www.meti.com/hpsn_main.htm)). The METI includes a whole body mannequin which can include actual hemodynamic monitoring systems and can be used in a mock clinical setting. METI can be used to train and assess personnel in emergency medicine and critical care nursing. The simulator can be programmed to allow individuals or teams to train for unforeseen or catastrophic events

such as cardiac arrest or trauma, and require the cooperation of individuals with varying expertise and backgrounds. The METI simulator has also been used for continuing medical education; discussion about its use as a valid measure for performance evaluation of physicians is ongoing (Issenberg et al., 1999).

A framework for using simulations as a teaching strategy was developed by Jeffries (2005). Jeffries defines simulation as "... activities that mimic the reality of a clinical environment and are designed to demonstrate procedures, decision-making, and critical thinking through techniques such as role playing and the use of devices such as interactive videos or mannequins" (p.97). Simulations can be high fidelity involving mannequins and interactive situations with role play and realistic physical responses from the mannequins.

The simulation framework includes five components which are necessary to consider when designing an effective teaching or research strategy using simulators. The five components are: teacher factors, student factors, educational practices, simulation design, and outcomes. Simulation design includes: objectives, planning, fidelity, complexity, cues, and debriefing. Each simulation scenario should have written objectives and a plan to guide student learning. The planning should also include a determination of the amount of time required and the role expectations. The fidelity or realism of the simulation needed to mimic clinical reality should be process based and have established validity. The scenarios need to be authentic and contain as many realistic environmental factors as possible (Jeffries, 2005; Medley & Horne, 2005).

The scenario structure requires three elements: 1) relatively little information is given initially; 2) the student is allowed to investigate freely; 3) the student is given the

clinical information over time during the simulation (Jeffries, 2005, 2007). Simulations can range from simple to complex and cues are given during the process to either respond to questions or provide additional information. A debriefing at the end of the simulation is usually conducted to reinforce the learning (Jeffries, 2005).

When developing and implementing a simulation scenario a seven-step process should be used. The seven steps are: (1) define educational objectives, (2) construct a clinical scenario, (3) define the underlying physiologic concepts, (4) modify programmed patients and scenarios, as necessary, (5) assemble the required equipment, (6) run the program until completed, and then (7) repeat steps 2-6 until satisfied (Shumaker, 2004).

Research conducted to evaluate the effectiveness of simulators has focused on student experiences and skill development. Macdowell (2006) evaluated student's perceived level of confidence and competence following a simulated experience using the Laerdal SimMan. A sample of 23 students completed a pre and post simulator questionnaire and rated their perceived level of confidence and competence significantly higher ( $p < .05$ ) after three sessions. This self assessment included the student's ability to assess the patient, correctly administer therapies and work together as a team.

### *Performance Assessment Using Simulation*

A comprehensive review of the current literature on using simulation to determine performance was conducted to provide a foundation for development of an instrument to measure performance during the simulation scenario. Studies have been done to look at assessment of clinical performance during simulated crisis. Gaba et al. (1998) looked at scoring both technical performance and crisis management behaviors in a study reviewing 14 video tapes of different teams managing scenarios of cardiac arrest and

malignant hyperthermia. Technical performance was rated on a dichotomous scale based on scenario specific checklists of appropriate actions. Raters scored the presence or absence of each action during the scenario and then summed all the points; scores were reported as a fraction of the possible points. Behavioral ratings were on a five point scale and consisted of ten crisis management behaviors: orientation to case, inquiry/assertion, communication, feedback, leadership, group climate, anticipation/planning, workload distribution, vigilance and reevaluation. There were also two overall ratings for the primary anesthesiologist and anesthesia team. The results showed that technical ratings were high overall for both scenarios, ratings of crisis management behaviors varied, and the inter-rater reliability was fair to excellent depending on the item rated.

Devitt et al. (1998) also looked at testing the items in a rating system developed to evaluate anesthesiologists' performance in a simulated patient environment. Two clinically relevant scenarios were developed, each containing five anesthetic problems. The scenarios were all reproducible by the computer program to ensure the items were standardized. The rating for each individual item was based on preset criteria. The ratings were: 0 for no response, 1 for a compensating intervention, and 2 for a corrective treatment. "A compensating intervention was defined as a maneuver undertaken to correct perceived abnormal physiological values. A corrective treatment was defined as definitive management of the presenting medical problem" (Devitt et al., 1998, p. 1161).

Each subject was evaluated by two trained raters and the score was the consensus of the two raters. Internal consistency was estimated using Cronbach's alpha and achieved .66 after poorly performing items were eliminated. Discriminant validity was established by evaluating how the experienced anesthesiologists performed compared to

the trainees. Overall they had significantly higher scores ( $p < .001$ ) on the six reliable items. The study concluded that the rating scale initially showed poor internal consistency but that improved to acceptable once the poorly performing items were removed. They recommended caution when interpreting findings from the evaluation of performance in the simulated scenarios.

Most often simulation is conducted for learning purposes, particularly for nursing student or physician education. The simulated practice situations can improve learners' self confidence and improve clinical judgment. The scenarios must be realistic and mimic clinical reality to be effective (Ciofi, 2001). Simulators have been used extensively in anesthesia and laparoscopy to both teach and evaluate skills of the physician learners. The benefits to physician education are well established in the literature (Ericksen & Grantcharov 2005; Van Sickle, McClusky, Gallagher, & Smith, 2005; Maithel et al., 2006; & Rosenthal et al., 2006). In addition, studies have been conducted to look at validity of simulation as a method to evaluate skills. Van Sickle et al. (2005) established construct validity in using the ProMIS simulator to objectively assess the levels of performance skills on a complex laparoscopic suturing task by distinguishing between novices and experts. Eriksen and Grantcharov (2005) found that LapSim, a virtual reality simulator, was able to differentiate between subjects with different laparoscopic experience.

In another study by Rosenthal et al. (2006) the effectiveness of simulator training in improving airway management skills was tested using 49 medical interns. The interns were tested prior to using the simulator and their airway management skills were judged

to be poor. Interns received training on the Laeredal SimMan and showed improved skills on retesting with the simulator and in actual patient situations.

Simulation has also been used in crisis management training. It allows the trainee to be exposed to a more realistic situation than case studies or didactic teaching. It can also teach more than clinical skills. The role playing and debriefing sessions allow trainees to gain useful insights into errors that contribute to the initiation and evolution of a crisis. The trainees also learn communication, teamwork, and leadership skills (Wong, Ng, & Chen, 2002). Evaluation of performance during the simulated scenario is often scored by someone watching and rating how well each trainee did. Inter-rater reliability has been tested in anesthesia scenarios in studies conducted. Gaba et al. (1998) found good inter-rater agreement on technical performance by scoring behaviors in each scenario and identifying the presence or absence of defined clinical actions. Devitt, Kurrek, and Cohen (1998) found the rating system was able to distinguish a difference between resident and staff anesthesiologists, thus demonstrating discriminant validity.

A scale to measure teamwork was also developed by Malec et al. (2007). The Mayo High Performance Teamwork Scale (MHPTS) is a sixteen item scale which measures key teamwork behaviors after training in crew resource management. The original development testing included 19 medical residents and 88 nurses. Items on the scale were scored on a three point scale with 0 being never or rarely, 1 being inconsistently and 2 being consistently. Cronbach's alpha on the scale was  $\alpha=.85$ .

Although most research has focused on measuring current skill level, a study done by Morgan and Cleave-Hogg (2002) used simulation in evaluating medical students experience, confidence and competency. During an educational session, 144 medical

students were asked to complete a 25 item questionnaire regarding specific clinical experiences and their level of confidence in their ability to manage patient problems. Then each student participated in a standardized simulated performance test. The three scenarios included recognition and management of: (1) hypertension, tachycardia, and anaphylaxis; (2) hypotension, tachycardia and anaphylaxis; and (3) rapid sequence intubation, hypoxaemia, and endobronchial intubation. Analysis of the results showed good correlation between clinical experience and confidence level. There were non-significant correlations between the frequency of skill performance, the level of confidence and simulator test scores. In scenario one (hypertension, tachycardia, and anaphylaxis), however, the Spearman's rank coefficient was  $r = .67$  ( $p .66$ ) for the correlation between test score and level of confidence.

The role of using patient simulation is not new to healthcare but it is new to nursing in the practice area. Simulation has been primarily used by surgeons and anesthesiologists to refine their skills and responses to patient situations. Simulation has been used in nursing schools to teach students skills before they 'practice' on real patients. Simulating crisis situations has been used in aviation to teach pilots how to deal with unexpected situations, and more recently it has been used to evaluate skills of surgical residents and the effects of sleep deprivation on anesthesia residents (Jeffries, 2005; Howard et al., 2003).

The measure of capacity to rescue behaviors by direct observation of nurses in a clinical scenario should provide for a more accurate score than a self rated scale on their perception of their own behaviors. It is always challenging in social science to accurately measure phenomena (DeVellis, 2003). It is also difficult to measure clinical judgment in

the patient care environment; however, by creating a simulated environment the researcher can observe the process the nurse uses to ‘care’ for their patient. Combining this with a talk aloud procedure (Ericsson & Simon, 1993) when the nurse is asked to describe what she/he is thinking and doing during the process will allow for capture of the behaviors in capacity to rescue.

These factors were considered in development of the instrument to measure capacity to rescue. The instrument was developed and testing occurred around a simulated scenario. The next section describes the methods used for instrument development and testing.

### *Methods*

#### *Scenario Development for Measurement of Capacity to Rescue*

To measure capacity to rescue behaviors in a clinical situation, a scenario was developed for use with the Laerdal Sim Man using version 3.2 software (<http://www.laerdal.com/>). The scenario developed for Sim Man was based on the treatment of a patient who is in the early phase of septic shock or sepsis. This simulation scenario was designed to test the nurse’s capacity to rescue behaviors across the three areas of recognition, timely response, and appropriate actions. Sepsis was chosen because it has a defined evidence-based protocol available and it required capacity to rescue nurse behaviors across all three areas or subscales. It also allowed for the programming of patient related outcomes specific to the treatment of sepsis. This was necessary to be able to measure patient outcomes at the end of the clinical scenario.

An extensive review of the research and clinical literature on sepsis management was conducted. The scenario was developed by the researcher in collaboration with

several expert clinicians with experience in critical care and flight nursing. The scenario was reviewed by nursing experts in simulation and sepsis care. Treatment of sepsis should follow the evidence-based protocols established in the literature (Dellinger et al., 2004, Rivers et al., 2001 & Zubrow et al., 2008) and it is anticipated that ICU nurses have access to this knowledge (Picard et al., 2006). Sepsis has classic markers that nurses should be able to recognize and make the determination that the patient is septic. The sepsis scenario includes the cues that should lead to the conclusion that the patient is experiencing sepsis if the nurse has the knowledge of what those sepsis markers or indicators are. Rivers et al. (2001) developed the seminal work on sepsis diagnosis and treatment. The criteria they developed for sepsis includes vital signs, lab values and physical signs/symptoms. The criteria are: presence of suspected or documented infection, two of the following parameters (temp greater than 38 degrees Celsius, heart rate above 90, respiratory rate above 20, white blood count above 12, 000 or less than 4000), systolic blood pressure less than or equal to 90 and/or lactate level greater than 4 mmol/liter. If the patient met these criteria then sepsis was suspected and goal directed therapy was recommended. Goal directed therapy includes: fluids to maintain central venous pressure between 8 and 12 mm Hg, vasopressor therapy to maintain mean arterial blood pressure greater than 65 mm Hg, blood products if the central venous oxygen saturation was less than 70%, and sedation and mechanical ventilation to assist as necessary in meeting the goals.

The clinical scenario also included a few other patient anomalies or adverse events that the nurse would need to recognize and treat. The anomalies were added to test capacity to rescue behaviors beyond the sepsis protocol and covered basic patient

care needs such as airway management and arrhythmia control. These anomalies included an episode of unstable ventricular tachycardia (VT) and a malpositioned endotracheal tube. The nurse was required to defibrillate the patient to treat the VT. The nurse had to identify that the endotracheal tube was advanced too far, by auscultating breath sounds and visually checking the tube placement. The nurse would then need to adjust the endotracheal tube to improve the patient's oxygen saturation.

In instrument development it is important to make sure that scale items have a theoretical basis to ensure measurement of the phenomena the researcher intends to measure (DeVellis, 2003). Once the sepsis scenario was complete a scoring sheet (Appendix A) was developed based on key assessments and interventions the nurse needed to perform during the scenario to optimize the patient's outcome. These assessments and interventions are consistent with the capacity to rescue behaviors of early recognition, timely response and appropriate actions. These key assessments and interventions were additionally based on the evidence-based protocols published in the literature and are included in the Surviving Sepsis Campaign and sepsis protocols that are used (Ahrens & Vollman, 2003; Ahrens & Tuggle, 2004; Dellinger et al., 2004; Rivers et al., 2001; Picard et al., 2006). These protocols are also endorsed by the American Association of Critical Care Nurses and the Society for Critical Care Medicine.

The key assessments and interventions were brainstormed after an exhaustive literature review of current sepsis treatments. This list was also matched to the sepsis scenario which was developed from the same literature. The score sheet included key assessment and intervention items related to sepsis care, as well as timing variables to measure how quickly the nurse intervened. The score sheet also contained items to rate

the nurse's performance with general assessment and critical thinking. The scenario documentation contained inappropriate physician orders that must be identified and challenged. This was important to measure the nurse's recognition and appropriate actions. The score sheet also contained assessments and interventions related to two problems the patient experiences during the scenario that are unrelated to sepsis but are problems that can occur in any intensive care unit patient. Both of these problems can lead to a poor patient outcome if not identified and treated promptly. Both of these are within the scope of the nurse to independently assess and take steps to correct.

