RESCUE EVENTS IN MEDICAL AND SURGICAL PATIENTS: IMPACT OF PATIENT, NURSE & ORGANIZATIONAL CHARACTERISTICS

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RESCUE EVENTS IN MEDICAL AND SURGICAL PATIENTS: IMPACT OF PATIENT, NURSE & ORGANIZATIONAL CHARACTERISTICS

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Medical emergency teams (METs) were developed to more rapidly respond to changes in patient condition that might result in a preventable death. While effective, MET do not address events which precede the call for a response. Such information could provide direction for interventions that avert the need to initiate a MET response or identify the need to do so more quickly. This study examined differences in patient, nurse, and organizational characteristics for 108 MET calls involving patients on five medical and five surgical units in a tertiary care hospital. MET activations occurred more often on the 7AM-7PM shift than the 7PM-7AM shift ($p \leq .007$) for medical patients ($p=.036$) but not surgical patients. Of the 108 events, 44% were delayed events, defined as events with documented evidence in the medical record that pre-established criteria for calling the MET were present for > 30 minutes. More delays occurred on the 7PM-7AM shift ($p=.012$) for surgical patients ($p=.036$) but not medical patients. Delayed events were not significantly related to the number of medical or surgical patients the nurse was assigned ($p=.608$). However, there was a trend for more delays when more patients were assigned (4:1 = 21% vs 6:1= 43%). In a logistic regression model, the variables of shift (7AM, 7PM) and care on a unit designated for medical or surgical patients were significant predictors of delay. Shift was associated with a significance level of .009 and a 3.25 greater likelihood (95%CI, 1.34-7.9) of a delay occurring on the 7PM shift. Receiving care on a designated unit was associated with a significance level of .014 (OR, .07; 95%CI, .009-.579). These findings have implications for patient safety by demonstrating avoidable delays in responding to clinical deterioration. Study findings suggest that a combination of patient, nurse, and organizational characteristics influence the timely rescue of hospitalized patients.

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1.0 INTRODUCTION

In 1863, Florence Nightingale stated that "the very first requirement in a hospital is that it should do the sick no harm"(Nightingale, 1863). Yet 150 years later, adverse events and medical errors continue to be associated with substantial mortality, with estimates as high as 44,000 to 98,000 patient deaths per year (*To Err is Human*, 2000). Adverse events are rarely the result of the negligence of a single individual. More commonly, they result from interconnected processes and parts that combine to fulfill a common purpose (*To Err is Human*, 2000).

Unexpected cardiac arrest in hospitalized patients is one of the most serious adverse events because despite advances in cardiac arrest team and resuscitation efforts, the risk of death from such an event has remained static over the last decade, at rates reported to range from 50 to 80% (Bedell, DelBanco, Cook, & Epstein, 1983; Peatfield, Taylor, Sillett, & McNicol, 1977). It has been estimated that 60-70% of patients who experience cardiac arrests in hospitals have evidence of deterioration with abnormal signs and symptoms for 6 to 8 hours preceding the event (Buist et al., 2002; Franklin & Mathew, 1994; Schein, Hazday, Pena, & Sprung, 1990). Conversely, early recognition and clinical intervention can decrease the incidence of cardiac arrest and in-patient mortality (Bellomo et al., 2004; Buist et al., 2002; DeVita et al., 2004; Goldhill, Worthington, Mulcahy, Tarling, & Sumner, 1999).

To direct resources toward earlier intervention, many hospitals have established Medical Emergency Team (MET) system. This team is designed to supersede the cardiac arrest team and

is modeled on principles of early recognition, response and rescue. The use of the medical emergency teams has been shown to reduce in hospital cardiac arrest events (Bellomo et al., 2004; Buist et al., 2002; DeVita et al., 2004; Goldhill et al., 1999).

One of the major underpinnings in the success of the MET intervention rests with the ability to recognize the need to rescue. The concept of "failure-to-rescue" was first introduced by Silber and colleagues (1992) as a means to differentiate between factors that predicted patient mortality versus factors associated with adverse occurrences. They proposed that, in addition to variation in mortality rates among hospitals, there were differences in hospitals' ability to provide appropriate care to rescue patients. Notably, differences in the ability to rescue patients were found to be less related to patient characteristics and more related to organizational factors. Although patient characteristics were the primary indicators and predictors of complications, once a complication occurred, death due to that complication was more likely to be related to hospital characteristics than patient age, history and severity of illness (Silber, Williams, Krakauer, & Schwartz, 1992).

Ten years later, Aiken and colleagues used the term failure-to-rescue to evaluate the quality of nursing care by comparing the number of surgical patients who developed complications and who survive to those who did not survive (Aiken, Clarke, Sloane, Sochalski, & Silber, 2002). Their research and that of others found that, in addition to patient characteristics, adverse patient outcomes, including failure-to-rescue, were related to registered nurse staffing ratios (Blegen & Vaughn, 1998; Flood & Diers, 1988; Kovner & Gergen, 1998; Needleman, Buerhaus, Mattke, Stewart, & Zelevinsky, 2002). Notably, failure-to-rescue rates were lower in hospitals where a greater proportion of care was provided by registered nurses or nurses educated at the baccalaureate level (Aiken , Clarke, Cheung, Sloan , & Silber, 2003;

Needleman et al., 2002). These findings support the observation of Lewis Thomas, author of "The Youngest Science" who described that hospitals are held together and enabled to function in large part by the nurses (Thomas, 1983).

The level of staffing is an incomplete measure and explanation of the role of registered nurse performance in recognizing and responding to complications, whether measured in hours of care, the proportion of registered nurse hours or ratios (Aiken et al., 2003). Aiken and colleagues (Clarke & Aiken, 2003) introduced two key components of failure-to-rescue: careful surveillance for timely identification of complications and taking action by initiating appropriate intervention. Death with failure-to-rescue is thought to occur at least in part due to a breakdown in the surveillance system, e.g., when signs of a complication are not recognized or acted upon early or quickly enough (Clarke, 2004). This observation introduces aspects of surveillance beyond levels of staffing.

The nurse's ability to monitor patient response is, in part, related to the number of patients assigned. However, there are other aspects of failure-to-rescue that relate to the ability to anticipate, recognize, and promptly and appropriately intervene which may relate to differences in educational level and clinical experience. Aiken et al (2003) reported differences in the proportion of nurses holding baccalaureate or higher degrees that ranged from 0% to 77% across 168 Pennsylvania hospitals. After adjusting for hospital and structural characteristics, e.g., size, teaching status, nurse experience, a 10% increase in the proportion of nurses holding a bachelor's degree was associated with a 5% decrease in mortality and failure-to-rescue.

Most studies examining failure-to-rescue have examined nursing skill levels and adequate nurse staffing levels through a retrospective review of medical records and large administrative databases (Aiken et al., 2002; Boyle, 2004; Needleman et al., 2002). The causes of failure-to-

rescue events have rarely been explored at the unit level. Clarke and Aiken (2003) cite the limitation of using discharge abstract databases as this approach cannot be used to identify subtleties in how events unfold. Smaller prospective studies can examine patient, nurse and organizational characteristics in more detail. Also, such studies can address the complex issues related to care on medical units, which have not yet been examined.

No studies were identified that examined factors such as continuity of care in regard to patient assignment, the clinical experience of the nurse, or transfer between units as factors influencing MET activation. Also no studies were identified that explored causes of MET activation on medical units. Further research using a smaller sample of medical and surgical patients who require a MET intervention may provide information that identifies patient, nurse or organizational characteristics that can be modified to prevent failure-to-rescue events.

1.1 PURPOSE OF THE STUDY

The purpose of the study is to identify factors of MET intervention in medical and surgical patients in a tertiary care institution. Selected nurse characteristics, patient characteristics, and organizational characteristics will be compared in patients admitted to these units who have a MET intervention during their hospital stay.

1.2 SPECIFIC AIMS

The specific aims of the study are:

1. to describe factors associated with MET activation that relate to nurse, patient and organizational characteristics.
2. to compare differences in nurse, patient, and organizational characteristics between medical and surgical patients with a MET intervention.
3. to examine differences in continuity of care by the registered nurse of medical and surgical patients with a MET intervention.
4. to examine timing of transfers from the intensive care unit of medical and surgical patients with a MET intervention.

1.3 DEFINITION OF TERMS

Rescue event = a call for MET activation.

Delayed rescue event = a MET activation for which clinical criteria for activation existed for more than 30 minutes prior to calling the event.

Nurse characteristics = education (BSN, Non-BSN); experience (years in nursing, years on unit).

Patient characteristics = age (years); admitting diagnosis; length of stay; status change (new onset dyspnea, chest pain, acute mental status change, unilateral weakness, seizure, change in color of extremity); hypoxia (SpO_2 < 90 for 5 minutes); vital signs (RR> 36 or < 8; systolic blood pressure < 80mm Hg; HR > 160 bpm or 140 bpm with symptoms or < 40 bpm);

monitoring (telemetry, SpO_2); pain control (patient controlled analgesia); procedure (within the last 24 hours); respiratory (oxygen, treatments); fall since admission; physical restraint (ordered within the last 24 hours).