The original scoring sheet contained the items generated during the literature review and scenario development. The scoring was dichotomous, 0 for not done and 1 for done, for each item.

#### *Pilot Testing the Instrument*

The scoring sheet and scenario were tested with two flight nurses who have prior intensive care unit experience and are considered experts in their current roles. Both nurses have BSN degrees and are certified paramedics. This determined the scenario flowed well and the scoring sheet was able to be completed during the scenario. The test also indicated the twenty minute scenario time frame was appropriate to allow for completion of the tasks necessary to improve the patient's condition. Additional interventions (nurse gives paralytics and nurse states sepsis as the problem) were added to the scoring sheet based on the performance of the nurses during this phase. Additional tools were also developed for the nurses to use. These tools consisted of a flow sheet to relay the previous shift's vital signs and assessment values to the nurse, a set of physician

orders, written report that the nurse would receive from the previous nurse and instructions for how to role play the scenario.

Once the scoring sheet was finalized by the researcher it was reviewed by two content experts to determine the content validity index (CVI). A content validity index is used to measure the degree of agreement between two content experts. The expert panel review assessed the test items for relevance to the measure, clarity and conciseness and items that might have been missed in measuring the phenomena (DeVellis, 2003). To determine content validity of case simulations, Ciofi (2001) also recommends using an expert panel. Both content experts who reviewed the capacity to rescue measurement tool had more than five years experience in critical care nursing. They both have been involved in writing and implementing standards for the care of patients with sepsis. They were both part of an ongoing project which involves implementation of the evidence-based sepsis guidelines. These expert nurses reviewed the objectives of the scenario, the scenario itself and the expected assessments and actions of the nurse. They independently rated each assessment and intervention that was part of the scenario score sheet for relevance of that item to prevent failure to rescue or to improve the patient's outcome. They also rated the items that would increase the risk for a bad outcome if the nurse performed those interventions. They used a four point scale: (1) not relevant, (2) somewhat relevant, (3) quite relevant, and (4) very relevant. "The CVI is defined as the portion of items given a rating of quite/very relevant by both raters involved" (Waltz, Strickland, & Lenz, 2005, p. 155). To determine the validity of a tool a rating greater than .5 is considered acceptable (Waltz et al.). The score sheet at this time contained 61

items. The content validity index was determined to be .61 which means the experts agreed that 61% of the items were quite or very relevant.

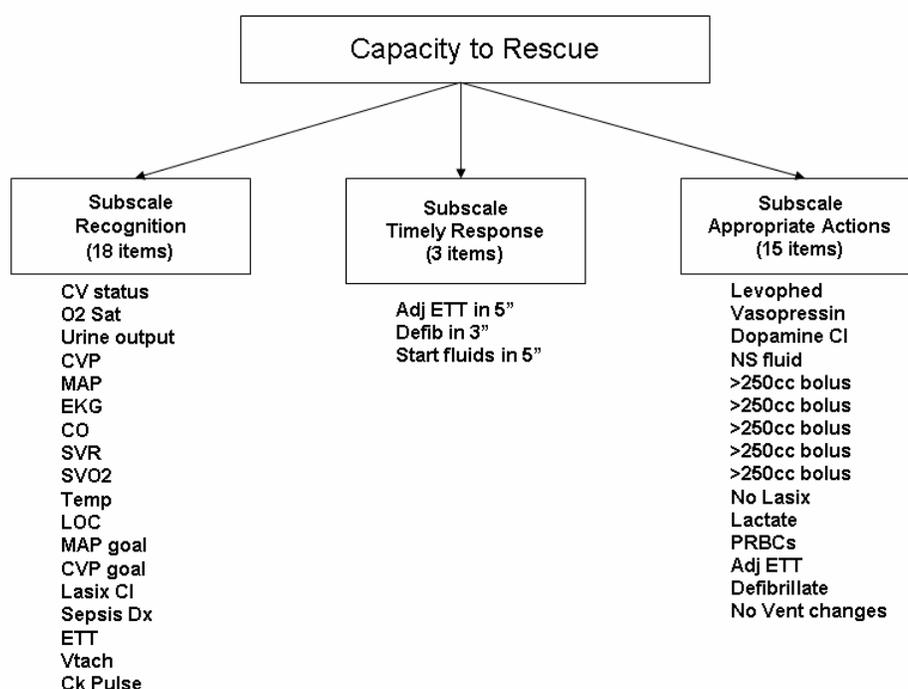
Five nurse volunteers with recent intensive care unit experience were used to pilot test the instrument and the process. The nurses came to the simulation lab and participated in the scenario. During the scenario the nurse's actions were entered in the debriefing module of the Sim Man by an assistant familiar with using Sim Man and the researcher completed the scoring sheet. The debriefing log was printed after the scenario was completed and used to fill in any missing items on the scoring sheets and to score the timing variables. While it was intended originally to video tape, it was discovered during the pilot that the debriefing log and score sheet were sufficient to capture the actions and interventions of the nurse during the scenario. After the scenario the nurses went through a debriefing process.

The results of the pilot test indicated the simulation scenario ran well, nurses were able to determine the appropriate assessment items and two of the five nurses were able to make the diagnosis of sepsis. The nurses were able to gain enough information from the flow sheet and the report sheet and had no additional questions in order to perform in their role as an ICU nurse in the scenario. Scores on the scenario ranged from 21-29 out of a possible 61. The nurse received one point for each correct assessment and intervention and lost one point for each incorrect action on the score sheet. This negative scoring method was changed after the pilot and is discussed later in this chapter. After completing the pilot test, some items on the score sheet were deleted. The items removed were ranked less relevant by the expert reviewers. The number of fluid boluses was increased from two to five to be able to credit the nurse for giving all the fluid needed to

get to the final outcome. The scenario was also adjusted to ensure that if the nurse performed all the correct parameters in the time frame that the patient's ending parameter for the outcome measurement would improve to the pre-determined ending goals that indicated a 'rescue' of the patient.

Once the scenario was developed and the nurse behaviors identified, items were placed in the appropriate subscales based on the subscale definitions. Assessment items were placed on the recognition subscale and interventions were placed on the appropriate actions subscale. Timely response included three items with measured time parameters (Figure 3.2).

**Figure 3.2 Capacity to Rescue Subscales for Sepsis Scenario**



### *Capacity to Rescue Instrument*

The Capacity to Rescue Instrument (CRI) at this point contained 36 items (Appendix B). There were 18 items in the recognition subscale, 3 items in the timely response subscale, and 15 items in the appropriate actions subscale. Thirty-two of the items are positive assessments or interventions and the nurse received one point for doing each of those. Four of the items are incorrect actions and the nurse received one point for not doing the incorrect item. This was changed from the pilot testing to allow for ease of scoring.

### *Outcome Parameters*

An additional measurement, outcome goals, was added at this time. The clinical scenario developed for Sim Man has built in trends based on the actions of the nurse during the scenario. If the nurse takes the correct actions then the patient will achieve certain outcomes at the end of the scenario. There is a time component to this as well. Some of the actions such as fluid administration and vasopressor therapy needed to be started early in the scenario to achieve the ending parameters. A new section was added to reflect desired patient outcomes in the scenario. There are five goals in the outcome scale in the scenario: heart rate, mean arterial pressure, oxygen saturation, central venous pressure and pulmonary artery systolic/diastolic pressure (Table 3.1). These goals are consistent with the evidence-based sepsis guidelines. The goals should be achievable by the end of the 20 minute scenario if the appropriate actions are taken for the care of this patient. These are based on trends established during scenario development. This section was scored dichotomously with the nurse receiving one point for each ending parameter met based on the debriefing log vital signs at the 20 minute mark.

**Table 3.1 Capacity to Rescue Outcome Scale Parameter**

Outcome	Goals
Heart Rate (HR)	< 122
Mean Arterial Pressure (MAP)	≥ 65
Central Venous Pressure (CVP)	8-12
Oxygen Saturation	> 95
Pulmonary Artery Pressure	≥ 24/11

### *Subjects*

Institutional Review Board (IRB) approval was obtained prior to beginning the study and nurses were recruited primarily from the intensive care units and emergency services at a large Midwestern university hospital. After meeting with the managers of the units/areas, an email was sent to the staff by the manager and flyers were posted in prominent areas. The researcher also visited units to do on site recruiting and respond to questions after the distribution of the email. Volunteers were sought from a variety of experience levels and job categories.

The subjects for this study were registered nurses (RNs) who had current or previous experience working in an intensive care unit or a unit similar to intensive care such as emergency department or critical care transport. The nurses needed to have a background that would have exposed them to the type of patient and monitoring equipment used in the clinical simulation scenario.

### *Procedure*

Initially the nurses were given an overview of Sim Man if they had not worked with Sim Man in the past. They were then given a report on the patient scenario which included physician orders and a flow sheet which contained the previous eight hours of vitals signs and lab values. These tools were available to the nurse during the scenario. Next Sim Man was started and the nurse was given an overview to the monitor and told if they wanted to prescribe a treatment that required a physician's order they would be automatically given the order needed during the scenario. They could ask questions during the scenario which were answered in a standardized fashion by the researcher. They could get updated labs, a chest x-ray and other parameters such as pedal pulses that were not readily apparent on the mannequin. These parameters were standardized so all nurses received similar information. After each scenario the nurses were debriefed and asked about their experience. They were also told the nature of the clinical scenario and the appropriate goal directed therapy the scenario was based on.

### *Data Collection*

During the simulation scenario data was collected in two ways. The nurse was asked to use a 'think aloud' procedure (Ericsson & Simon, 1993) so the observer could record the recognition behaviors that were not readily apparent such as the CVP goal. The observer functioned in the role of participant observer (Waltz et al., 2005) because it was necessary to interact with the nurse during the scenario to provide additional information and respond to questions using a standardized set of answers. The observer recorded all of the actions and recognition behaviors of the nurse during the scenario on the capacity to rescue scoring sheet. Additional information was also recorded in the

debriefing log of the Sim Man Software during the scenario. At the end of the simulation scenario the debriefing log was saved and then printed out. The log was used to validate that the observer captured all of the necessary items on the score sheet as well as to determine if the nurse met the timely action variables. The last set of vital signs on the log was also used to determine if the nurse met the outcome goals. Initially two observers ran the scenario until familiarity was obtained so that a single observer, the researcher, could record all the data and run the simulation.

### *Results*

#### *Sample*

Seventy-eight subjects completed the clinical simulation scenario. Education levels ranged from diploma to Masters Degree or higher. The nurses were all from the same academic medical center and had either no or minimal exposure to using simulation to measure performance during a scenario, except the flight nurses who had more exposure to Sim Man for skills development. Some of the other nurses used simulation and Sim Man during Advanced Cardiac Life Support Training. The clinical experience levels are detailed in Table 3.2.

**Table 3.2 Experience Level of Nurses (n=78)**

Experience of Nurses	Range	M	SD	Mdn
Years in current unit	0-34	9.3	8.4	7.0
Total years of ICU experience	1-34	12.8	9.0	12.0
Total years of clinical experience	1-45	17.2	10.7	18.8

### *Scores*

The scores on the capacity to rescue instrument are outlined in Table 3.3. All subscale scores were symmetrically distributed around the mean.

**Table 3.3 Capacity to Rescue Results (n=78)**

CRI Scores	# of items	Range	M	SD	Mdn
CRI Total	36	13-36	22.3	4.4	22.0
Recognition	18	5-18	11.1	2.6	11.0
Timely Response	3	1-3	1.9	0.8	2.0
Appropriate Actions	15	3-15	9.3	2.3	9.5

The total score on the capacity to rescue outcome scale ranged from 0 to 5 out of a possible score of 5. The mean score was 2.7 (SD 1.5) and the median was 3.0. The scores were distributed symmetrically around the mean.

### *Measurement Reliability*

Internal consistency reliability is used to determine instrument consistency in a group of individuals across the items of a single measure. When the items are scored dichotomously then a special alpha K-R 21 procedure is used (Waltz et al., 2005). The alpha coefficient is the preferred index of internal consistency reliability because it has a single value for any given set of data and it is equal in value to the mean of the distribution of all possible split-half correlations associated with the data (Waltz et al., 2005).

Internal consistency was measured for the capacity to rescue tool using the SPSS Reliability Analysis procedure. The initial reliability on the entire 36 item tool was  $\alpha=.70$ . Subscales were also analyzed. Reliability for the recognition subscale was  $\alpha=.57$  and reliability for the appropriate actions subscale was  $\alpha=.57$ . The subscale timely response had only three variables and the alpha for that scale was not able to be obtained due to negative item intercorrelations.

Inter-item correlations were then run on each of the items in the three subscales using both Pearson's and Spearman's correlation procedure. Items were removed if they had low or no significant correlations or high correlations to determine if overall subscale reliability could be improved. One item was removed from the subscale appropriate actions (no lasix). The reliability of the subscale improved to  $\alpha=.60$ ; however the overall alpha of capacity to rescue remained unchanged. Four items had low inter-item correlations on the recognition subscale. Removing these items resulted in the subscale correlation improvement to  $\alpha=.59$ ; however, overall scale reliability was decreased. The timely response items were then added to the appropriate action subscales because conceptually they are actions but they have an additional time component. The reliability improved to  $\alpha=.67$ . As a result of these analyses the scale was left at 36 items. Additionally subscale correlations were run for the three subscales. All subscales showed a significant and positive correlation of a low to moderate magnitude (Table 3.4).

**Table 3.4 Intercorrelations Between Capacity to Rescue Subscale Scores (n=78)**

Subscale	1	2	3
1. Recognition	1.000	.287*	.370**
2. Timely Response		1.000	.457**
3. Appropriate Actions			1.000

\*correlation is significant at the 0.05 level (2-tailed)

\*\*correlation is significant at the 0.01 level (2-tailed)

#### *Measurement Validity*

As indicated previously, content validity was determined during the pilot phase of the instrument design by two expert reviewers. The CVI was .61 on the original instrument. Another measure of validity that was performed was construct validity. Construct validity is used to determine whether the instrument is measuring what it is intended to measure (Polit, 1996); in this case, that construct is capacity to rescue. Construct validity was determined by comparing the capacity to rescue scores with the outcome scale at the end of the scenario. The outcome scale represents the condition of the patient at the end of the scenario. The goals for this outcome score were those identified in the evidence-based literature to improve clinical outcomes and reduce mortality (Dellinger et al., 2004; Rivers et al., 2001; & Zubrow et al., 2008). It was hypothesized that a higher capacity to rescue score would correlate with higher outcome scores. Capacity to rescue was significantly correlated to the capacity to rescue outcome score at .77 ( $p < .01$ ).

Principle axis factor analysis was then performed on the 36 item instrument. A correlation matrix was first prepared to determine if there were any issues of multicollinearity. Two items (VTach and defibrillation) were perfectly correlated and removed from the scale. The final 34 items were used in the initial factor analysis procedure. A Kaiser-Meyer-Olkin Test (KMO) was then performed to determine sampling adequacy. The KMO can range between 0 and 1 with values above .50 being acceptable. The KMO result was .584 which places it just in the barely acceptable range. Bartlett's test of sphericity was also performed. This tests the null hypothesis, that states the correlation matrix is an identity matrix which means there is no correlation between items. A significant test indicates that the null hypothesis is rejected and there are some relationships and factor analysis can be performed. The Bartlett's test was significant indicating that factor analysis was appropriate to perform (Pett, Lackey & Sullivan, 2003).

Using a minimum Eigen value of 1.0 as the criteria for factors (Pett et al., 2003; Polit, 1996), eight factors accounted for 67% of the variance. The scale was then reduced to 22 items after removal of many variables with loadings less than 0.3. The scree plot showed a bend at three factors but two factors had Eigen values greater than 2.0. The factor analysis was re-run forcing a factor solution at 3 factors, without a good theoretical fit. The third factor had only one item that loaded at greater than 0.3, so it was re-run again forcing a two factor solution. This time the variables loaded better on two factors. The two factors cluster around items from the appropriate action scale and the recognition scale. Varimax, Direct Oblimin, Quartimax, Equamax, and Promax rotations were run. A direct oblimin rotation was used to determine the final loads although all

rotations produced similar results. Direct oblimin was chosen because the assumption was that the subscales were correlated which is a characteristic of oblique rotations such as oblimin (Pett et al, 2003). Variables from the timely action scale loaded higher with the appropriate actions scales. Eight out of 13 variables had greater than .3 loading on factor 1 and 3 out of 9 variables had greater than 0.3 loading on factor two. The items that did not fit well but were conceptually associated with those variables were left in that factor (Table 3.5).

**Table 3.5 Capacity to Rescue Factor Analysis**

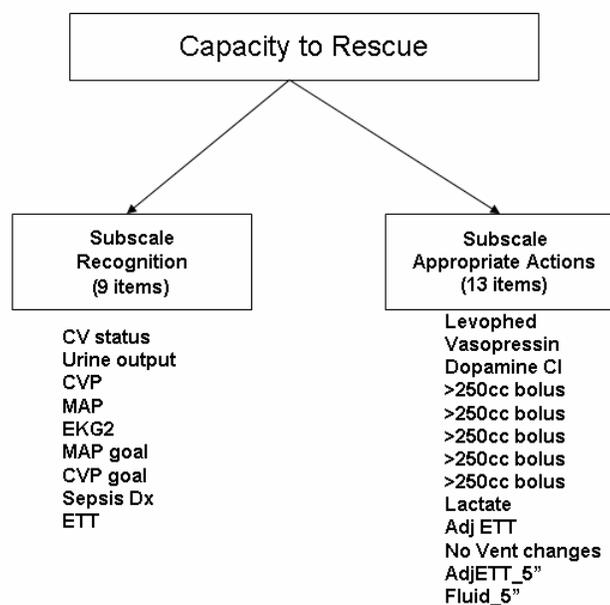
Variable	<u>Factor Loadings</u>		Communality
	1	2	
CV status	.127	<b>.265</b>	.087
ETT	.541	<b>.655</b>	.723
CVP	.171	<b>-.133</b>	.047
Urine Output	.154	<b>.432</b>	.211
MAP	.096	<b>.278</b>	.086
EKG	.127	<b>.419</b>	.192
Adj ETT	<b>.482</b>	.686	.703
Levophed	<b>.141</b>	-.292	.105
MAP goal	.096	<b>.278</b>	.076
Vasopressin	<b>.111</b>	-.075	.018
No Vent chg	<b>.290</b>	.144	.105
>250cc bolus_1	<b>.329</b>	-.024	.109
>250cc bolus_2	<b>.541</b>	-.191	.329
>250cc bolus_3	<b>.601</b>	-.235	.416
>250cc bolus_4	<b>.672</b>	-.332	.562
>250cc bolus_5	<b>.554</b>	-.212	.352
CVP goal	.398	<b>-.178</b>	.190
PRBC's	<b>-.078</b>	.099	.016
Sepsis	.228	<b>-.266</b>	.123
Dopamine CI	<b>.274</b>	-.381	.221
AdjETT_5"	<b>.399</b>	.302	.250
Fluid_5"	<b>.309</b>	-.311	.192

Note: items in bold correspond to the factor they were assigned to.

### *Final Capacity to Rescue Instrument*

The final CRI contained 22 items clustered around two subscales: recognition and appropriate actions (Figure 3.3).

**Figure 3.3 Final Capacity to Rescue Subscales**



The timely actions subscale became part of the appropriate actions subscale because they loaded well with that subscale. The final distribution of scores ranged from 5 to 22 with a mean of 13.2 (SD 3.5). Distribution remained symmetrical around the mean. Reliability on the final tool was  $\alpha=.69$ . Correlation between the two subscales was .338 ( $p<.01$ ). Reliability on the subscale recognition was  $\alpha=0.53$  and on the appropriate actions subscale reliability was  $\alpha=.64$ . Correlations between capacity to rescue overall score and the outcome score was .772 ( $p<.01$ ).

### *Discussion*

The simulation scenario and corresponding measurement scoring sheet developed to measure capacity to rescue show initial promise as a good measurement instrument. The internal consistency measure of  $\alpha=.69$  is considered acceptable for a newly developed instrument. The factor analysis allowed the tool to be reduced to 22 items without changing its overall reliability. Although some of the items did not load well on the theoretical subscales, the factor analysis was only based on two cases per item. Five cases per variable are generally recommended for factor analysis (Polit, 1996). Since this is the initial attempt to develop this instrument, further analysis will need to be done.

The ability to evaluate the relationship of the overall score on the capacity to rescue instrument with the outcome scores was helpful in determining overall construct validity. This demonstrated that if the nurse performed many of the behaviors (recognition, timely intervention, and appropriate actions) then the simulated patient had a good recovery. This is supported by studies done using these key interventions of early goal-directed therapy to improve outcomes in patients with sepsis (Dellinger et al., 2004; Rivers et al., 2001; Zubrow et al., 2008). Although Benner's (1984) work initiated the ideas around expert nurses' care of patients leading to better outcomes, to date a measurement tool does not exist to measure that. Proxy measures such as education, staffing levels, and nurse satisfaction have been used to attempt to understand why nursing care is linked to patient outcomes. However, this is only a part of the overall picture. Understanding what comprises expert care and then being able to measure it by utilizing the concept of capacity to rescue is a first step in developing interventions to improve nurse competencies and capacity to rescue.

### *Future Implications/Recommendations*

The CRI instrument held up well upon initial testing, however, its dichotomous scoring may prove problematic in the future. The instrument is also specific to the measurement of capacity to rescue in a simulated scenario involving a patient with a particular condition. To add to its usefulness in the future some modifications to the instrument could be made. When analyzing the items in each subscale it became apparent that the items tend to cluster around activities such as airway management, pharmacology, fluid balance, or cardiac monitoring.

The scale could be modified to include item clusters such as appropriate actions: fluid management. This would then include a list of interventions that would pertain to fluid balance such as: fluid boluses and packed red blood cells. The nurse would then receive a score ranging from 0-2 on that item with 0 being inappropriately managed/done, 1 partially managed/done, and 2 consistently managed/done. These would be defined as the frequency or number of appropriate actions being done in that item. For example, if the nurse gave three fluid boluses and a unit of blood the score would be 3. If the nurse gave only one bolus the score would be 0.

This would allow more of a range in scores and provide more variability to the scores. This would also add in the potential complication of rater bias which was easier to avoid when using the former dichotomous scale of 0 (not done) and 1 (done). This would, however, allow the instrument to be used for a variety of scenarios because each major item such as fluid management is common across many patient scenarios; the tool would be individualized for the goals of fluid management in the scenario being used.

Overall the CRI measured capacity to rescue in this scenario with a degree of reliability and validity for a new instrument. Further work in this area can enhance its usefulness for future use. A further course of study will be to develop an instrument to measure a nurse's perceived capacity to rescue. Measurement of capacity to rescue is labor and resource intensive. However, if perceived capacity to rescue can be a proxy measurement for capacity to rescue then more work can be done in this area.

The CRI can be used for both practicing nurses and students. By modifying the simulation scenario and expectations it can be used to measure the capacity to rescue in nursing students as they progress through their education. The scenarios will also educate the nurses and students on evidence-based care that should be delivered to patients. The debriefing that is conducted at the end of each scenario provides an opportunity for reflective thinking and knowledge integration which can be critical to the nurse's continued development of expertise (Ericsson, Charness, Feltovich & Hoffman, 2006). The CRI has many uses in both the practice and education areas and can also be used in future research.

## Appendix A

Item-Assessment/Intervention	Performed task	Item-Assessment/Intervention	Performed Task
Assess lungs		<b>Nurse dose not adjust vent or call RT to adjust vent settings</b>	
Determines unequal breath sounds		<b>Nurse does not suction patient</b>	
Assess circulation-pulse, color or cap refill		Nurse determines total fluid to give	
Assess RR-too high		Nurse uses .9NS for bolus	
Assess SPO2-too low		Nurse gives fluid bolus > 250cc	
Assess ETT position-too far in		Nurse gives fluid bolus > 250cc	
Assess urine output-low		Nurse gives fluid bolus>250cc	
Assess CVP-too low		Nurse give fluid bolus>250cc	
Assess MAP-too low			
Assess EKG – sinus tach with PVC's		Nurse states goal is CVP >8	
Assess CO – too high		Nurse identifies V tach	
Nurse requests SVR		Nurse assesses for pulse	
Nurse requests SV02		Nurse obtains AED and connects to pt.	
Assess temp-too high		Nurses shocks patient	
Assess LOC		<b>Nurse does not give epinephrine</b>	
Review orders		<b>Nurse does not start CPR</b>	
Review labs		Nurse identifies V Fib	
Review previous shift documentatation		<b>Nurse does not call code</b>	
Adjust ETT to correct position		Nurse treats high K+	
Nurse gives vasopressors		Nurse gives Bicarb	
Nurse starts levophed(norepinephrine)		Nurse identifies Lasix is an incorrect order	
Nurse titrates levophed		<b>Nurse does not give Lasix</b>	
Nurse states goal for MAP> 65		Nurse gives Tylenol for fever	
<b>Nurse does not start dopamine</b>		Nurse treats glucose	
<b>Nurse does not titrates dopamine</b>		Nurse recommends labs: lactate	
Nurse starts vasopressin		Nurse recommends ABG	
Nurse identifies Unasyn is contraindicated		Nurse gives sedation	
<b>Nurse does not give Unasyn</b>		Nurse gives paralytic	
Nurse recommends alt. Abx		Nurse recommends PRBC's	
		Nurse states Sepsis as problem	

ID \_\_\_\_\_ BP \_\_\_\_\_ MAP \_\_\_\_\_ CVP \_\_\_\_\_ SP02 \_\_\_\_\_ PAP \_\_\_\_\_

## Appendix B

## Capacity to Rescue Scoring Sheet-Final

Item-Assessment/Intervention	Performed task	Item-Assessment/Intervention	Performed Task
Assess circulation-pulse, color or cap refill		Nurse starts levophed(norepinephrine)	
Assess RR-too high		Nurse states goal for MAP> 65	
Assess SPO2-too low		<b>Nurse does not start dopamine</b>	
Assess ETT position-too far in		Nurse starts vasopressin	
Assess urine output-low		Nurse states goal is CVP >8	
Assess CVP-too low		Nurse uses .9NS for bolus	
Assess MAP-too low		Nurse gives fluid bolus > 250cc	
Assess EKG – sinus tach with PVC's		Nurse gives fluid bolus > 250cc	
Assess CO – too high		Nurse gives fluid bolus>250cc	
Nurse requests SVR		Nurse give fluid bolus>250cc	
Nurse requests SV02		Nurse identifies V tach	
Assess temp-too high		Nurse assesses for pulse	
Assess LOC		Nurses shocks patient	
<b>Nurse does not adjust vent or call RT to adjust vent settings</b>		Defibrillate within 3" of VT	
Adjust ETT to correct position		Nurse identifies Lasix is an incorrect order	
Adjust ETT within 5"		<b>Nurse does not give Lasix</b>	
Start fluid within 5"		Nurse recommends labs: lactate	
		Nurse recommends PRBC's	
		Nurse states Sepsis as problem	

ID\_\_\_\_\_

Outcome Scales

BP\_\_\_\_\_ MAP\_\_\_\_\_ CVP\_\_\_\_\_ SP02\_\_\_\_\_ PAP\_\_\_\_\_

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## Chapter 4

### Analysis of the Capacity to Rescue Conceptual Model

#### *Background*

The Institute of Medicine (IOM) (Page, 2004) report on nursing work environments has issued a blueprint to enhance patient safety that includes four recommendations for health care organizations: adopt evidence-based transformational and management leadership practices, maximize the capabilities of the workforce, design work and workspace to reduce error, and create and sustain a culture of safety. This blueprint focuses on both system and individual factors needed to improve patient safety. Recently there has been a shift in health care to focusing on safety issues from a systems approach, avoiding the blaming mentality that had been used in the past (Buerhaus, 2004; Kohn, Corrigan, & Donaldson, 2001). This systems approach can improve workplace conditions and create cultures of safety; however, there are still individuals in the system and understanding their competencies and characteristics is critical to the success of any initiative to enhance patient safety. “Because nurses are with patients consistently, they are the ones who diagnose and intervene, together with other health professional colleagues, to arrest developing complications or adverse events that threaten patients” (Hinshaw, 2008, p. S5).