Organizational characteristics = admission site (Emergency Department, other); time of day the event occurred; day of week the event occurred; delayed event.

Continuity of care = nurse cared for the patient day before; patient and unit type match.

Timing of transfers = time of day the transfer occurred; and time of the event related to intensive care transfer.

1.4 SIGNIFICANCE AND INNOVATION

Nurses deliver 65 -95% of all direct care provided in hospitals (Hodge, Asch, Olson, Kravitz, & Sauve, 2002; McClure & Hinshaw, 2002; Wunderlich, Sloan, & Davis, 1996). They are the primary members of the health care team responsible for conducting surveillance on a constant basis to detect subtle signs and symptoms of developing complications. The development of a complication may be life threatening and result in death without the appropriate nurse surveillance. As an example, early signs and symptoms of pneumonia may manifest in alterations of respiratory status. The ability of the nurse to detect subtle changes in respiratory rate, breath sounds and oxygenation should result in a change in the management plan. Such changes can be subtle, e.g., hypoxemia may manifest as a change in mental status or restlessness. If not put into context, the treatment plan may not be changed until the problem is more serious and, if sufficient time passes, life threatening. By examining clinical events that place patients at risk for requiring MET intervention or experiencing a delayed event, it may be possible to

develop targeted interventions to decrease the number of such events. The bedside nurse has a critical role in this process because the nurse is often the first to observe such changes. By analyzing circumstances that surround MET activation it may be possible to identify critical assessment skills that can better equip the nurse to take appropriate actions to prevent or respond to such events.

Decreasing medical errors and improving patient safety are important components of quality health care. It is important to learn about and examine specific MET response events to understand how they relate to nurse staffing, education and experience. The information obtained from this study may be useful in determining appropriate monitoring requirements, staffing levels, and clinical skills required of the nursing staff to best identify and respond to patient deterioration outside the intensive care unit. Specifically, if variables influencing the ability to provide appropriate surveillance at critical junctions in care, such as transfer from an intensive care unit, can be identified, more prescriptive transfer regimes for nursing assessment and intervention can be implemented and tested.

This study is unique in several ways. It will be the first, to our knowledge, to compare factors that preceded MET activation in units specializing in the care of medical or surgical patients. Second, the study will be unique in examining processes leading to a MET activation in patients admitted to these units, rather than focusing on the outcome, e.g., event frequency, as has been done in prior studies (Aiken et al., 2002; Needleman et al., 2002). Third, the study will include both a concurrent and retrospective review of the event and examine a small number of cases in detail, rather than utilizing a retrospective database. Thereby, it will be possible to more closely examine factors that might predispose patients to require MET intervention. With this methodology, it will be possible to examine organizational factors, such as continuity of care and

timing of transfer, that are not recorded in large databases and therefore difficult or impossible to analyze from such sources. It is hoped this study will lead to interventions directed at the patient, nurse or organizational level that can decrease the number or improve the timeliness to activate the MET system.

1.5 CONCEPTUAL FRAMEWORK

The conceptual framework for this study is based upon the Role Effectiveness Model which was developed to guide the assessment of nurses' contribution to patient care (Irvine, Sidani, & McGillis Hall, 1998). It is based on the structure-process-outcome model of quality care. The structure component consists of nurse, patient and nursing unit variables that influence the processes and outcomes of health care. The process component consists of the independent, dependent and interdependent role functions of the nurse. They include the activities of patient assessment, decision-making, intervention and follow-up. The model is based on the premise that nurses' capacity to effectively carry out their independent and interdependent role function is influenced by nurse characteristics and unit structure characteristics. The process variables are posited by the authors to have a direct effect on patient outcomes (Irvine et al., 1998). The Role Effectiveness Model served as the theoretical base for this research to explore patient, nurse and organizational characteristics and their relationships to MET intervention. The conceptual framework for the study is shown in Figure 1-1.

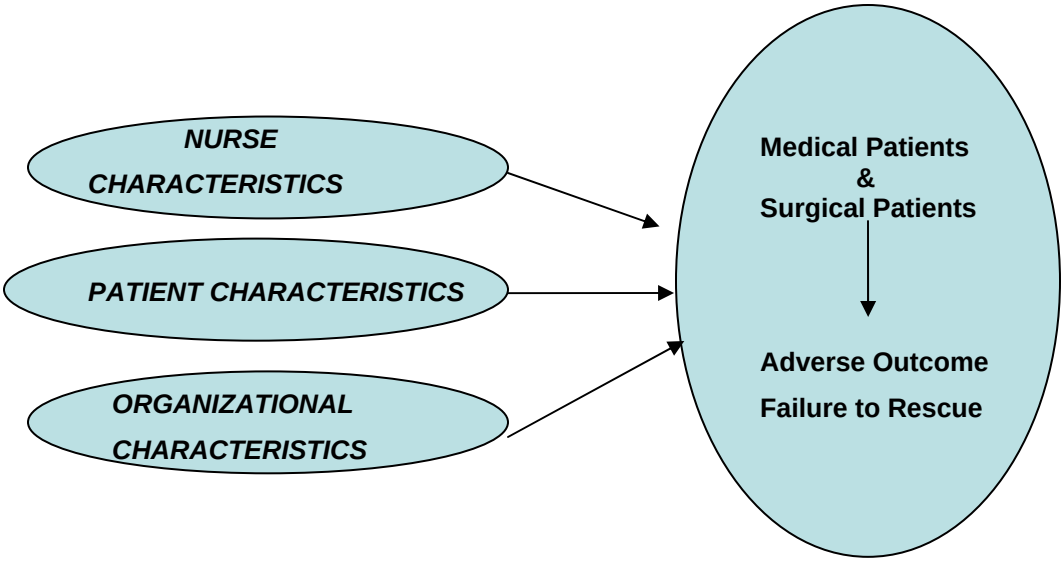

Figure 1-1 Conceptual framework

2.0 LITERATURE REVIEW

The following literature review is presented in the format of a manuscript for submission. The journal selected for submission is the Journal of Nursing Administration.

2.1 INTRODUCTION

Despite strong convictions, nursing research is only beginning to provide empirical evidence that the level of registered nurse staffing may influence patient outcomes. A variety of outcome measures have been examined, including patient mortality and, more recently, the relationship between registered nurse characteristics, e.g., level of education, experience, staffing levels. Through this research, authors have identified statistically significant relationships between staffing levels and patient outcomes (Aiken et al., 2002; Needleman et al., 2002). Despite the use of highly sophisticated risk adjustment techniques, studies that attempt to attribute nurse staffing level to mortality are inevitably confounded by numerous variables. An important trend has therefore been to examine additional measures as indicators of quality.

Typically, patients experience a number of adverse events that precede death, some of which may be unexpected and not preventable. Conversely, some events may be unexpected but highly preventable, if recognized promptly and appropriately managed. Recognition of the importance of unexpected, but preventable events that influence mortality led to the

conceptualization of the phenomenon of "failure-to-rescue". Failure-to-rescue refers to the inability to save a patient's life after the development of a complication (Silber, Rosenbaum, & Ross, 1995; Silber et al., 1992). It is well established that, even when successful, cardiopulmonary resuscitation is associated with a poor prognosis despite technological advances (Bedell et al., 1983; Peatfield et al., 1977). Early nursing recognition and intervention prior to a cardiac arrest situation may decrease morbidity and mortality if appropriate management is instituted in a timely manner. The skills needed to appropriately intervene prior to the onset of life threatening health problems require complex assessment, highly intensive therapies, targeted interventions, critical evaluation and immediate adjustment dependent on patient response (Curley, 1998). Although failure-to-rescue is commonly discussed within the context of preventable adverse events and hospital deaths, failure-to-rescue does not necessarily imply wrong doing (Aiken et al., 2003; Silber et al., 1992). Instead the reference is to *not recognizing deterioration* in patient status and taking steps designed to reverse these changes.

This review examines the association between registered nurse staffing and failure-to-rescue by reviewing selected literature and presenting the key research findings. The emergence of failure-to-rescue as an outcome measurement will be initially discussed. Research findings regarding the relationship between failure-to-rescue and registered nurse staffing will be explored, as well as research findings regarding the use of a medical emergency team and the ability of this intervention to reduce failure-to-rescue events.

To identify eligible published English language original research articles, the search was conducted through OVID and MEDLINE from 1965 to April 2005. The search was conducted using the following terms: *adverse events, failure-to-rescue, preventable deaths, medical emergency teams, and rapid response teams*. All the papers examined were research studies that

examined the relationship between registered nurse staffing and failure-to-rescue. As only English language studies were included, the literature review may have missed some studies that merited inclusion. In addition, published bibliographies from the National Patient Safety Foundation and The Institute for Healthcare Improvement were also reviewed. If there was uncertainty as to the appropriateness of an article, the abstract was reviewed. The purpose of this review was to use published data from original research to improve the understanding of failure-to-rescue events and the impact of interventions designed to improve recognition and response.