A new concept in nursing, capacity to rescue, can assist researchers and clinicians in understanding the role individual nurses play in patient safety and how that role can be

supported. Capacity to rescue is the enactment of nursing behaviors which allow for the optimization of patient outcomes, prevention of adverse events, or reduction in the impact of an adverse event through early identification and timely interventions.

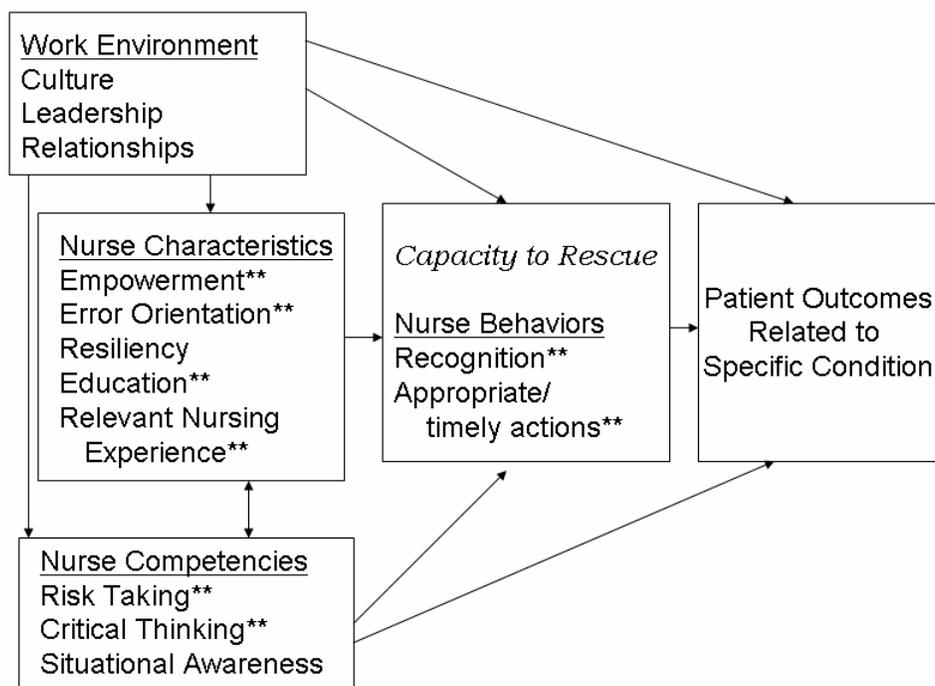
Failure to rescue has been studied extensively in the literature but has limitations in its usefulness for two reasons. The failure to rescue indicator is used at the aggregate level and is impacted by coding errors and variations in definition (Manojlovich & Talsma, 2007). Failure to rescue is also negatively framed and it is difficult for nurses to evaluate objectively poor patient outcomes without feeling victimized (Clarke, 2004).

Capacity to rescue can overcome some of these limitations because it is positively framed and it is measured at the individual level providing opportunities for individually targeted interventions. The concept also focuses on prevention of failure to rescue, prevention of adverse events and/or dealing effectively with complications when they occur. The set of nurse behaviors included in capacity to rescue are: early recognition of clinical problems, timely response to the problems and appropriate actions taken by the nurse. Nurses comprise 23% of the entire health care workforce (Page, 2004). Nurses play a significant role in preventing and minimizing errors through functions such as surveillance (Mitchell & Shortell, 1997) and capacity to rescue can provide insight into how that process occurs on the front line of care.

Capacity to rescue nurse behaviors are part of an overall conceptual model derived through Norris' (1982) approach to concept development. The model was extensively discussed in Chapter Three of this dissertation and is briefly reviewed here. The conceptual model as seen in Figure 4.1 contains four components that impact patient

outcomes: work environment, nurse characteristics, nurse competencies, and capacity to rescue nurse behaviors.

**Figure 4.1 Capacity to Rescue Conceptual Model**



\*\*measured as a part of this research

Work environment includes culture, leadership and relationships. Research has found that unit characteristics can have an impact on nurse and patient outcomes (McGillis Hall, Doran & Pink, 2008). The type of culture that would impact outcomes would be a safety culture. Safety cultures are considered essential for enhancing patient safety as noted in the recent IOM (Page, 2004) report and in research conducted in high reliability organizations (HROs) and in aviation and nuclear power agencies (Reason, 1997; Weick & Sutcliffe, 2001). Leadership is characterized by transformational leadership which is linked to increased patient satisfaction and reduced adverse events (Wong & Cummings, 2007). Relationships are primarily focused on RN to MD

relationships as the largest contributor to a positive work environment. Shortell et al. (1994) found that in intensive care units positive nurse- physician relationships lead to improved patient care.

Nurse characteristics are comprised of intrapersonal empowerment and error orientation which are defined in the next section. Empowered nurses are intrinsically motivated, find meaning in their work and are competent (Spreitzer, 1995; Thomas & Velthouse, 1990). Benner's (1984) work links competent nurses to better patient outcomes. Resiliency is the capacity to absorb strain and to bounce back from untoward events (Sutcliff & Vogus, 2003). Education refers to the nurse's college degree and relevant experience is the years of experience in the area of care where his/her skills are measured. Educational preparation such as bachelors degree in nursing has been linked to positive patient outcomes (Aiken, Clarke, Cheung, Sloane, & Silber, 2003).

Nurse competencies are risk taking and critical thinking defined in the next section and situational awareness. Risk taking can be difficult in situations of greater outcome uncertainty (Sitkin & Pablo, 1992) which often happens in patient care environments. Critical thinking skills are the skills needed for effective practice (O'Neil & Dluhy, 1997). Situational awareness is defined as the knowledge of what is occurring at the front line (Weick & Sutcliffe, 2001). Only the five variables outlined in the next section from the capacity to rescue conceptual model were analyzed in this research study. Work environment was not measured at this time due difficulty in measuring work environment with only small numbers of nurses from each unit.

### *Variables and Operational Definitions*

The concept of empowerment used in capacity to rescue is intrapersonal empowerment, which is motivational and is manifested by meaning, competence, self-determination and impact (Spreitzer, 1995). Intrapersonal empowerment was measured using the 12 item Personal Empowerment Instrument (PEI). The PEI measures the nurse's level of empowerment in four dimensions: meaning, competence, self-determination and impact (Spreitzer, 1995). The total score of each dimension was measured as well as the overall score. The total score on the 12 items was used to measure the nurse's overall level intrapersonal empowerment.

Error orientation is defined as how one copes with errors and how one thinks about errors at work. Error orientation is a concept developed by Rybowskiak, Garst, Frese, and Batinic (1999). The nurse's error orientation was measured using the Error Orientation Questionnaire (EOQ). The EOQ contains eight subscales; however, only the six subscales originally developed and tested were used for this analysis. The six subscales are: error competence, learning from errors, error risk taking, error strain, error anticipation, and covering up errors. The overall score on six subscales (24 items) was used to measure the nurse's error orientation.

Critical thinking is the nurse's ability to use the cognitive skills of analysis, synthesis and evaluation in a challenging situation (Facione, Facione & Sanchez, 1994; O'Neill & Dluhy, 1997). Critical thinking was measured using the Watson Glaser Critical Thinking Appraisal (WGCTA). The overall score on the WGCTA short version was used to measure the nurse's critical thinking skills.

Risk taking is specific to error risk taking, and is defined as openness toward errors and willingness to take risks. Risk taking was measured using the error risk taking subscale score from the EOQ (Rybowiak, et al., 1999).

Capacity to rescue is the enactment of behaviors which allows for the optimization of patient outcomes, prevention of adverse events or reduction in the impact of an adverse event through early identification and timely interventions. Capacity to rescue was measured using the Capacity to Rescue Instrument (CRI) developed during this dissertation. The CRI is a 22 item scale that contains two subscales, recognition and appropriate actions and was developed for use with a clinical simulation scenario. Patient outcomes were measured using the outcome parameters developed as part of the clinical scenario and only pertains to the specific clinical scenario used.

These key variables were measured using a combination of standardized tests and a simulation scenario. The model assumptions were tested using a human patient simulator and a clinical scenario designed to measure the nurse's ability to respond appropriately and effectively in a patient crisis that could lead to a failure to rescue outcome. This chapter presents testing of the following research questions:

Q1: Are there certain nurse characteristics that are associated with capacity to rescue?

Q2: Are there certain nurse competencies that are associated with capacity to rescue?

Q3: Is capacity to rescue associated with positive patient outcomes specific to the condition being measured?

Q4: Are there certain nurse competencies associated with positive patient outcomes specific to the condition being measured?

The following hypotheses were tested in this research study:

H1: Levels of capacity to rescue are influenced by empowerment, error orientation, and critical thinking.

H2: Patient outcomes related to specific condition are influenced by capacity to rescue.

H3: Patient outcomes related to specific condition are influenced by critical thinking, error risk taking, and capacity to rescue.

The capacity to rescue model was tested in three stages. The first stage determined if there were certain variables that influenced the levels of capacity to rescue. This was determined by testing hypothesis one. The second stage determined if capacity to rescue influenced patient outcomes specific to the condition tested. The third stage of testing determined which other variables directly influenced patient outcomes.

Hypotheses were considered acceptable at  $p \leq .05$ .

### *Methods*

#### *Sampling*

The study's target population was nurses with critical care or similar background such as intensive care nurses, flight nurses, critical care transport nurses or emergency room nurses. The nurses needed to have at least six months of recent experience in one of the designated areas. The goal was to recruit nurses with a sufficient knowledge and experience base to be able to perform appropriately in the simulation scenario. The nurses had to have a skill set that allowed them to care for a patient who required

invasive hemodynamic monitoring, ventilator support, vasopressor therapy, and arrhythmia management. The nurses also needed to have experience with interpreting common lab values, cardiac monitors, and changes in patient's response to drug therapies and other interventions. A power analysis was done to determine the sample size required to achieve a power of .8 at a .05 significance level to determine a medium effect size. The sample size needed for a regression analysis was 76. This is based on three predictor variables and one dependent variable (Cohen, 1992). A medium effect size was chosen because this is a new concept and no research exists to guide in determining effect size.

#### *Data Collection*

Institutional Review Board (IRB) approval was obtained prior to beginning the study. Nurses were recruited primarily from the intensive care and emergency services units at a large Midwestern university hospital. Nurses were recruited in a variety of ways. After IRB approval an email was sent to the staff nurses in the targeted units and departments. Flyers were also posted in prominent areas and the researcher visited units to do on site recruiting. Volunteers were sought from a variety of experience levels and job categories.

Once the nurse volunteers were selected and consent was obtained the nurses were asked to fill out the three questionnaires (PEI, EOQ, and WGCTA) and a demographics questionnaire. The nurse was then scheduled to come to the simulation center to complete the scenario portion of the study. The questionnaires were collected prior to completing the scenario in all but a few situations. In those instances the nurse was asked to return the questionnaires with two days. When the nurse arrived in the

simulation center they were given an orientation to the mannequin and explained the role they would play in the scenario. They were then given report on their patient and the scenario was started. The scenario ran for 20 minutes and then the nurse was debriefed on their performance and asked not to share the details of the scenario with others who might be in the study.

During the simulation, scenario data were collected in two complimentary ways. The nurse used a 'think aloud' procedure (Ericsson & Simon, 1993) so the observer could identify some of the recognition behaviors that were not readily apparent, such as the MAP goal. The observer then functioned in the role of participant observer (Waltz, Strickland & Lenz, 2005) because it was necessary to interact with the nurse to provide additional information during the scenario and respond to questions using a standardized set of answers. The observer recorded the actions and recognition behaviors of the nurse during the scenario on the capacity to rescue scoring sheet. Information was also recorded in the debriefing log of the Sim Man Software during the scenario. At the end of the simulation scenario the debriefing log was printed and saved. The log was used to ensure the observer captured all of the items on the score sheet as well as to determine if the nurse met the timely action variables. The last set of vital signs, at the 20 minute mark, on the log was also used to determine if the nurse met the outcome goals. Initially two observers ran the scenario until familiarity was obtained so that a single observer, the researcher, run the simulation and record all the data.

## *Instruments*

### *Demographics*

Educational preparation has been linked to positive patient outcomes (Aiken, Clarke, Cheung, Sloane, & Silber, 2003). Educational preparation in capacity to rescue was collected and nurses were asked to identify their highest nursing degree as well as any non-nursing degrees held. Nursing focused degrees would give the nurse additional knowledge and competencies to deliver better care so it was important to be able to analyze the data at this level. The levels collected were diploma, associates degree in nursing (ADN), bachelor's degree in nursing (BSN), bachelor's degree in another field and master's degree in nursing (MSN) or higher.

Years of relevant experience are also important. Relevant experience is a better indicator than total experience alone, because a nurse needs to be experienced in caring for a particular patient population to become an expert in that care. If the nurse has experience in acute care but moves to an intensive care setting they become a novice in that area (Benner, Hooper-Kyriakidis & Stannard, 1999). Years of relevant experience includes experience caring for the patient population in the setting that the nurse is currently practicing in, such as intensive care or emergency department. Total years of experience in nursing were also collected as well as the number of years in the nurse's current unit.

### *Psychological Empowerment Instrument*

Empowerment was measured using the Psychological Empowerment Instrument (PEI) (Appendix A). Spreitzer (1995) developed the PEI to measure empowerment as

part of an overall conceptual framework looking at work environments and psychological empowerment. The purpose of that study was to begin to develop a theoretically derived measure of empowerment. The instrument was originally designed to specifically measure intrapersonal empowerment in the workplace, defined as how the individual experiences empowerment. The PEI was tested in a framework designed to look at empowerment as a mediating variable between the key social structure antecedents and the individual outcomes.

The PEI measures four dimensions of empowerment: meaning, competence, self-determination and impact. These dimensions were developed using a thematic analysis of the interdisciplinary literature of empowerment and are consistent with work done by Thomas and Velthouse (1990) on psychological empowerment. Meaning is defined as the fit between the needs of one's work role and one's beliefs, values and behaviors. Competence is defined as an individual's belief in his or her capability to perform activities with skill. Self-determination is defined as an individual's sense of having choice in initiating and regulating actions. It reflects autonomy over the initiation and continuation of work behaviors. Impact is defined as the degree to which an individual can influence strategic, administrative or operating outcomes in one's work unit. It is the opposite of learned helplessness.

*Psychometrics.* The primary sample used to test the PEI consisted of 393 mid-level managers randomly selected from diverse work units at a Fortune 50 company. The sample demographics were: 93% male, 85% white, mean age 46 years, mean company seniority 13 years and mean position tenure three years. The second sample used to test the instrument included 128 employees selected by random stratified sampling from an

insurance company. They were stratified by team membership and functioned within a team. Sample demographics in this group were: 83% non-managers, 84% women, 54% high school graduates, mean age of 40 and mean years of seniority in the company of 15 years (Spreitzer, 1995).

The entire PEI contains 16 items, but can be reduced to a 12 item version without compromised reliability and validity. The 12 item version has three questions that correspond to each of the four subscales. The instrument is scored on a seven point Likert-type scale with the seven categories ranging from very strongly disagree to very strongly agree. The instructions for the tool ask the respondent to answer the questions by indicating the extent to which they agree or disagree that each statement describes their self-orientation to their work role. The questions are similarly worded and begin with “I”, “My” or “The work I do”. This helps to focus the respondent on the self-orientation nature of empowerment. The statements are short and easy to understand.

The tool can be scored in two ways. The first is to generate an overall mean empowerment score. The second is to generate subscale scores based on a mean score for the items in each subscale. The psychometric properties of the instrument were documented as part of the original study to determine construct reliability and initial validity of the four dimension measure of psychological empowerment. In addition a confirmatory factor analysis was done to determine convergent and discriminant validity of the items and to determine the contribution of the four dimensions of empowerment to the overall construct of empowerment. Convergent validity was used to determine if the questions within the 4 separate measures (meaning, impact, self determination, and competency) correlate highly with each other. Discriminant validity was used to

determine if the questions within the four dimensions do not correlate well with questions of the other dimensions (Spreitzer, 1995).

The results of the psychometric tests show a Cronbach's alpha reliability coefficient of the overall empowerment construct to be  $\alpha=.72$  for the industrial sample (primary sample) and  $\alpha=.62$  for the secondary sample. Cronbach's alpha in this case is measuring the internal consistency of the group's performance across all items in the survey. Test-retest reliability was also measured in the second sample and showed Cronbach's alpha for time one and two to be  $\alpha=.73$  to  $\alpha=.85$  across the four dimensions of empowerment. Validity was determined by second order confirmatory factor analysis. According to Spreitzer (1995) "Each of the items loaded strongly on the appropriate factor, and the four factors were significantly correlated with each other in both samples" (p. 1457-1458). In second order confirmatory factor analysis, the model is evaluated to determine if the first order factors (in this case meaning, competency, self-determination, and impact) are correlated and reflect a more global or higher order factor. The adjusted goodness of fit, which is a test of the overall model fit that adjusts for complexity of the model, showed 0.93 for sample one and 0.87 for sample two. In addition root mean squared standardized residuals (RMSR) were measured. In sample one the RMSR was 0.04 and sample two was .007.

*Scoring.* The PEI, as used in this research study, was the 12 item version. The items were scored on a seven point Likert-type scale: very strongly disagree, strongly disagree, disagree, neutral, agree, strongly agree, and very strongly agree. The instructions tell the respondent that each item listed is a self-orientation that people have with regard to their work role. The respondent is then asked to indicate the extent to

which they agree or disagree that each item describes their self-orientation. A score on each item ranges from 0 (very strongly disagree) to 7 (very strongly agree). The overall scores can range from 0 to 84. The higher the score, the more empowered the nurse is. All items are scored in the same direction; there are no reverse or negatively scored items in the PEI.

#### *Error Orientation Questionnaire*

Error orientation was measured by the Error Orientation Scale (EOQ) (Appendix B). The instrument contains six subscales and was designed to measure error orientation in a variety of settings. The six subscales are: error competence, learning from errors, error risk taking, error strain, error anticipation, and covering up errors. Error competence refers to the knowledge of and capability to deal with errors immediately after they occur. Learning from errors refers to how one learns from errors to make changes in the future. Error risk taking refers to openness toward errors and willingness to take risks. Error strain refers to fearing the occurrence of errors or reacting to errors with high emotions. Error anticipation refers to the general expectancy that errors will happen because even though one is competent in one's job, errors can happen. Covering up errors refers to a strategy used by people who consider errors a threat and avoid accusations of errors by failing to disclose them. It can also be a reaction to a culture of blame in the workplace around errors (Rybowiak et al., 1999).

*Psychometrics.* Reliability of the subscales was reported in a study which compared the English and Dutch versions of the EOQ. The original survey was written in German and then translated. The translation method used consisted of several steps. The instrument was translated from German into English and then back into German.

The instrument was also translated into Dutch from both the German and English version independently. The resulting English and Dutch versions were then field tested with Dutch university students who were primarily bilingual. The Cronbach's alphas for each of the subscales were greater than  $\alpha=.70$  except in the English version of error competence which was only  $\alpha=.56$ . This was attributed to the fact that English was a second language to the respondents and there was a potential for error due to language difficulties. Construct validity was documented through factor analysis and convergent and divergent validity (Rybowiak et al., 1999).

When the scale was constructed, exploratory factor analysis was used to understand the underlying structures and then LISREL techniques were used to fine tune the model. Construct validity was conducted by developing a nomological net for each construct and then the EOQ scales were correlated with constructs to which they should have a theoretical relationship. For example, error competence and learning from errors were positively correlated to self efficacy (.44, .37) and self esteem (.42, .33). This was expected because both constructs deal with competence as self efficacy and self esteem are based on competence (Rybowiak et al, 1999).

*Scoring.* The EOQ used in this study contained 24 items divided into six subscales: error competence, learning from errors, error risk taking, error strain, error anticipation, and covering up errors. The items are scored on a five point Likert type scale with the response categories: (1) Not at all, (2) a bit, (3) neither a bit, nor a lot, (4) a lot, and (5) totally. Some items on the scale are reversed, making it necessary to reverse score those items in the final scoring. The respondent was asked to indicate to what extent each item applies to them. The questions refer to mistakes instead of errors and

some questions are repeated but phrased slightly differently. The range of scores for each item is 1-5. The questions are all framed from an intrapersonal perspective and begin with or refer to 'I' or 'my'. The EOQ, as originally tested, was scored based on the subscale scores. Scores on the subscales would be used to measure a person's error orientation. High scores on the subscales of error competence, learning from errors, error risk taking and error anticipation indicate a positive error orientation. Low scores on error strain and covering up errors would also be indicative of a positive error orientation. The total score for the EOQ ranges from 28 to 140. A score of 140 would indicate a nurse with a high degree of error orientation (Rybowiak et al, 1999).

#### *Watson-Glaser Critical Thinking*

Critical thinking ability was measured using the Watson-Glaser Critical Thinking Appraisal (WGCTA) Short Form. The WGCTA is an assessment tool designed to measure an individual's critical thinking skills. It provides a single score based on five critical thinking skills: inference, recognition of assumptions, deduction, interpretation, and evaluation of arguments. Inference is defined as discriminating among degrees of truth or falsity from given data. Recognition of assumptions is recognizing unstated assumptions in given assertions. Deduction determines whether conclusions follow from given premises. Interpretation is deciding if generalizations or conclusions based on given data are warranted. Evaluation of arguments distinguishes strong relevant arguments from weak irrelevant arguments (Hart et al., 2000; Watson & Glaser, 2006). The WGCTA is one of the most widely used standardized tests to measure critical thinking among nursing students. The tool uses problems and arguments similar to those encountered in actual nursing situations.

*Pyschometrics.* The WGCTA Short Form is a shortened version of Form A. The original Form A had 80 questions and took about 60 minutes to complete. The Short Form has 16 scenarios and 40 questions taken from Form A and takes about 30 minutes to complete. The WGCTA is appropriate to use with persons who have at least a ninth grade education. Reliability of the Short Form was established in 1994 using a sample of 1608. Cronbach's alpha was  $\alpha=.81$ . Cronbach's alphas were also calculated for several subgroups within that sample and ranged from  $\alpha=.66-.83$ . A test-retest reliability study was also conducted using the Short Form in a large publishing company with a sample of 42 employees who took the test two weeks apart. The test-retest correlation was .81 ( $p<.001$ ) (Watson & Glaser, 2006). Criterion related validity has been established in several studies including studies in law enforcement and English Proficiency Test scores (Watson & Glaser, 2006).

The WGCTA has been used in numerous studies since its development. Adams (1999) looked at research studies reported from 1977-1995 on critical thinking and found 18 studies using the WGCTA. The studies were focused on measuring the change in critical thinking skills during nursing education. Messmer, Jones and Taylor (2004) used the WGCTA to evaluate an ICU internship program. The reliability of the WGCTA was measured using split-half reliability coefficients. These ranged from .69 to .85.

Frye, Alfred and Campbell (1999) used the WGCTA to measure the critical thinking abilities of baccalaureate students. Reliability of the WGCTA over time was tested by administering the test to 96 college students and then re-testing them in three months. The correlation between the two time periods was .73.

In a study by Brown, Alverson, and Pepa (2001) the WGCTA was used to measure the change in critical thinking abilities of students pursuing several pathways to baccalaureate degrees. The WGCTA was administered to a convenience sample of 123 participants. Spearman-Brown reliability coefficient for the total score on the WGCTA was established at .77 in this study.

*Scoring.* The WGCTA is composed of a set of five tests. A high level of critical thinking is operationally defined as the ability to correctly perform the domain of tasks represented by the five tests: inference, recognition of assumptions, deduction, interpretation, and evaluation of arguments. Each test has scenarios followed by several questions or statements. Test one is inference and it contains two scenarios with a total of seven statements. The respondent is directed to indicate true, probably true, insufficient data, probably false, or false. Test two is recognition of assumptions and it has three statements followed by two or three proposed assumptions (total of eight). The respondent is then asked to indicate if each statement represents whether an assumption is made or not made. Test three is deduction and it has four scenarios with a total of nine statements. Each scenario is a statement that has several alternate answers. The respondent is requested to indicate for each alternate answer: conclusion follows or conclusion does not follow. The fourth test is interpretation which has three paragraphs with two or three conclusion statements after it (total of seven). The respondent is asked to indicate if the conclusion statement follows or does not follow. The fifth and final test is evaluation arguments. The test contains four questions each followed by two to three answers (total of nine). The respondent is asked to indicate if each answer is a strong argument or a weak argument (Watson & Glaser, 2006).

The entire test contains a total of forty possible points. The scores can range from 0 to 40 with 40 indicating high critical thinking skills. The raw scores can be used if a large group was tested to determine the overall level of critical thinking skills. If the sample size is small the raw scores can be converted to percentile scores and compared to a normative group (Watson & Glaser, 2006)

### *Capacity to Rescue*

Capacity to rescue was measured by the Capacity to Rescue Instrument (CRI) (Appendix C) developed for this research. Capacity to rescue is defined as the enactment of behaviors which allow for the optimization of patient outcomes, prevention of adverse events or reduction in the impact of an adverse event through early identification and timely interventions. The CRI was designed to be used with clinical simulation scenario written for use with the Laerdal Sim Man (<http://www.laerdal.com/>). The scenario was based on the care needs of a patient experiencing the early phase of septic shock. Septic shock or sepsis is a devastating condition which can lead to multi-system organ failure and has a mortality rate of 50% (Rivers et al, 2001). Sepsis has been researched extensively and a set of evidence-based protocols have been developed to treat sepsis and nurses have access to this knowledge (Picard et al., 2006). This scenario along with the CRI was used to measure the nurses' capacity to rescue. Patient outcomes specific to the condition (sepsis) were also identified. Five goals were established to measure patient outcomes and consisted of: heart rate, mean arterial blood pressure, central venous pressure, pulmonary artery pressures and oxygen saturation.