2.2 FAILURE-TO-RESCUE AS A CONCEPT

In 1992, Silber and colleagues conducted seminal research to determine if the factors that decrease mortality and prevent complications during a hospitalization are the same or different from those that promote rescue after a complication has occurred. This research was the first that attempted to measure and evaluate failure-to-rescue as a discrete outcome that was separate from mortality. Silber and colleagues (1992) argued that using death rate as a valid comparison of quality across hospitals ignored important precursors, including complications and response to patient condition once a complication occurred. They argued further that the management of complications or preventing death after a complication, an outcome referred to as "rescue", was an important outcome measurement of hospital performance. Failure-to-rescue was defined as a death that occurs after a patient develops a complication in the hospital that was not present on admission (Silber, Rosenbaum, Schwartz, Ross, & Williams, 1995; Silber et al., 1992).

To support their argument, Silber and colleagues (1992) examined the influence of both hospital and patient characteristics on three variables: death rate, the adverse occurrence rate and

failure-to-rescue rate. The research was conducted to determine if factors that predicted mortality were different than factors that predicted adverse occurrences (defined by the researchers as complications), and failure-to-rescue. The sample included patients who underwent cholecystectomy (n=2,831) or transurethral prostatectomy (n=3,141) in 7 states and 531 hospitals selected from the Health Care Financing Administration MEDPAR files. Two rationales were given for choice of these procedures: commonality of the procedures and association with well known adverse occurrences. Patients younger than 65 years of age and patients admitted through the emergency department were excluded.

Both hospital and patient characteristics were shown to be associated with the death rate. However, the only hospital characteristic which had a significant association ($p<0.05$) was the percentage of full time board-certified surgical staff. Patient characteristics, e.g., age, admission severity of illness, has a stronger association with complications ($p<0.001$). Failure-to-rescue revealed a different pattern. A reduced risk of failure-to-rescue was associated with a higher proportion of board certified anesthesia staff ($p<0.01$) and an increased risk with the presence of surgical house staff ($p<0.05$). The only patient characteristics which demonstrated a significant relationship were age and history of metastatic disease ($p<0.005$). There were no differences across hospital groups and the distribution of adverse occurrences which disputed the argument that some hospitals cared for sicker patients. These findings were noteworthy because they directed attention to hospital characteristics as a potential cause of failure-to-rescue. Silber and colleagues (1992) proposed that failure-to-rescue provided a powerful tool to detect true differences in patient outcomes across hospitals.

Building upon their initial study, Silber and colleagues (1995b) conducted a second exploratory study to compare the relative importance of patient and hospital characteristics to the

variation of death rate, adverse occurrence rate, and failure-to-rescue rate that expanded the variables examined to include capabilities of the hospital, its staff and its facilities. Notably, this was the first study to introduce the variable of registered nurse staffing as a possible explanation of variation in failure-to-rescue events across hospitals.

The sample included 73,174 patient admissions in 1990 and 1991 at 137 hospitals that were included in the MedisGroups National Comparative Data Sets. The sample included patients who underwent simple surgical procedures which included Medical Diagnostic Classification 6, 7 and 9, excluding liver transplantation. Each hospital was described by 12 variables, including the number of beds, percentages of surgical and anesthesia staff that were board-certified, ratio of registered nurses to hospital beds, and indicators reflecting activities and facilities such as cardiac catherization services, open heart surgery, organ transplant, magnetic resonance imaging, trauma and teaching programs.

Estimated variance ratios and Spearman rank correlations among hospitals and the three outcomes were conducted. Using logit models, they concluded that both patient and hospital characteristics contribute to the variation in death rate. Several findings were of particular interest to nursing. There was a negative correlation for failure-to-rescue with the number of board certified anesthesiologists ($r=-.40$; $p=.38$) and the ratio of registered nurses ($r = -.45$; $p=.01$). Accordingly, high values of registered nurse staffing were associated with hospitals in the model that had a low risk of failure-to-rescue. A major contribution of this study was the identification that the ratio of registered nurses was an important hospital characteristic that explained the outcomes of death rate, adverse occurrence rate and failure-to-rescue rate. The limitations of the study related to the interconnectedness of the indicators and the number of variables examined. These and other studies conducted by this research team extended prior

thinking about mortality as an indicator of hospital quality, introduced the failure-to-rescue event as an important phenomenon when assessing mortality, and most importantly, provided objective evidence documenting the importance of registered nurse staffing when evaluating hospital quality and patient outcomes (Table 2-1).

Table 2-1 Research regarding failure to rescue conducted by Silber and colleagues

	Purpose	Sample	Statistical Analysis	Hospital Characteristics	Definition	Findings
Silber,J. et al (1992)	To determine whether hospital and patient characteristics that prevent mortality are the same as those that prevent complications, or allow for rescue, should a complication occur.	Surgical patients > 65 years of age admitted for cholecystectomy (n=2831) or transurethral prostatectomy (n=3141) in 1985 in 7 states & 531 hospitals. Data obtained from HCFA MEDPAR files & Hospital Association Annual Survey	Student's test & chi square Multiple logistic regression models Odds ratio	Number of beds % of board certified anesthesiologists & surgeons Presence of anesthesia & surgical house staff	Failure Rate = Number of deaths in those patients that develop an adverse occurrence	Failure rate showed different pattern than death or adverse event. Anesthesia board certification significantly reduced risk of failure OR 0.63(0.5, 0.9); p<.01. Failure rate not influenced by severity or procedure
Silber, J. et al (1995a)	To determine whether hospital rankings based on complication rates provide the same information as hospital rankings based on mortality rates.	All patients undergoing CABG at hospitals in 1992 & 1992 MedisGroups National Comparative Data Bases linked American Hospital Association Annual Survey data (1991). 16,673 total patients;	Correlations-pair wise interactions Logistic regression models Odds ratio	Number of beds % of board certified anesthesiologists & surgeons Presence of anesthesia & surgical house staff MRI, Transplant, trauma programs, Nurse to Bed Ratio	Failure Rate = Number of deaths in those patients that develop an adverse occurrence	After adjusting for pt admission severity correlations b/t hospital rankings based on death or failure to rescue and complications were not significant. Death vs Cx (r=.07;p=.58) FTR vs Cx (r=-.22;p=.11) 717FTR events of the 7173 developed CX = 10% FTR rate
Silber, J. et al (1995b)	To determine why, when adjusted for recorded patient characteristics, mortality. Adverse occurrence and failure rates rank hospitals differently	73,174 patients admitted in 1990 & 1991 at 137 hospitals. Patients underwent simple surgical procedures. Merged data from HCFA MEDPAR files and Hospital Association Annual Survey	Logit model fitting Spearman Correlation	12 hospital variables- ratio of registered nurses to hospital beds was included.	Failure is defined as death following adverse occurrence	Failure rates negatively correlated with ratio of registered nurses to beds (r=-0.45;p<.01)
Silber, J. (2000)	To compare outcomes of surgical patients whose anesthesia care was or was not personally performed or medically directed by anesthesiologist	Medicare claims records for pts >65 in PA who underwent general or orthopaedic surgical procedures among 245 hospitals procedures b/t 1991 & 1994. 194,430 directed and 23,010 undirected	Logistic regression models; Odds Ratio	11 hospital variables- ratio of registered nurses to hospital beds was included.	Failure is defined as death following adverse occurrence	Ratio of registered nurses significant relationship to failure to rescue Nurse to Pt Ratio OR 0.95(0.93,0.98);p<0.0001
Silber J. et al (2002)	To compare outcomes of pts who underwent surgical procedures under the care of an anesthesiologist with or without board certification	Medicare claim records for 144,883 pts in PA who underwent general surgical & orthopedic procedures between 1991 and 1994. Outcomes of 8,894 cases involving mid career anesthesiologist who lacked certification were compared to all others	Logistic regression models; Odds Ratio	10 hospital variables- ratio of registered nurses to hospital beds was included.	Failure is defined as death following adverse occurrence	Ratio of registered nurses significant relationship to failure to rescue OR 0.84(0.79,0.89); p<.0001

The work of Silber and colleagues led to a more critical evaluation of the use of mortality as an outcome measurement for quality (Silber et al., 2000; Silber et al., 2002; Silber, Rosenbaum, & Ross, 1995; Silber, Rosenbaum, Schwartz et al., 1995; Silber et al., 1992). In addition, introduction of the concept of failure-to-rescue provided insight into the influence of hospital characteristics, including registered nurse staffing, as an important contribution to patient outcomes. Their findings introduced an analytic approach not previously used in studying these variables. There were also several important limitations. Only surgical patients were studied. Consequently, study findings cannot be generalized to other patient populations. Also the method used to determine registered nurse staffing was not clearly described and, therefore, it was not possible to determine if their analysis included all nurses employed in the institution or only those providing direct patient care.