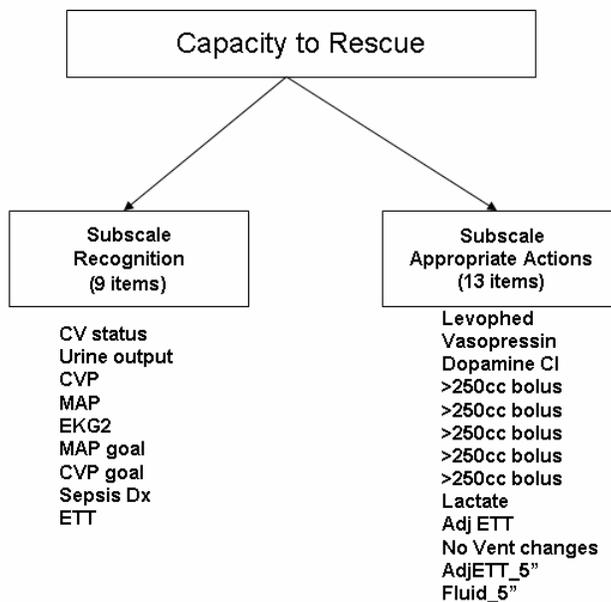
*Psychometrics.* Initial testing of the CRI was conducted as part of this overall research study on capacity to rescue. The instrument was developed based on expert

review of the literature to determine the assessments and interventions needed to improve the outcome for a patient in sepsis. Items were also added to ensure adequate measurement of capacity to rescue behaviors. Once the items were identified they were given to an expert panel for review of validity. The Content Validity Index determined by the expert review process was .61 indicating a 61% agreement with the items relevancy to capacity to rescue.

Internal consistency was determined as part of this study and the overall alpha (KR21) was found to be  $\alpha=.70$  which is adequate for a newly developed instrument. The tool also had good construct validity based on the relationship of the CRI score to the outcome goals developed for the clinical scenario used to test the tool ( $r=.77, p<.01$ ).

Principle axis factor analysis was performed on the CRI. The original instrument contained 36 items and three subscales (recognition, timely response, appropriate actions) which were based on the definition of capacity to rescue. Factor analysis reduced the CRI to 22 items and two subscales and explained 37% of the variance. Timely actions became part of the appropriate actions subscale and recognition remained as a subscale. The resulting scale is shown in Figure 4.2.

Figure 4.2 Capacity to Rescue Instrument



*Scoring.* The CRI is a dichotomous scale where the nurse is evaluated on certain behaviors performed during the simulation. The set of behaviors include: recognition items and appropriate actions. The scale contains 22 items and two subscales. The scores can range from 0-22 with 22 representing a high capacity to rescue. Subscale correlations were .338 ( $p < .01$ ) and alphas on the subscales were: recognition  $\alpha = .53$  and appropriate actions  $\alpha = .64$ .

## *Results*

### *Sample*

Ninety-seven nurses volunteered to be in the study. Seventy-eight completed all the study requirements. Three nurses withdrew and 18 nurses did not complete the study after initially volunteering. The nurses had a variety of experiences: flight nursing, critical care transport, emergency department, trauma-burn unit, surgical intensive care unit, cardiovascular intensive care unit, medical intensive care unit, and cardiac intensive care unit. The educational preparation of the nurses ranged from diploma to PhD and had from one to 45 years of nursing experience. These characteristics are presented in Tables 4.1 and 4.2.

**Table 4.1 Sample Characteristics - Number of Nurses with Education Preparation (n=78)**

Diploma	ADN	BSN	Bachelors (other)	Masters (or beyond)
4 (5.3%)	17 (22.7%)	37 (49.4%)	4 (5.3%)	13 (17.3%)

**Table 4.2 Experience of Nurses (n=78)**

Experience of Nurses	Range	M	SD	Mdn
Years in current unit	0-34	9.3	8.4	7.0
Years of relevant experience	1-34	12.9	9.0	12.0
Total years of experience	1-45	17.2	10.7	18.8

### *Psychological Empowerment Instrument*

The PEI was administered to the nurses in conjunction with the simulation scenario. Seventy-eight nurses completed the tool and there were no missing items. The results on the PEI were then analyzed. The mean score was 65.9 (SD 10.1) out of a possible 84 with the scores ranging from 18-84. The median score was 64.5 and the scores were symmetrical around the mean with the exception of one outlier (score of 18). The outlier was left in the results. The overall Cronbach's alpha was  $\alpha=.92$ . The mean PEI and subscale scores are presented in Table 4.3. The correlations between subscales are outlined in Table 4.4 and the subscale alpha coefficients are in Table 4.5.

**Table 4.3 PEI Total and Subscale Scores (n=78)**

PEI Scores	Range	M	SD	Mdn
Meaning	1-7	6.1	.99	6.0
Competency	2-7	5.7	.95	5.7
Impact	1-7	4.8	1.2	4.7
Self Directed	2-7	5.4	1.1	5.4
Total PEI	1.5-7	5.5	.84	5.0

**Table 4.4 Intercorrelations between PEI Subscales (n=78)**

Subscale	1	2	3	4
1. Meaning	1.000	.586**	.429**	.548**
2. Competency		1.000	.571**	.481**
3. Impact			1.000	.589**
4. Self Directed				1.000

Note: \*\*correlation is significant at the .01 level (2-tailed)

**Table 4.5 PEI Subscale Alpha Coefficients (n=78)**

Subscale	Alpha
Meaning	.87
Competency	.80
Self Directed	.89
Impact	.94

#### *Error Orientation Questionnaire*

The EOQ was administered to the nurses in conjunction with the simulation scenario. Seventy-eight nurses completed the tool and there were no missing items. The mean total score was 82.3 out of a possible 120 with the scores ranging from 65-103. The standard deviation was 8.7 and the scores were symmetrical around the mean. The overall Cronbach's alpha was  $\alpha=.73$ . The subscale scores are outline in Table 4.6 and the correlations between subscales are outlined in Table 4.7.

**Table 4.6 EOQ Total and Subscale Scores (n=78)**

EOQ Scores	Range	M	SD	Mdn
Error Competency	2.25-5	4.2	.48	4.3
Learning from Errors	2-5	4.1	.87	4.3
Error Risk Taking	1-5	3.5	.85	3.5
Error Strain	1.25-5	3.3	.85	3.3
Error Anticipation	1.25-4.25	2.7	.70	2.6
Covering up Errors	1-4.25	1.8	.72	1.8
Total EOQ	2.8-4.5	3.6	.40	3.5

**Table 4.7 Intercorrelations Between EOQ Subscale Scores (n=78)**

Subscale	1	2	3	4	5	6
1. Error Competence	1.000	.182	.091	-.126	.174	.169
2. Learning from Errors		1.000	.464**	.143	.375**	.022
3. Error Risk Taking			1.000	.257*	.373*	.050
4. Error Strain				1.000	.264*	.265*
5. Error Anticipation					1.000	.167
6. Covering up Errors						1.000

Note: \*\*correlation is significant at the 0.01 level (2-tailed)

\*correlation is significant at the 0.05 level (2-tailed)

The subscale alphas are shown in Table 4.8.

**Table 4.8 EOQ Subscale Alpha Coefficients (n=78)**

Subscale	Alpha
Error Competence	.57
Learning from Errors	.95
Error Risk Taking	.76
Error Strain	.80
Error Anticipation	.62
Covering up Errors	.69

Overall alpha was slightly low for the sample for an established instrument and some of the subscale correlations were poor. The subscale alphas were acceptable for learning from errors, error risk taking and error strain. Learning from errors did correlate significantly with error risk taking and error anticipation indicating that those who are willing to take risks anticipate risks can happen but also expect to learn from those errors. Error risk taking and error strain also correlated significantly indicating those who risk taking errors also experience strain from it. The subscale of error strain and covering up errors would be expected to correlate negatively with the other subscales; however, it only correlated negatively with error competence.

#### *Watson Glaser Critical Thinking Appraisal*

The scores on the WGCTA ranged from 17-39 out of a possible 40 points (n=78). The mean score was 29.34 with a standard deviation of 5.3. The median score was 30.0.

The scores were symmetrical around the mean. This is a standardized test and the mean score for the health care industry is 28.3 with a standard deviation of 6.3.

### *Error Risk Taking*

This variable was measured using the subscale error orientation from the EOQ. The overall alpha for the subscale was  $\alpha=.76$ . This subscale showed significant and positive correlations to the subscales learning from errors (.464,  $p<.01$ ) and error anticipation (.375,  $p<.01$ ).

### *Capacity to Rescue Instrument*

The CRI scores ranged from 5 to 22 with the distribution symmetrical around the mean. Reliability was  $\alpha=.69$ . Subscales correlations between the two subscales (recognition and appropriate actions) was .338 (significant at .01). Overall and subscale scores and reliabilities are outlined in Table 4.9 and Table 4.10

**Table 4.9 CRI Total and Subscale Scores (n=78)**

CRI Scores	Range	M	SD	Mdn
CRI Total Score	5-22	13.2	3.5	13.0
Recognition	1-9	5.7	1.8	6.0
Appropriate Actions	1-13	7.5	2.4	8.0

**Table 4.10 CRI Alphas (n=78)**

Subscale	Alpha
Recognition	.53
Appropriate Actions	.64

*Patient Outcome Goals*

The results on the patient outcome scores showed a range of 0-5 out of a possible five points. The mean was 2.7 (SD 1.5) and the scores were symmetrical around the mean.

*Bivariate Analysis*

Prior to hypotheses testing correlations between the predictor variables and capacity to rescue were analyzed. Results are summarized in Table 4.11. There were no significant relationships found.

**Table 4.11 Intercorrelations Between Predictor Variables for Capacity to Rescue (n=78)**

Subscale	1	2	3	4
1 WGCTA	1.000	-.208	.006	.075
2 PEI		1.000	.152	-.022
3 EOQ			1.000	-.043
4 CRI				1.000

Correlations were also analyzed between predictor variables and patient outcomes related to specific condition (Table 4.12). A significant and positive relationship was found between capacity to rescue and patient outcomes related to specific condition.

**Table 4.12 Intercorrelations Between Predictor Variables for Patient Outcomes Related to Specific Condition (n=78)**

Subscale	1	2	3	4
1 WGCTA	1.000	.095	.075	.183
2 Error Risk		1.000	.027	.140
3 CRI			1.000	.772**
4 Outcomes				1.000

\*\*Correlation is significant at  $p < .01$  (2-tailed)

Correlations were also analyzed between demographic variables and predictor variables. There was a significant relationship found between empowerment and years of ICU experience ( $r = .309$ ,  $p < .01$ ) and years of overall experience ( $r = .329$ ,  $p < .01$ ). All other relationships were non-significant.

### *Hypotheses Testing*

*Hypothesis 1.* Hypothesis testing was done using a regression model to test the following hypothesis:

H1: Levels of capacity to rescue are influenced by empowerment, error orientation, and critical thinking.

Multiple regression analysis was chosen to predict the three measures that are hypothesized to influence capacity to rescue: empowerment, error orientation and critical thinking. These measures were chosen as an initial test of the capacity to rescue model

because of the availability of standardized tests to measure them and the previous research which points to a possible link between the variables and patient outcomes (Page, 2004; Spreitzer, 1995).

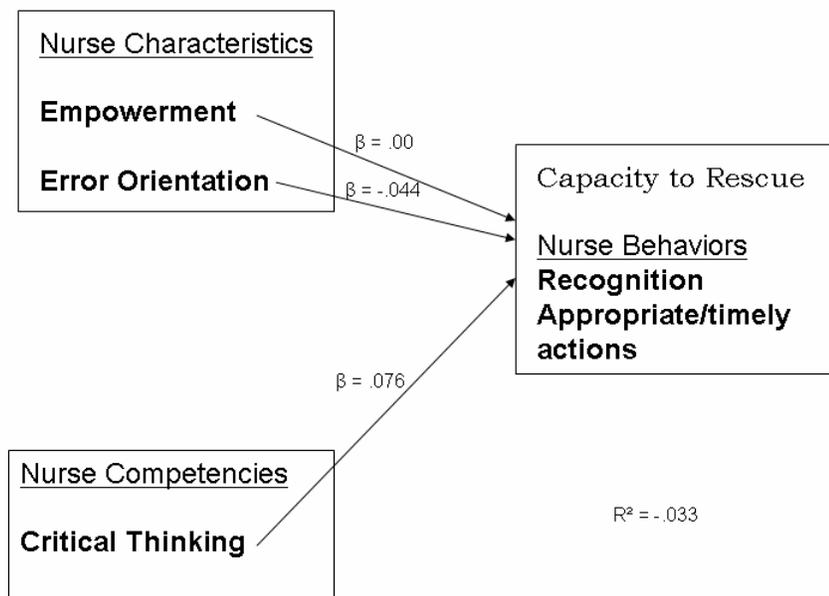
Capacity to rescue is the dependent variable and empowerment, error orientation and critical thinking are the independent or predictor variables. The results are summarized in Table 4.13 and Figure 4.3.

**Table 4.13 Summary of Regression Analysis for Variables Predicting Capacity to Rescue (n=78)**

Variable	B	SE B	$\beta$	t	Sig.	F	Sig.
(Constant)	13.198	5.151		2.562	.012	.189	.904 <sup>a</sup>
PEI total	.000	.041	.000	.003	.998		
EOQ total	-.018	.047	-.044	-.373	.710		
WGCTA	.050	.078	.076	.639	.525		

a. Dependant Variable Capacity to Rescue. Adjusted R<sup>2</sup> = -.033

Figure 4.3 Capacity to Rescue Test Model (n=78)



The results of the regression analysis show a very poor model fit. The F-statistic, which is a test for model fit or the variability in the dependent variable that is attributed to the independent variables, did not show significance. Additionally, the adjusted R-squared shows that less than 1% of the variance in the model is explained by the predictors. Regression residuals were plotted and analyzed to test the assumption of residuals having a normal distribution and a mean of zero. They were found to be acceptable. This is an unexpected finding. However, given that this is the first test of this new concept and model it points to the direction that more work needs to be done.

When analyzing the variables in the regression model some interesting findings were revealed. The scores on the PEI show most scores are clustered between five and seven. The average mean score on the PEI is 5.49 (S.D. = 0.8). The correlation between capacity to rescue and empowerment is -.022 which shows no relationship. In addition it is negative which is in the opposite direction of what would be expected.

The EOQ instrument did not hold up as well as expected. The overall alpha was lower than expected for a developed instrument and the subscale correlations did not hold up well. The subscale alphas, however, were good. The correlation between error orientation and capacity to rescue was -.043 indicating that there was no relationship between these two variables and again the direction was opposite of what was predicted. This is a new concept, not originally developed in health care and it may not translate well into the health care environment. The WGCTA also demonstrated no correlation with capacity to rescue ( $r=.075$ ).

*Hypothesis 2.* Bivariate regression was chosen to measure the follow hypothesis.

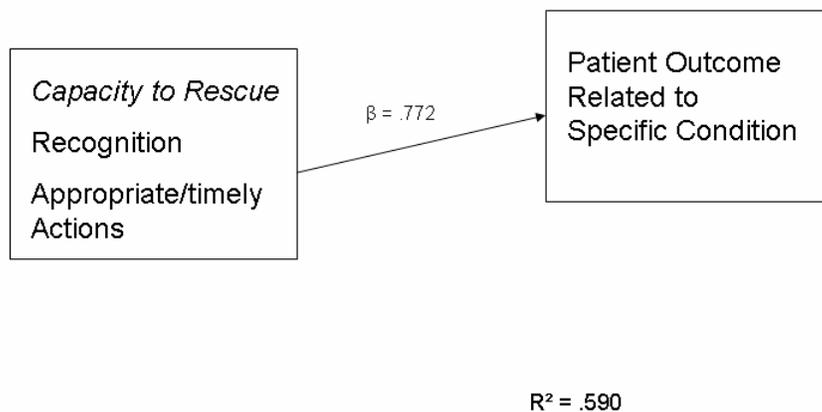
H2: Patient outcomes related to specific condition are influenced by capacity to rescue.

The patient outcome goals were established based on the specific patient condition, sepsis, and were designed to measure the effectiveness of the interventions in the sepsis scenario and based on evidence-based guidelines for sepsis treatment (Rivers et al 2001). Capacity to rescue is the independent variable and patient outcomes related to specific condition was the dependent variable. The results are summarized in Table 4.14 and Figure 4.4.

**Table 4.14 Summary of Bivariate Regression Analysis (n=78)**

Variable	B	SE B	$\beta$	t	Sig.	F	Sig.
(Constant)	-1.705	.431		-3.959	.000	111.969	.000 <sup>a</sup>
CRI	.333	.032	.772	10.582	.000		

a. Dependent Variable: Patient outcome related to specific condition

**Figure 4.4 Capacity to Rescue and Outcome Model (n=78)**

The results demonstrate that capacity to rescue is a significant predictor for patient outcomes related to specific condition. The F-statistic was significant at  $p < .01$

and the adjusted  $R^2$  was .590 indicating that capacity to rescue explains 59% of the variation in the patient outcome related to specific condition scores. Again, the regression residuals were plotted and analyzed to test the assumption of residuals having a normal distribution and a mean of zero. They were found to be acceptable.

*Hypothesis 3.* Regression analysis was used to test the following hypothesis:

H3: Patient outcomes specific to related condition are influenced by critical thinking, error risk taking, and capacity to rescue.

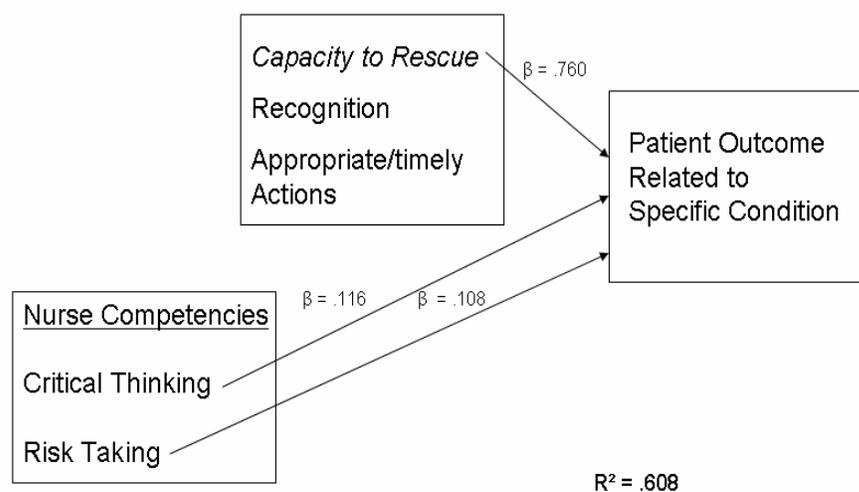
Multiple regression analysis was chosen because a predictive relationship is known to exist between capacity to rescue and patient outcomes related to the specific condition used to measure capacity to rescue levels as demonstrated by testing of hypothesis two. These measures were also chosen as an initial test of the capacity to rescue outcome model because of the availability of standardized tests to measure them and the previous research which points to a possible link between the variables and patient outcomes. Critical thinking skills and risk taking are also nurse competencies and capacity to rescue is measuring nurse behaviors so it is anticipated that these will relate more closely to patient outcomes. Results are summarized in Table 4.15 and Figure 4.5.

**Table 4.15 Summary of Regression Analysis for Variables Predicting Patient Outcome Specific to Condition (n=78).**

Variable	B	SE B	$\beta$	t	Sig.	F	Sig.
(Constant)	-3.285	.806		-4.077	.000	40.769	.000 <sup>a</sup>
WGCTA	.033	.021	.116	1.607	.112		
CRI	.328	.031	.760	10.619	.000		
Risk	.193	.128	.108	1.512	.135		

a. Dependant Variable Patient Outcome Specific to Condition Adjusted R<sup>2</sup> .608

**Figure 4.5 Patient Outcome Test Model (n=78)**



The results demonstrated that overall this model is a good fit. The F-statistic was significant at  $p < .01$  and the adjusted  $R^2$  was .608 indicating that the predictors (critical thinking, capacity to rescue and risk taking) accounted for 60% of the variance in the dependent variable, patient outcome specific to the condition measured. Regression residuals were again plotted and analyzed to test the assumption of residuals having a normal distribution and a mean of zero. They were found to be acceptable. Capacity to rescue was a significant predictor ( $\beta = .760, p < .001$ ). The other variables were not significant predictors.

### *Discussion*

The conceptual model initially identified three key components: work environment, nurse characteristics and nurse competencies. Two of these components (nurse competencies and nurse characteristics) were hypothesized to have a positive impact on capacity to rescue nurse behaviors. However, the regression analysis did not demonstrate any relationships between key variables of the components tested and capacity to rescue. The variables measured in the initial regression model of capacity to rescue behaviors were empowerment, error orientation and critical thinking. There were no correlations between capacity to rescue and the predictive variables measured for this dissertation. Several reasons identified for this finding. The level of empowerment in the sample of nurses measured was very high and overall there were no nurses who did not feel some level of overall intrapersonal empowerment, with the exception of one outlier. The institution has engaged in many activities and interventions over the past several years to improve the work environment for the nurses. Work environment was not tested

during this initial phase so the influence of work environment is unknown. Error orientation was also found not to be related to capacity to rescue. The results showed that nurses had a higher level of learning from errors and error competency which shows a willingness to see errors as a learning opportunity. However, they were not as high on error risk taking. Error strain was average and covering up errors was low which are both good findings. Error anticipation was also low and this would be expected to be higher if the nurses are looking for errors. It may be that this instrument did not hold up well in a health care environment or the concepts are new and the findings are a result of the newness of the movement towards a safety culture. The tool was originally developed in a non-health care setting. Perhaps for this particular scenario error orientation was not a key predictor but might be in another scenario. Critical thinking was also not a predictor for capacity to rescue. Some studies in nursing have found that critical thinking is not responsive to measuring the effectiveness of interventions so it may not be sensitive in this particular study either. The PEI and EOQ both measured perceptions of the nurse and the CRI measured actual performance. There may be some limitations in assessing perceptions or attitudes versus actual behaviors, as the CRI measured. The sample size, although appropriately powered for a three variable model, may be insufficient. There were not studies to inform this one of an appropriate effect size and further analysis might find that a medium effect size was inappropriate for this.

Other limitations to the study are the effects of 'talk alouds' and observer presence during the clinical scenario. During the scenario there was variation in how verbal each nurse was. Some nurses talked during the scenario and engaged in verbal dialogue as they worked through the patient situation. This may have helped some nurses

perform and/or score higher on the CRI. The observer may also have been able to record more points for recognition items which were easier to score when nurses were more verbal during the scenario. There is also a potential of increased performance because the nurse knew he/she was being observed during the performance of the clinical scenario.

The relationship between capacity to rescue and patient outcomes specific to the patient was significant and the regression analysis demonstrated a significant predictive relationship. The model tested explained just over 60% of the variance in the patient outcome scores. This demonstrates that capacity to rescue behaviors do have an impact on patient outcomes as measured in this particular patient situation. These results are promising for future work. This model only tested a specific patient condition in a simulated environment but shows promise for future types of research in this area. The nature of patient care prevents us from measuring actual outcomes on real patients in this manner but simulation provides researchers with a setting that can mimic the patient care environment.

Overall the results are mixed for initial model testing of a new concept. Some further work will need to be done to analyze the relationships between the variables in the model to understand more of the potential mediating and moderating effects. The work environment component was not tested and the potential influence of work environment on some of the variables will need to be further explored. There are few studies that look at the individual nurse. Most studies have focused on institutional variables such as staffing ratios and overall nurse satisfaction, (Aiken, Clarke, Sloane, Sochalski, & Silber, 2002; Needleman, Buerhaus, Mattke, Stewart, & Zelevinsky, 2002; Clarke, 2004;

Servellen & Schultz, 1999). They link a favorable nurse to patient ratio to surveillance and nurse presence which leads to fewer adverse events. What isn't completely known from those studies is what nurse presence and surveillance is comprised of. Some of the behaviors such as recognizing a downturn in a patient's condition and initiating rescue measure are known, however, that does not account for good patient outcomes for those patients who never experience recognizable complications. Capacity to rescue has the ability to study those individual nurse behaviors on the frontline to add to the understanding of the link between nurses and patient outcomes. Using a simulated environment to assess experts' skills during the performance of their practice provides a rich environment to conduct future research and has shown promising results in aviation, sports and medicine (Ward, Williams, & Hancock, 2006). The CRI is a way to measure capacity to rescue and to understand nurse behaviors and provide a way to study how expert nurses engage in their practice by testing them in a simulated environment.

## Appendix A

ID Number \_\_\_\_\_

## Psychological Empowerment Instrument

Directions: Listed below are a number of self-orientations that people may have with regard to their work role. Using the following scale, please indicate the extent to which you agree or disagree that each one describes your self-orientation.

- |                           |            |                        |
|---------------------------|------------|------------------------|
| A. Very Strongly Disagree |            | E. Agree               |
| B. Strongly Disagree      | D. Neutral | F. Strongly Agree      |
| C. Disagree               |            | G. Very Strongly Agree |

- \_\_\_ I am confident about my ability to do my job.
- \_\_\_ The work that I do is important to me.
- \_\_\_ I have significant autonomy in determining how I do my job.
- \_\_\_ My impact on what happens in my department is large.
- \_\_\_ My job activities are personally meaningful to me.
- \_\_\_ I have a great deal of control over what happens in my department.
- \_\_\_ I can decide on my own how to go about doing my own work.
- \_\_\_ I have considerable opportunity for independence and freedom in how I do my job.
- \_\_\_ I have mastered the skills necessary for my job.
- \_\_\_ The work I do is meaningful to me.
- \_\_\_ I have significant influence over what happens in my department.
- \_\_\_ I am self-assured about my capabilities to perform my work activities.

## Appendix B

ID Number \_\_\_\_\_

## Error Orientation Questionnaire

Please answer the questions based the following scale.