Additional work by McKee and colleagues attempted to validate failure-to-rescue as an outcome measure in other health care delivery systems (McKee, Coles, & James, 1999). The study was conducted using a sample of patients admitted to hospitals in England. Findings from more than 900,000 surgical procedures and 140 hospitals revealed that adverse events were recorded at a substantially lower rate in England compared to the United States. There were also differences in secondary diagnosis coding in England that precluded use of failure-to-rescue as a comparison measure in English hospitals. The study did validate the observation that overall death rates are poorly correlated with the failure-to-rescue rate and that death rates are a function of patient characteristics and other institutional characteristics (Silber et al., 2000).

2.3 FAILURE TO RESCUE AND REGISTERED NURSE STAFFING AND EDUCATION

Prior to the work of Silber and colleagues (1992), several early studies reported a relationship between nursing surveillance as an organizational process variable and lower mortality (Kahn et al., 1990; Mitchell & Shortell, 1997). Ten years after Silber and colleagues (1992) published their original work, two pivotal studies appeared in the literature (Aiken et al., 2002; Needleman et al., 2002). These studies were the first to identify the relationship of failure-to-rescue to nursing related structures, processes and hospital characteristics. They also extended prior findings by examining the role of nursing in failure-to-rescue events in more detail using large sample populations.

Using the same surgical patient population as Silber and colleagues (1992, 1995b), Aiken and colleagues (2002) conducted a cross sectional analyses of linked data from staff nurse surveys (n=10,184) and general, orthopedic, and vascular surgery patients (n= 232,342) discharged from 168 hospitals in Pennsylvania between April 1998 and November 1999. Failure-to-rescue was included as a main outcome variable along with risk-adjusted mortality and nurse reported job dissatisfaction and job burnout. The study was designed to examine whether risk-adjusted surgical mortality and rates of failure-to-rescue were lower in hospitals where nurses were assigned fewer patients. Failure-to-rescue was defined as death in a surgical patient who developed serious complications. The study offered a unique contribution in methodology by linking de-identified nurse and patient data. It also addressed another limitation of prior research when looking at registered nurse staffing. Historically, nurse staffing was determined by retrospectively analyzing administrative databases. This research used a direct measurement through the registered nurse survey.

Data were collected on structural characteristics from two external administrative databases (American Hospital Association Annual Survey, PA Department of Health Hospital Questionnaire) for hospitals with at least 10 nurses responding to the questionnaire. Three hospital characteristics were used as control variables: size, teaching status and technology. Nurse staffing was measured as the mean patient load across all staff registered nurses who reported having responsibility for at least one but fewer than 20 patients on the last shift they worked. Nurses were asked to use a list to identify the hospital where they worked and were asked about demographics, work history, workload, job satisfaction and feelings of job burnout.

After adjusting for patient and hospital characteristics (size, teaching status, and technology), having been assigned one additional patient per nurse was associated with a 7% (odds ratio [OR], 1.07; 95% confidence interval [CI], 1.03-1.12) increase in the likelihood of dying within 30 days of admission and a 7% (OR, 1.07; 95% CI, 1.02-1.11) increase in the odds of failure-to-rescue. There were a number of limitations to the ability to reach this conclusion. There was considerable variation in mean patient-to-nurse ratio, which ranged from 4:1 to 8:1. Also, the sample of surgical patients represented only about 50% of the total surgery patients admitted to these hospitals. The response rate to the survey was 52% which, although high, creates the potential for response bias.

Despite these limitations, the study suggested important implications for registered nurse staffing and patient safety. The researchers posited that the nursing surveillance system explained the link between higher nursing skill mix and lower rates of failure-to-rescue and the ability to intervene before the patient's condition deteriorates so severely that it cannot be reversed or a cardiac arrest event occurs. Nurses are in the best position to initiate action that could minimize negative outcomes and prevent failure-to-rescue events.

Needleman and colleagues (2002) added to these findings by conducting research designed to define the relationship between patient outcomes potentially sensitive to nursing and nurse staffing in acute care hospitals. Hospital discharge data from 799 hospitals across 11 states (covering over 6 million discharges) were used to identify outcomes potentially sensitive to nursing in medical and surgical patients. State hospital financial reports or hospital staffing surveys were used to construct measures of nurse staffing at the level of registered nurses, licensed nurses and nursing aides. The level of staffing was estimated in hours. To allow for comparison of staffing levels across hospitals, the relative level of nursing care needed by patients was estimated and a nursing case mix index was constructed for each hospital. Failure-to-rescue was defined as the death of a patient with one of five life threatening complications (pneumonia, shock or cardiac arrest, upper gastrointestinal bleeding, sepsis, or deep vein thrombosis). These complications were selected because they could be identified early by nurses and influenced by nursing intervention.

Consistent with Silber and colleagues (1995b), findings indicated that, among surgical patients, a greater number of registered nurse hours per day was associated with a lower failure-to-rescue rate ($p=0.008$). The evidence for a relationship between failure-to-rescue and a higher proportion of care provided by registered nurses was not as strong for medical patients ($p=0.05$) and weaker than the association between staffing levels and the five other variables examined, i.e, length of stay ($p=.01$), urinary tract infection ($p <.001$), upper gastrointestinal bleeding ($p=.03$), pneumonia ($p=.001$), and shock or cardiac arrest ($p=.007$). Of interest among both medical and surgical patients, there was no evidence of an association between in-hospital mortality and the proportion of registered nurse hours. The authors acknowledge the limitations encountered when using large data sets involving hospitals in multiple states. The inability to

standardize and interpret different methods of reporting allocation of nursing staff to direct patient care is one of the major weaknesses of this type of analysis. Conversely, strength of this approach is the size of the sample and its geographic distribution.

Research investigating the effect of educational levels of the registered nurse and effect on nurse performance and patient safety outcomes is limited. Aiken and colleagues (2003) conducted a follow-up study using the same database of 168 Pennsylvania hospitals to determine if hospitals with a higher proportion of direct care registered nurses educated at the baccalaureate level or above had a lower risk adjusted mortality and lower failure-to-rescue rates. A secondary aim of the study was to determine if educational background was a predictor of patient mortality beyond factors of nurse staffing and experience. Aiken and colleagues (2003) constructed a risk-adjustment model similar to that used by Silber and colleagues (1995b). Significance testing was used to compare groups of hospitals that varied in educational composition and hospital characteristics including nurse staffing, nurse experience and patient characteristics. Logistic regression models were used to estimate the effect of a 10% increase in the proportion of nurses who held a bachelors or masters degree on mortality and failure-to-rescue. After adjusting for patient and hospital characteristics, a 10% increase in the proportion of nurses holding a bachelors degree was associated with a decrease in failure-to-rescue by a factor of 0.95 or by 5%. This is the first study to provide empirical evidence that the employment of nurses with bachelor and higher degrees in hospitals improves patient outcomes.

The most common criticism of this study was the methodology used to combine education categories, particularly combining the baccalaureate degree and higher. In rebuttal, the authors provide strong testimony to the number of checks they instituted to insure the validity of the findings. This testing included allowing nurse education variable to have a nonlinear effect

and testing whether the effect of education varied across levels using quadratic and dummy variables. This analysis did not improve the fit of the model. Consequently, the authors argue that they can provide strong evidence to validate their methodology and the findings. As in prior studies by Silber and colleagues (1992; 1995b) and Aiken and colleagues (2002) the use of surgical patient populations prohibits generalization to other patient populations. In addition the sample used by Aiken and colleagues (2002) was drawn from a single state.

One additional study was identified which used failure-to-rescue as an outcome measurement in an exploratory cross sectional study that investigated the association between nursing unit organizational characteristics and patient outcomes (Boyle, 2004). The sample was drawn from a 944 bed teaching facility and included 21 medical surgical units. The Nursing Work Index was used to measure unit characteristics. B+ variate correlation and Pearson r was used to detect relationships between variables. Results showed significant associations between unit characteristics and select adverse events. The adverse event variables are: patent fall, pneumonia, urinary tract infection, pressure ulcer, cardiac arrest, death, and failure to rescue. Nurse autonomy and collaboration as measured by the Nursing Work Index-Revised showed a statistically significant inverse relationship (r=-0.53) with failure-to-rescue.

2.4 FAILURE-TO-RESCUE AS A QUALITY INDICATOR

Failure to rescue has been identified by the Agency for Health Care Quality (AHRQ), the lead agency for the United States government on quality in health care, as one of the 16 patient safety indicators (PSI) created and released to the public in 2003 which are to be used to assess and improve patient safety in United States hospitals. The 16 PSI were developed in collaboration

with the University of California-Stanford evidence based practice center. Four PSI are recognized by the AHRQ as staffing/nurse –sensitive quality indicators –decubitus ulcer, failure-to-rescue, post operative respiratory failure and post operative deep vein thrombosis. All the indicators have been evaluated for construct validity, precision and minimum bias (selection effect, confounding and misclassifications). It is reported that failure-to-rescue performed well on dimensions of reliability, bias, relatedness of indicators and persistence over time. Reliability was reported as moderately high at 66.7%, suggesting that differences in risk adjusted rates of failure-to-rescue would reflect true differences across hospitals.