To what extent does this apply to you:

1- Not at all 2 – a bit 3 – neither a bit, nor a lot 4 - a lot 5 – totally

1. When I have made a mistake, I know immediately how to correct it	1	2	3	4	5
2. When I do something wrong at work, I correct it immediately	1	2	3	4	5
3. If it is at all possible to correct a mistake, then I usually know how to go about it	1	2	3	4	5
4. I don't let go of the goal, although I may make mistakes	1	2	3	4	5
5. Mistakes assist me to improve my work	1	2	3	4	5
6. Mistakes provide useful information for me to carry out my work	1	2	3	4	5
7. My mistakes help me to improve my work	1	2	3	4	5
8. My mistakes have helped me improve my work	1	2	3	4	5
9. If one wants to achieve at work, one has to risk making mistakes	1	2	3	4	5
10. It is better to take the risk of making mistakes than to "sit on one's behind"	1	2	3	4	5
11. To get on with my work, I gladly put up with things that can go wrong	1	2	3	4	5
12. I'd prefer to err, than to do nothing at all	1	2	3	4	5
13. I find it stressful when I err	1	2	3	4	5
14. I am often afraid of making mistakes	1	2	3	4	5
15. I feel embarrassed when I make an error	1	2	3	4	5
16. While working I am concerned that I could do something wrong	1	2	3	4	5
17. In carrying out my task, the likelihood of errors is high	1	2	3	4	5
18. Whenever I start some piece of work, I am aware that mistakes occur	1	2	3	4	5
19. Most of the time I am not astonished about my mistakes because I expected them	1	2	3	4	5
20. I expect that something will go wrong from time to time	1	2	3	4	5
21. Why mention a mistake when it isn't obvious	1	2	3	4	5
22. It is disadvantageous to make one's mistakes public	1	2	3	4	5
23. I do not find it useful to discuss my mistakes	1	2	3	4	5
24. I would rather keep my mistakes to myself	1	2	3	4	5

## Appendix C

## Capacity to Rescue Instrument

<b>Item-Assessment/Intervention</b>	<b>Performed task</b>	<b>Item-Assessment/Intervention</b>	<b>Performed Task</b>
Assess circulation-pulse, color or cap refill (CV)		Nurse starts levophed(norepinephrine)	
Assess urine output-low		<b>Nurse does not start dopamine</b>	
Assess CVP-too low		Nurse starts vasopressin	
Assess MAP-too low		Nurse gives fluid bolus > 250cc	
Assess EKG – sinus tach with PVC's		Nurse gives fluid bolus > 250cc	
Nurse states goal for MAP> 65		Nurse gives fluid bolus>250cc	
Nurse states goal is CVP >8		Nurse give fluid bolus>250cc	
Nurse states Sepsis as problem		Nurse give fluid bolus>250cc	
Assess ETT position-too far in		Nurse recommends labs: lactate	
		Adjust ETT to correct position	
		<b>Nurse does not adjust vent or call RT to adjust vent settings</b>	
		Adjust ETT within 5"	
		Start fluid within 5"	

ID\_\_\_\_\_

Outcome Scales

BP\_\_\_\_\_ MAP\_\_\_\_\_ CVP\_\_\_\_\_ SP02\_\_\_\_\_ PAP\_\_\_\_\_

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## Chapter 5

### Summary, Conclusions, and Recommendations

This dissertation introduced the concept, capacity to rescue, as a new concept in nursing to measure the individual nurse's role in patient safety and patient outcomes. This dissertation started by describing the process used to develop the conceptual model of capacity to rescue and presented a definition of the concept using concept analysis techniques. Chapter Three described the process used to develop an instrument, the Capacity to Rescue Instrument (CRI). The CRI was used in a simulated patient care clinical scenario to measure the nurse's capacity to rescue. Overall the instrument performed well as a newly developed instrument during psychometric testing. Chapter Four described the initial testing on the capacity to rescue conceptual model. This included three stages of testing: 1) assessment of the predictors for capacity to rescue, 2) evaluation of the relationship between capacity to rescue and patient outcomes related to specific condition and 3) testing of predictors for patient outcomes related to the specific condition being measured. The model testing phase produced mixed results. There were no significant predictors found for capacity to rescue, but there was a relationship between capacity to rescue and patient outcomes. Capacity to rescue was a significant predictor for patient outcomes in the clinical scenario designed for a patient developing sepsis.

There were limitations in this initial study. The CRI is a new instrument and therefore not fully tested. The work environment variables were not tested in this research; there is a hypothetical relationship between work environment and empowerment that will need to be tested for in future research. The sample included nurses from only one hospital. The level of empowerment may be unusually high in the work environment where the nurses are employed. The study may have lacked a sufficient sample size. Although a power analysis was done to ensure it was appropriately powered for a three variable regression model, a medium effect size may have been too large for this initial research endeavor. Finally, there may be other variables influencing capacity to rescue that were not accounted for in the initial model such as nurse expertise or knowledge of evidenced-based practice guidelines. If the nurse had extensive knowledge of the goal directed therapy guidelines for sepsis treatment, he/she would have performed well in the scenario.

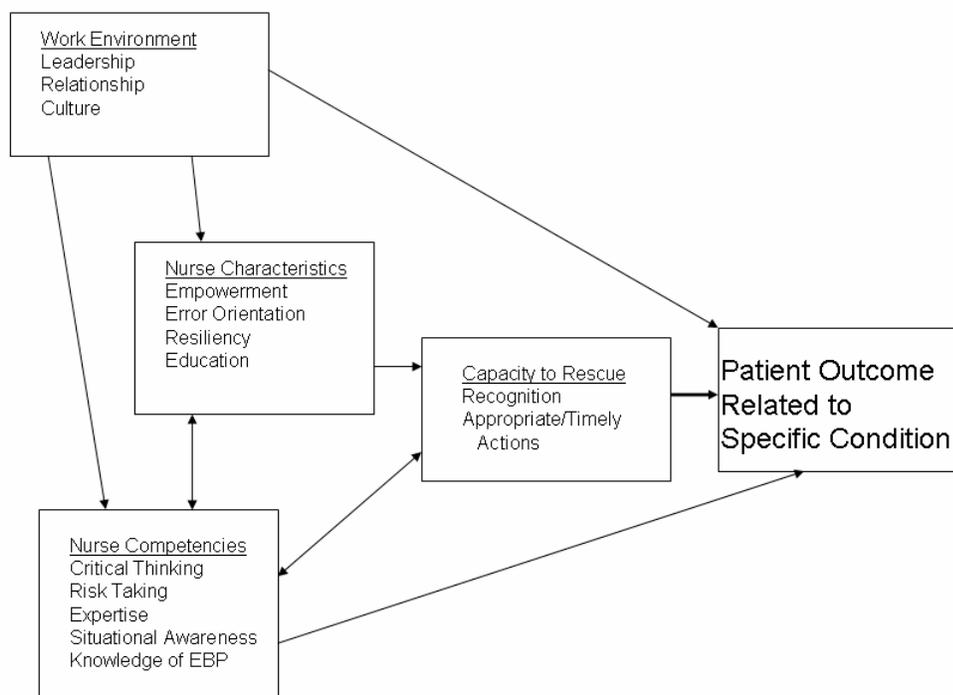
#### *Recommendations for Future Research*

This dissertation has demonstrated the usefulness of the concept, capacity to rescue. The development of the concept and initial conceptual model testing provided some initial data that resulted in an instrument to measure capacity to rescue and some changes to the conceptual model. As previously discussed in Chapter Three, a perceived capacity to rescue scale could be developed to help measure capacity to rescue on a large scale. This will allow for a larger study to be conducted and additional variables to be measured.

The analysis of the capacity to rescue conceptual model showed mixed findings. Capacity to rescue was a significant predictor for patient outcomes related to specific

condition but the other variables tested were not significant predictors. After analyzing the results some changes were made to the model as seen in Figure 5.1.

**Figure 5.1 Revised Capacity to Rescue Model**



In this revised model expertise and knowledge of evidence-based practice are added to the competency component. Expertise should allow for a more precise measurement of the nurse's skills than relevant experience. Knowledge of evidence-based practice will determine if the nurse has advanced knowledge regarding the scenario he/she is being tested with. Both of these variables may need to be measured based on self report if no instruments exist to measure them. Capacity to rescue was changed to include recognition and appropriate/timely actions to align with the subscales in the

instrument development. The model relationships have also changed. Work environment is now hypothesized to influence nurse characteristics directly which then influences capacity to rescue. This will need to be tested in the future to determine if work environment does influence nurse characteristics. In addition to the model revisions several other recommendations are outlined next.

The effect of work environment on empowerment needs to be further studied. This initial research on capacity to rescue did not test this relationship. An analysis of empowerment in other organizational work environments would give some insight into the expected variability with this instrument. Another recommendation would be to measure work environment to use in future model testing to evaluate its influence on nurse characteristics, in particular empowerment. At this time the most useful tool to measure work environment is the Practice Environment Scale of the Nursing Work Index (Lake, 2007).

There is also the factor of years of experience as a proxy for expertise. Correlations between years of experience and both capacity to rescue and patient outcomes were negative. The more years of experience the slightly lower the score. The ability to measure nurse expertise directly may be a better option. Using a measurement instrument based on Benner's (1984) novice to expert framework could be utilized. It will be important to develop this factor of expertise more fully before further testing is done by looking into the most recent research on expertise.

The scenario was based on evidence-based practice guidelines and those nurses who were aware of those guidelines and followed them may have done better. It would

be important to test this variable also in the future through an assessment of the nurse's knowledge of the particular evidence-based guidelines for the clinical scenario used.

This research was an initial step to measure capacity to rescue and understand the relationships and predictors in the capacity to rescue model. Further replication of this work needs to be done in other settings using larger samples. This model also addressed individual capacity to rescue and the performance of a nurse in a team setting would also be important to measure. Nurses may perform differently when they have team members they can access for information and support.

The new model also needs to undergo testing. Testing of the new model would include measuring the work environment factors in addition to the key variables in the model. Measurement tools for expertise and knowledge of evidence-based practice would need to be identified or developed for use.

As outlined in Chapter Three, the Capacity to Rescue Instrument needs further refinement. In particular the scale could be adapted to include item clusters such as recognition: respiratory assessment. This would then include a list of assessments that would pertain to respiratory assessment such as: assess lung sounds and airway. The nurse would then receive a score ranging from 0-2 on that item with 0 being inappropriately managed/done, 1 partially managed/done, and 2 consistently managed/done. These would be defined as the frequency or number of recognition items being done in that item. Another step is to develop a perceived capacity to rescue instrument which could be used for larger sample sizes. This instrument could be validated with the current CRI which measures actual capacity to rescue.

The measurement of capacity to rescue was initially developed for a specific scenario. This process will be revised in the future to use with other clinical scenarios which require a high level of nurse involvement to demonstrate the usefulness of the instrument in measuring various situations involving nurse's capacity to rescue. One example of this might be detecting early signs of stroke in a patient at risk for stroke.

### *Nursing and Policy Implications*

The concept, capacity to rescue, is a new concept in the field of nursing and shows great promise as a theoretical concept to understand nurses' role in patient outcomes. While aggregate studies of nurses' role in patient outcomes will continue to be important, studies of the individual role will also be necessary. The approach to studying capacity to rescue through the use of simulation is a novel approach but one that will be essential to the future. Simulation can provide many research opportunities in nursing from the individual's role in outcomes to the roles and interactions of teams of health care personnel and the resulting effect on patient outcomes. Simulation is a safe and effective way to evaluate the skill level of nurses and to measure how nurses respond in situations. Simulation can be used to evaluate how expert nurses deliver care to their patients. It can also be used to evaluate the effectiveness of care given to a patient by looking at the outcomes for the simulated patient. This insight into the role of the nurse will provide nursing leadership with valuable information to structure education and training to enhance the capacity to rescue of the nurse.

As reimbursement changes impact hospitals it will become important to understand, at an individual level in addition to a systems level, the impact of nurses on the patients they care for. New rules from the Centers for Medicare and Medicaid (CMS)

go into effect in Fall 2008 and hospitals will be dependent upon nursing to document outcomes present on admission and to prevent additional adverse events (<http://www.cms.hhs.gov/HospitalAcqCond/>). Nursing will become a focus for scrutiny and understanding how individual nurses impact errors and adverse events will be a key focus. Using the individual variable, capacity to rescue, in combination with systems analysis will position hospitals to ensure high quality and safe care is delivered to their patients. Agencies such as the Institute for Healthcare Improvement and the Agency for Health Care Research and Quality have many initiatives underway to address the systems issues in health care today. They focus on creating and sustaining improvements in health care. This focus on continual improvement is critical. However, traditionally too much time is spent on the plan-do stages of the continuous quality cycle and more time needs to be spent on the check-act. It is the check-act portion of the continuous quality improvement cycle that sustains and builds upon innovations. Sustaining systems improvements is the role of individuals and understanding more about the individuals in the process will enable the sustainability of the improvements. Systems can be changed but unless individuals in the system are willing to participate in and support the changes there is little hope that things will improve.

This is an important time for nursing to be recognized and valued for their contribution to the prevention of problems and to the enhancement of capacity to rescue. This research will help to inform policy makers of how nurses impact patient safety and outcomes and what additional support is needed. If work environment continues to be a key indicator, as earlier research suggests, then support in that area is also critical. If capacity to rescue impacts outcomes, as this research suggests, then interventions

designed to improve nurses' capacity to rescue need to be developed. This research focused on the individual nurse's role in patient safety. The systems approach also remains a critical component as well and future research should evaluate both areas, however, in the end it is still the individual nurse, who is on the front line, caring for the patient.

This research also demonstrates the usefulness of simulation in health care research and should inform policy makers to consider funding to support its use in the future. Simulation is a very exact methodology for measuring a nurse's ability in a situation that mimics real life. The ability to measure the nurse's capacity to rescue provides an opportunity to discover strengths and weaknesses in performance that can be informative for the design of educational interventions to improve capacity to rescue and patient outcomes. Health care will continue to be error prone. There are no systems that can remove the human element from the work done in health care. As long as humans are involved in the delivery of care to patients, nurses will often be the last point in the chain of events leading to an error (Reason, 2000). If the nurse has a high degree of capacity to rescue, then more errors or potential adverse events will be intercepted or prevented by early recognition of problems and appropriate/timely interventions. Using overall individual capacity to rescue is an important variable for the future of nursing and further research needs to be done to fully understand this new concept.

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