The Health Grades Second Annual Quality Study used the AHRQ PSI to study the safety and associated cost of inpatient care among Medicare patients. The study reported approximately 1.18 million total patient safety incidents among nearly 39 million hospitalizations. Failure-to-rescue was found to be one of the PSI with the highest incidence rate along with decubitus ulcer and post operative sepsis, accounting for 62% of all patient safety incidents among Medicare patients hospitalized in 2001 through 2003. The failure-to-rescue incident rate was reported as 148 per 1000 at risk hospitalizations followed by decubitus ulcer at 31 per 1000 at risk hospitalizations. There were 198,793 actual number of failure-to-rescue incidents reported in the study, which accounted for 16.9% of the total number of incidents. Failure-to-rescue was one of six indicators that did not demonstrate substantial improvement in frequency. This finding speaks to the struggle the health care industry has in achieving improved approaches to health care delivery, even when areas for patient safety improvement are evident. It also speaks to the need for ongoing investigation into the causes of failure-to-rescue events to develop empirically sound solutions and strategies.

Kremsdorf argues that the lack of improvement is the result of treating failure-to-rescue as a series of errors of commission (Kremsdorf, 2005b). Often, the series of events leading to a failure-to-rescue event are seemingly minor errors of commission. For example, important laboratory tests may not be reviewed by the nurse. The nurse may not recognize the importance of subtle changes in patient condition because the patient is newly assigned or may not appropriately analyze assessment data or communicate changes in patient condition that indicate a deterioration in condition to the medical care team. Hours pass before these subtle changes become readily apparent and present as a clinical crisis. The same situation can occur with changes in vital signs that go unrecognized, are viewed as unimportant, or not recognized to be critical until a catastrophic patient event occurs. He proposes a model which describes "how catastrophes develop" which describes the process of patient admission to a medical surgical unit based upon assessed needs and treatment plan (Kremsdorf, 2005b). In this model, staffing intensity and experience are proposed as important factors as are acuity of illness. If patient acuity is high and staffing intensity and expertise is insufficient, the result is a failure-to-rescue event. Kremsdorf proposes technologic and training solutions that help to predict and recognize changes in patient conditions (Kremsdorf, 2005a, 2005b).

2.5 MEDICAL EMERGENCY TEAMS

The empirical evidence that identified consequences of a failure-to-rescue led to the institution of measures to improve surveillance, recognition and response to patients failing outside the intensive care unit. One approach involves the formation of a MET that can be summoned when clinicians experience concern for their patients or when patients meet predefined clinical criteria

(Bellomo et al., 2004; Buist et al., 2002; DeVita et al., 2004). The Institute for Healthcare Improvement has identified the deployment of medical emergency teams, which they refer to as rapid response teams, as one of six changes to prevent deaths in patients who are progressively failing outside the intensive care unit (*Institute for Healthcare Improvement*).

The first study reporting outcomes of the use of medical emergency teams was reported in 1995 by clinicians in Australia (Lee, Bishop, Hillman, & Daffurn, 1995) who described outcomes following institution of a MET in a 375 bed teaching institution. During the 12-month observation period, there were 522 MET calls, including 62% in the emergency department and 26% on hospital wards. Nurses summoned the team in the majority (69%) of the calls. Most patients were medical (76%) and acute respiratory failure and seizures were the most frequent conditions prompting the call. In almost half (42%) of the events, a decreased level of consciousness was one of the main alerting physiologic abnormalities. Concern that the patient would deteriorate if urgent help was not available occurred only in three instances of the 522 calls. Conversely, others (Bellomo et al., 2004) have reported that this concern was the most frequent reason for calling the MET (30 of 52 calls).

The establishment of a MET system has been shown to decrease the incidence of adverse outcomes such as cardiac arrest (Buist et al., 2002; DeVita et al., 2004). Buist and colleagues (2002) reported a 50% reduction in the incidence of unexpected cardiac arrest during a comparison of events occurring in 1996 (pre MET; n=73) to those occurring in 1999 (post MET; n=37). DeVita and colleagues (2004) retrospectively analyzed data and reported a 17% decrease in the incidence of unexpected cardiopulmonary arrest between a five year period (1996-2000; n=1973) before objective criteria and 1.8 year period after the implementation of clinical criteria (Jan 2001-September 2002; n= 1296). These findings provide consistent support for the benefits

of an in-house MET to respond to patients who are progressively failing outside the intensive care in reducing the number of unexpected cardiac arrest events. There are several limitations of this research. All studies were conducted at a single institution. Given the nature of the event, it is not possible to conduct a study that is randomized or blinded. Other measures which would introduce more control to the design, such as use of a "sham" response team would be unethical (Bellomo et al., 2004). Consequently, it is not possible to eliminate the influence of potential confounding variables, such as changes in the delivery of care or staffing variables as factors which led to the decrease in events. Despite the limitations, the findings are encouraging and worthy of additional inquiry to the intervention and failure to rescue events. Table 2-2 includes a review of the evaluation and testing of MET as an intervention to improve patient care.

Table 2-2 Literature review of MET system

AUTHOR	DESIGN	MET TEAM COMPOSITION	MET TEAM CRITERIA	OUTCOME EVALUATION	FINDINGS
Hillman et al Lancet 2005	23 hospitals randomized to control(n=11) or intervention (n=12) In Australia, United Kingdom & New Zealand over a 6-month period.	At least1 RN & 1 MD from ICU or ED	Respiratory or Cardiac Arrest; Respiratory Rate <5 >36 Pulse Rate <40 > 140 SBP <90; Sudden fall in GCS >2 points; Worried about patient	1. cardiac arrests without pre-existing do not resuscitate order 2. unplanned ICU admissions 3. unexpected deaths	Calls for cardiac arrest or MET higher in intervention hospitals (p<0.0001). Calls not associated with cardiac arrest or unexpected death higher in MET hospitals (p=<0.0001) No significant differences between MET and control hospitals for any outcome
Parr et al Resuscitation, 2001	Retrospective analysis of MET calls for 12 months. 580 bed tertiary care hospital in Australia	ICU Physician, Medical Physician; ICU Nurse	Respiratory or Cardiac Arrest Respiratory Rate <5 >36 Pulse Rate <40 > 140 SBP <90 Sudden fall in GCS >2 points Worried about patient	1.Reason for MET call 2. Immediate Outcome 3. Impact on Not for Resuscitation Orders	713 MET calls. Most common reasons: decrease in GCS (n= 155), SBP <90 (n=142), respiratory rate >35 (n=109), worried (n=83). Early identification of 252 patients who required ICU transfer
Buist et al BMJ ,2002	Non randomized ; retrospective review before & after introduction of MET 300 bed tertiary hospital in Australia	2 MDs 1 ICU Nurse	Respiratory rate < 6 >30; SaO2 <90 on oxygen Difficulty speaking SBP < 90 despite treatment; Pulse >130. Unexplained decrease in consciousness; Agitation or delirium; Concerned about pt; Uncontrolled pain; Failure to respond to treatment; Unable to obtain prompt assistance	Incidence & outcome of unexpected cardiac arrest	Unexpected cardiac arrest calls decreased (p<0.001). Mortality after intervention decreased (p<0.001). Odds ratio after adjustment for risk of cardiac arrest 0.50 (0.35 to 0.73)
Bellomo et al Critical Care Medicine,2004	Prospective controlled before & after intervention enrolling consecutive patients admitted to hospital for major surgery. 2 hospital systems Australia	Cardiology fellow ICU fellow; Coronary care nurse; Receiving unit fellow	Acute change in: heart rate <40 or >130; SBP <90; Respiratory rate <8 or >30; Pulse ox saturation to <90 despite O2 Conscious state; Urine Output 50cc/4hrs; Worried about patient	1. Patients affected by adverse outcomes 2 In-hospital deaths 3.Individual adverse outcomes 4.Mean duration of hospital stay	Decreased adverse outcomes in intervention period (p<0.0001). Decrease in respiratory failure (p<0.0001), stroke (p=.0026), sepsis (p=.0044). Emergent ICU admissions reduced (p=0.001) Decrease in postop deaths (p=0.0178); Decrease in mean hospital stay from 23.8 to 19.8 (p=0.0092)

Table 2-2 (continued)

AUTHOR	DESIGN	MET TEAM COMPOSITION	MET TEAM CRITERIA	OUTCOME EVALUATION	FINDINGS
DeVita et al BMA, 2004	Retrospective review of incidence of cardiac arrest before and after initiation of objective MET criteria Tertiary 622 licensed bed facility	ICU Physician 2 ICU Nurses, Respiratory Therapist	Respiratory rate<8 or >36; new onset of SaO2 of <85% for 5 minutes; Heart Rate <40 or >140; SBP <80 or >200, DBP >110 with symptoms; Acute neurological change; Pt c/o of chest pain, color change, unexplained agitation for >10 minutes, Suicide attempt, Uncontrollable bleeding, Administration of naloxone	Cardiac Arrest Event	MET usage significantly increased (p<0.001). Incidence of cardiac arrest events decreased by 17% (from 6.5/1000 admission to 5.4/1000 admission; p=0.016). No change in mortality of cardiac arrest events (33% of the pts with cardiac arrest event died)
Foraida, M. et al Journal of Critical Care,2003	Retrospective review of utilization of MET at 567 licensed bed tertiary care facility. Comparison of outcomes before and after increase of MET team use between January and June 2000.	ICU Physician 2 ICU Nurses, Respiratory Therapist	Respiratory rate<8 or >36; new onset of SaO2 of <85% for 5 minutes; Heart Rate <40 or >140; SBP <80 or >200, DBP >110 with symptoms; Acute neurological change; Pt c/o of chest pain, color change, unexplained agitation for >10 minutes, Suicide attempt, Uncontrollable bleeding, Administration of naloxone	1. Incidence of crisis events 2. Incidence of cardiac arrest events 3. Crisis with fatal outcomes	After objective criteria, significant change in condition events. Events increased by 19.2%; p<0.0001; sequential stat pages decreased by 5.7% (p<0.0001). Significant correlation (-0.52) between number of condition events and sequential stat pages. Fatal cardiac arrest decreased from 4.3 to 2.2/1000 adm (p<0.0001). Cardiac arrest declined from 6.0 to 5.2/1000 adm (did not reach statistical significance).
Hourihan et al Clinical Intensive Care,1995	Prospective study of all MET calls over 6 months in a 460 bed teaching hospital in Australia	Unspecified- consisting of Medical and nursing staff skilled in resuscitation	Respiratory Arrest Respiratory Rate <5 >36 Cardiac Arrest Pulse Rate <40 > 140 Systolic blood pressure <90Sudden fall in LOC Fall in GCS >2 points worried about patient	1. Unplanned readmission to ICU 2. Mortality	294 MET calls MET response > for medical (71%) than surgery pts (21%). 70/294(24%) cardiac arrest; 35/294 (12%) airway; 166/278 (60%); abnormal physiologic variables- decreased LOC (70/294); hypotension (42/294)

Table 2-2 (continued)

AUTHOR	DESIGN	MET TEAM COMPOSITION	MET TEAM CRITERIA	OUTCOME EVALUATION	FINDINGS
Lee et al Anesthesia Intensive Care, 1995	Description of utilization of MET and outcomes of patients requiring MET in Australia	Medical and nursing staffs skilled in resuscitation	Temperature <35.5 or > 39.5 Systolic blood pressure <100 or >200; Respirations <10 or > 30; Pulse <40 or >120; Urine Output <500/24hrs; Decreased or altered level of mental status	1. Reason and Time of MET call 2. Physiologic observation and Treatment 3. Patient outcome 24 hrs post met and discharge	522 MET calls. 29% were calls to medical surgical areas; 75% of the calls were to medical patients; 13% to surgical patients Cardiac Arrest for 148/522 calls (28%); Physiologic abnormality in 121/522(23%; Decrease level of consciousness most frequent physiologic abnormality (n=51; 42%); blood pressure 35/121(29%). Resuscitation occurred in 371/522(71%). Mortality from cardiac arrest 29% Mortality from other response 76%

3.0 METHODS

3.1 DESIGN

This exploratory study used a quasi-experimental study design. Selected nurse, patient, and organizational characteristics were examined in medical and surgical patients to identify circumstances in which rescue events, hereafter termed medical emergency team (MET) response, were more likely to occur and factors associated with an early and delayed call for assistance in managing the event. Approval to conduct this research was obtained from the institution's Total Quality and Patient Safety Committee (Appendix A).

3.2 SETTING AND SAMPLE

This study was conducted at the University of Pittsburgh Medical Center (UPMC) Health System, Presbyterian campus. UPMC Presbyterian, a university affiliated tertiary care facility, admits approximately 32,000 patients per year. The institution has a well established MET response system. Approximately five MET events are called each day in this institution.

The sample was a convenience sample of 108 patient rescue events that occurred between January, 2004 and January, 2006 involving 51 medical and 57 surgical patients. The criteria for selecting a rescue event analyzed for this study were:

1. patient admitted to a medical unit, defined as unit 10N;10S;9D;10D;12D
2. patient admitted to a surgical unit, defined as 10E/W;9N;11N;9G;10G

The criteria for selecting the MET activation required that it occurred on one of the identified medical or surgical units within the hospital. Cardiology, step-down and intensive care unit events were excluded, as were events which did not occur on an inpatient unit. MET events occurring on these units were included based on the availability of the nurse reviewer. To collect data for this study, the log of events was reviewed and the events meeting the selection criteria were forwarded to an independent nurse reviewer. Eligible events were reviewed based on the availability of the independent nurse reviewer. There was no pattern to the availability of the reviewer.

The MET was introduced as a component of care at this institution in 1989. It was designed to supersede the existing cardiac arrest team. Those individuals who respond to a MET event include an Intensivist, two Intensive Care Nurses, and a Respiratory Therapist. The team can be summoned by anyone in the hospital (registered nurse, nursing assistant, transport aide, information desk clerk) at any time they have concern for patient care by calling a designated number. The call creates an electronic page and overhead speaker announcement placed by the hospital operator. The operator records the location and type of condition. The MET was judged to be underused by the condition review team. In 1999, specific criteria were developed to indicate situations when calling a MET response was appropriate (Appendix B). Subsequently, the number of events when the team was called increased.

3.3 STUDY VARIABLES

3.3.1 Outcome variable

The dependent variable in this study was the rescue event. A rescue event was defined as activation of the MET system occurring on a selected medical or surgical unit. In addition, events were characterized as ***delayed or not delayed***. A delayed event was defined as an event for which there was documented evidence in the medical record that pre-established clinical criteria for calling the MET were present for > 30 minutes prior to the call.

3.3.2 Patient characteristics

In order to more fully understand the differences between medical and surgical patients who experienced MET events, the following patient characteristics were examined:

1. age (years);
2. status change (new onset dyspnea, chest pain, mental status at the time of admission and time of the event, unilateral weakness, seizure, change in color of extremity);
3. hypoxia (SpO_2 < 85 for >5 minutes);
4. vital signs (RR> 36 or < 8; systolic blood pressure < 80mm Hg; HR > 160 bpm or 140 bpm with symptoms or < 40 bpm);
5. pulse oximetry (present or absent);
6. telemetry (present or absent);
7. pain control (patient controlled analgesia);
8. procedure (invasive procedure within 24 hours of the event);

9. respiratory status (oxygen,treatments);
10. falls (< 24 hours); and
11. newly ordered restraint use (< 24 hours).

3.3.3 Nurse characteristics

To identify if nurse characteristics of education or experience were different between medical and surgical patients who experienced a MET event, the following variables were examined:

1. education (highest nursing degree completed)
2. experience (years in nursing, years on unit).

3.3.4 Organizational characteristics

Selected organizational characteristics thought to influence MET activation based upon prior research were also analyzed. These characteristics were:

1. admission site (Emergency Department, other);
2. staffing (nurse to patient ratio on unit); and
3. day of week and time of day the event occurred.

3.3.5 Continuity of care

In addition, selected variables were examined to evaluate the influence of continuity of care. These were:

1. care of this patient on the day prior to the event;
2. care on designated unit.

Continuity of care was determined by asking the nurse manager the following questions: 1) Did this nurse care for this patient yesterday? 2) If yes how many days prior to the day of the event? Care on designated unit was determined by matching the designated unit type (medical, surgical) to the patient type (medical, surgical), it was classified as match or mismatch.

3.3.6 Timing of transfers and outcome

In addition, timing of transfer from the intensive care was examined in regard to whether transfer occurred within 24 hours of the event. Data were also collected to describe the outcome of the event, e.g., death (event, in-hospital), intubation, intensive care admission, cardiopulmonary arrest.

3.4 MET ACTIVATION DATA COLLECTION INSTRUMENT

The data collection instrument was designed by the researcher with input from members of the Dissertation Committee who included an Intensivist, a Nurse Administrator, and two Nurse Researchers with expertise in critical care. The instrument includes desired items arranged in the three domains of interest: Patient Characteristics; Nurse Characteristics; Organizational Characteristics (Appendix C).

3.5 JUSTIFICATION OF SAMPLE SIZE

A sample of 108 subjects was judged sufficient to provide data for this exploratory study of factors influencing the need to call for a MET response in medical and surgical patients.

3.6 STEPS IN DATA COLLECTION

1. Each day during the study period the MET event log was reviewed for events on the selected units.
2. Based upon the availability of the nurse reviewer, events occurring on the selected units were forwarded for data review.
3. The nurse reviewer completed a review of the chart using the data collection tool developed by the researcher (Appendix C). The review tool was returned to the researcher. The researcher entered the information about the MET response review into the data base (Appendix D).
4. To ensure that the risk to privacy of patient information was minimal, any identifiable protected health information collected was stored in a secure manner (locked file and password protected database) accessible only to the investigator.
5. To ensure reliability of the reviews conducted, the researcher conducted an independent review and data collection on a random sample of 20% of the cases. The results of the researcher and independent reviewer were compared to assure consistency and no discrepancies in the results were found.

3.7 DATA ANALYSIS

For the preliminary data analysis, descriptive statistics were obtained for all the variables to check data entry error (outliers and missing data) and to clean the data. In addition to proof reading, descriptive statistics with a graphical representation of the variables was conducted prior to analyses. Histograms and scatter plots of variables were examined for skew, gaps in distribution of the data and outliers. Any unexpected values were checked against the master file for accuracy. The investigator used SPSS (version 12) to score and analyze the data. Underlying assumptions of the statistical procedures to be conducted were assessed. If violations of the assumptions were found, such as non-normality or non-linearity, data transformations were performed as appropriate. For all statistical tests, a p-value of < 0.05 was selected apriori to indicate statistical significance.

Descriptive statistics were used to discuss the demographics of the sample groups. Frequency distributions and proportions were used for categorical data and measures of central tendency, including mean, median, range, and standard deviation was analyzed for continuous variables. The variables were divided into three domains: patient characteristics, nurse characteristics, and organizational characteristics. Within each domain, the categorical variables were described with frequencies and analyzed for between group differences using chi-square. Continuous variables were tested for between group differences using the t-test. Missing data was managed using the case wise procedure. This method was selected due to the loss of power when using listwise procedure and the predominance of categorical variables not amenable to mean substitution.

The statistical analysis by Study Aim was as follows:

Aim 1: To describe factors associated with MET activation that relate to nurse, patient and organizational characteristics. Descriptive statistics were used to discuss nurse, patient and organizational characteristics. Results were presented as frequencies, means and standard deviations depending on the nature of the variable being discussed.

Aim 2: To compare differences in nurse, patient, and organizational characteristics of MET activation that involve medical and surgical patients. All variables were tested for between group differences using the appropriate parametric or nonparametric measures.

Aim 3: To examine differences in continuity of care by the registered nurse in events that involve medical and surgical patients. Continuity of care (cared for the patient the day before and coded as yes /0 or no/1) was described by frequency for total group, medical group and surgical group. The Pearson's chi-square statistic was employed to test for significant difference between the medical and surgical group.

Aim 4: To examine timing of transfers from the intensive care unit in MET activation that involved medical and surgical patients. Timing of transfer from the intensive care unit within 24 hours (yes/0 or no/1) was tested using the Fishers Exact testing due to small cell frequencies.

3.8 LIMITATIONS

The study was subject to several limitations. First, the sample was a convenience sample obtained at times when the nurse reviewer was available to collect data. It is possible that cases collected in this manner do not represent the total sample of available cases. However, there was

no pattern to the time of data collection and all available cases were reviewed when the nurse reviewer was available. Second, the study took place in a University affiliated facility that had extended experience with the MET concept. It is possible that cases would have been different if another setting was used. Third, the scope of variables examined was determined from a review of the literature. It is possible that other factors, not examined in this study, also influenced patient outcomes.

4.0 RESULTS

The results of this study are presented in manuscript format using guidelines for submission to Quality and Safety in Healthcare.

4.1 INTRODUCTION

Acute care hospitals are complex environments in which many factors contribute to the achievement of quality patient outcomes. Care delivered within these highly complex environments is an interdependent and interactive process that is influenced by nurses, physicians, support staff and the infrastructure and technology designed to support patient care. Providing clinically effective care has been defined as doing the right thing in the right way for the right patient at the right time (*Clinical Effectiveness:Royal College of Nursing Guide*, 1996). The ability to achieve this level of patient care requires advanced technical and professional expertise as well as scientific knowledge.

Organizations outside of health care, such as nuclear power plants and aviation, are considered to be highly reliable. In part, they gained this designation due to a continuous review process that attempts to identify the root cause of adverse or near miss events and implement changes needed to avoid these events. Although the majority of patient care is delivered with successful outcomes, a United States study showed that 3.7% of hospitalized patients experience

an adverse event and, of these, 70.5% suffered a disability lasting longer than 6 months; 2.6% experienced permanent disability, and 13.6% died as a result of the injury (Brennan et al., 1991). An adverse event is an injury to a patient caused by medical management, rather than the underlying disease, which prolongs hospitalization and/or produces injury (Brennan et al., 1991).

Silber and colleagues introduced failure-to-rescue as an outcome measurement which they defined as a death that occurs after a patient develops a complication in the hospital that was not present on admission (Silber et al., 2000; Silber et al., 2002; Silber, Rosenbaum, & Ross, 1995; Silber, Rosenbaum, Schwartz et al., 1995; Silber et al., 1992). They found failure-to-rescue to be influenced by characteristics other than patient acuity, such as care provided by a board certified anesthesiologist and registered nurse staffing. The assumption was that development of a complication is most strongly influenced by patient characteristics, but once a complication develops, provider and organizational characteristics are more strongly linked to patient survival. Using the same surgical patient population as Silber and colleagues (1992, 1995b), Aiken and colleagues (2002) conducted cross sectional analyses of linked data from staff nurse surveys and general, orthopedic, and vascular surgery patients. After adjusting for patient and hospital characteristics, having been assigned one additional patient per nurse was associated with a 7% increase in the likelihood of dying within 30 days of admission and a 7% increase in the odds of failure-to-rescue.

The presence of unrecognized deterioration before cardiac arrest has been well reported in the literature with as many as 66 to 70% of patients who experience a cardiac arrest showing evidence of deterioration in the 6 to 8 hours preceding the event (Franklin & Mathew, 1994; Schein et al., 1990). Medical emergency teams (METs) were developed in response to widespread evidence that such delays might result in a preventable death. Subsequent reports of

a reduction in cardiac arrest and unexpected intensive care (ICU) admissions led a growing number of hospitals to introduce a MET system (Bellomo et al., 2004; Buist et al., 2002; DeVita et al., 2004). In their 100,000 Lives Campaign, the Institute of Healthcare Improvement (IHI) specifically cited such MET, referred to as rapid response teams, as an intervention that had the potential to reduce preventable hospital deaths. DeVita and Jones have documented that the epidemiology of patient deteriorations is not well understood (DeVita, 2005; Jones et al., 2005; Jones et al., 2006). Jones and colleagues provide data regarding the temporal pattern of METs. They describe a diurnal variation to crises that strongly suggests that patient deterioration is found and ignored (Jones et al., 2005). Their findings and conclusions support development of methodologies to find patients who are in crisis, and better respond to provide more clinically effective care.

While effective, the MET system does not address the events which precede the need to call for a response. We were unable to identify any studies that attempted to identify unique reoccurring characteristics that preceded the need to initiate a MET response. Such information could provide direction for interventions designed to avert the need to initiate a MET response or identify the need to do so more quickly. Accordingly, we analyzed patient, nurse, and organizational characteristics associated with a MET response involving patients admitted to a general medical or surgical ward in a tertiary care institution affiliated with an academic medical center. The specific aims were: 1) to compare differences in nurse, patient, and organizational characteristics in medical and surgical patients requiring a MET activation; and 2) to identify nurse, patient, and organizational variables that predict a > 30 minute delay in activating the MET system once the patient meets criteria for such a response.

4.2 METHODS

4.2.1 Site and sample

The setting for this study was the University of Pittsburgh Medical Center (UPMC) Health System, Presbyterian campus. UPMC Presbyterian, a tertiary care facility, admits approximately 32,000 patients per year. This study examined a convenience sample of 108 MET activations that occurred between January, 2004 and January, 2006 involving 51 medical and 57 surgical patients. Approval to conduct this research was obtained from the institution's Total Quality and Patient Safety Committee.

The MET system was introduced as a component of care at this institution in 1989. Responders to a MET activation include an Intensive Care Physician, 2 Intensive Care Nurses, and a Respiratory Therapist. The team can be summoned by anyone in the hospital (registered nurse, nursing assistant, transport aide, information desk clerk) at any time they have concern for patient care by calling a designated number. All clinical units have access to a list of specific criteria for which calling the team is considered appropriate. The MET activation creates an electronic page and overhead speaker announcement placed by the hospital operator. The operator records the location which is logged in a database.

To collect data for this study, the log of events was reviewed and the events meeting the selection criteria were forwarded to an independent nurse reviewer. The criteria for selecting the MET activation required that it occurred on one of five medical or five surgical units within the hospital. Cardiology, step-down and intensive care unit events were excluded, as were events which did not occur on an inpatient unit. Eligible events were reviewed based on the availability of the independent nurse reviewer. There was no pattern to the availability of the reviewer.

4.2.2 Study variables

The study examined selected nurse, patient and organizational characteristics associated with a MET call. ***Nurse characteristics*** were defined as: 1) education (BSN, non BSN); 2) experience (total years in nursing, total years on unit); and 3) whether the nurse cared for the patient day before. ***Patient characteristics*** were defined as: 1) age (years), 2) gender, 3) hospital length of stay, 4) days in hospital prior to the event, 5) status change for MET activation (new onset dyspnea, chest pain, acute mental status change, unilateral weakness, seizure, change in color of extremity), 6) pulse oximetry monitoring, 7) vital signs (RR> 36 or < 8; systolic blood pressure < 80mm Hg; HR > 160 bpm or 140 bpm with symptoms or < 40 bpm), 8) monitoring (telemetry, SpO_2), 9) pain control (patient controlled analgesia), 10) procedure (within 24 hours), 11) respiratory status (oxygen, respiratory treatments), and 12) physical restraint (within 24 hours). ***Organizational characteristics*** were defined as: 1) admission site (Emergency Department, other); 2) shift when the rescue event occurred; 3) day of the week; 4) time of event related to intensive care transfer; 5) number of patients nurse was assigned; and 6) type of unit (medical, surgical). In addition, events were characterized as ***delayed or not delayed***. A delayed event was defined as an event for which there was documented evidence in the medical record that pre-established clinical criteria for calling the MET were present for > 30 minutes prior to the call.

4.3 DATA MANAGEMENT AND ANALYSIS

SPSS (version 12, SPSS, Inc., Chicago, IL) was used to perform the data analysis. Appropriate descriptive statistics were computed for the total sample and type of patient (medical, surgical).

For categorical variables, proportions and frequency counts were calculated. For continuous variables, means, medians, standard deviations, and ranges were computed. Group comparisons between events of medical and surgical patients on categorical variables were performed using Pearson's chi-square tests of independence, while surgical and medical groups were compared using t-tests on continuous variables. The dichotomous response variable delayed MET activation (yes or no) allowed for logistic regression to be used to evaluate the predictive ability of shift and number of patients assigned. Pearson's chi-square statistic was examined to determine significance. Testing was two-sided with the level of statistical significance set at .05.

4.4 RESULTS

4.4.1 Patient characteristics

There were 108 MET activation events recorded for patients included in the study. Compared to medical patients, surgical patients had more days in the hospital before the event (p= .005) and a longer total hospital length of stay (p=.01) (Table 4-1). In addition, surgical patients were more likely to be monitored using pulse oximetry (p=.005) and receive patient controlled analgesia (p=.03). No significant between group differences were found for age, gender, event within 24 hours of admission, cardiac monitoring, procedure within 24 hours of the event, oxygen, respiratory treatments, and restraint order within 24 hours.

Table 4-1 Characteristics of medical and surgical patients who experienced rescue events

Variable	Medical Patients	Surgical Patients	p
Age, years (n=108)	57.1±16.9	62.3±16.5	p=.112
Gender, (%) female (n=108)	50%	49%	p= .847
Event with 24hr admission (n=108)	14/51 (27%)	15/57(26%)	p=.89
Hospital LOS prior to event (n=104)	5.6±7.3	12.0±15.3	p=.005
Hospital length of stay (n=104)	15.1±13.9	26.7±27.1	p=.01
Pulse oximetry, % yes (n=107)	13/51 (25.5%)	29/56 (51%)	p=.005
Monitoring, % yes (n=106)	23/51 (45%)	32/55 (56%)	p=.178
PCA % (n=106)	2/51 (3.9%)	10/55 (17.5%)	p=.03
Procedure, % yes (n=106)	8/51 (15.7%)	4/55 (7%)	p=.225
Respiratory, % yes (n=104) Oxygen Treatments	 32/50 (62.7%) 21/50(41%)	 43/54 (75%) 33/54 (58%)	 p=.108 p=.051
Physical restraint use (n=106)	4/51 (7.8%)	5/55 (9%)	p=1.0

Definition of abbreviations: LOS = length of stay; PCA = patient controlled analgesia

4.4.2 Nurse characteristics

There was a significant difference in the mean number of patients assigned when comparisons were made between medical and surgical patients (p=.044); however, the actual difference was small (5.6 ± 1.02 vs. 5.2 ± 1.06, respectively). In concert with previous research examining staffing ratios, patient assignments were categorized into ≤ 5 patients and > 5 patients. No significant differences were found (p= .774); however the analysis for an assignment of ≤ 5 patients was underpowered (Table 4-2). There were no significant differences related to education, experience, or continuity of care.

Table 4-2 Characteristics of nurses assigned patients who experienced rescue events

Variable	Medical Patients	Surgical Patients	p
Education			
BSN (n=49)	22(50%)	27(52%)	
Non-BSN (n=47)	22(50%)	25(48%)	p=.851
(n=96)			
Experience, yrs			
Total	9.55±7.8	7.02±7.6	p=.119
Unit	4.97±5.5	3.52±3.9	p=.405
Mean patients assigned	5.6 ± 1.02	5.2 ± 1.06	p= .044
Events for nurses assigned			
≤ 5 patients	24(49%)	29(52%)	p=.774
> 5 patients	25(51%)	27(48%)	
(n=105)			
Care for the day before, % yes	11(21.6%)	8(14%)	p= .318

The modal patient assignment was 6 patients, with the majority (86%) of nurses assigned to 4-6 patients (Figure 4-1).

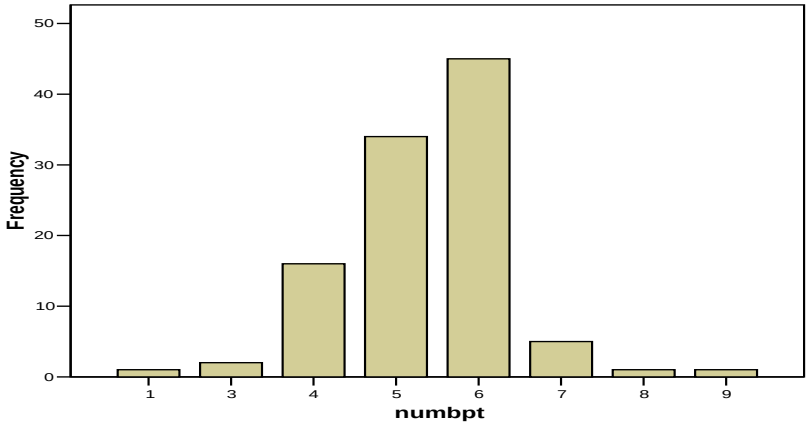

Figure 4-1 Number of patients assigned during shift of MET activation

4.4.3 Organizational characteristics

Significant between group differences were associated with the patient type and unit match (Table 4-3). Twelve of the 51 (24%) events for medical patients occurred while they were being cared for on a non-medical unit, while only two of the 57 (3.5%) occurred off a surgical unit (p=.002). In addition, a higher percentage of medical patients were admitted through the emergency department more frequently than surgical patients (p=.011).

Table 4-3 Organizational characteristics of MET activation events

Variable	Medical Patients	Surgical Patients	p
Time of Day (n=108) 7am shift 7pm shift	 33 (65%) 18 (35%)	 35 (61%) 22 (39%)	 p=.723
Day of Week (n=108) Weekday Weekend	 41 (80%) 10 (20%)	 44 (77%) 13 (23%)	 p=.685
Unit designated for this patient type, %yes (n=108)	39 (76%)	55 (96%)	p=.002
ICU transfer ≤ 24 hours (n=106)	5 (9.8%)	8 (14%)	p=.559

4.4.4 Reason for event and outcome

The reason for activating the MET system was categorized based upon the established clinical criteria used in the institution. The highest frequency for reason for activating the MET system for both groups was pulmonary (shortness of breath or desaturation), accounting for 36% and 43% of the events for medical and surgical patients, respectively. The next most frequent reasons were change in heart rate, blood pressure or chest pain (29% for medicine patients and 35% for surgery patients). Changes in mental status that were not present on admission were found to be low (18% for medicine and 13% for surgery).

The outcome for the MET event was most frequently associated with a transfer to the ICU (66.7%), followed by transfer to a higher level of care (16%) or no change in location (16%). Only one patient did not survive the rescue event. The majority of medical (80%) and surgical (88%) patients were discharged alive (Table 4-4).

Table 4-4 Outcomes of rescue event

Outcomes	Medical Group n=51	Surgical Group n=55
Care after event (n=106)		
Tx ICU	33(67%)	39 (68%)
Tx Step Down	8(16%)	9(16%)
No Change	8(16%)	9(16%)
Intubation (% yes)	16(31.4%)	14(25%)
CPR (% yes)	2(4%)	0
Discharged Alive	41(80%)	50 (88%)

4.4.5 Frequency and pattern of event occurrence

When the frequency and pattern of event occurrence were examined for a 24-hour interval, the rate of events increased during daylight hours (07:00 to 18:59) compared to night hours ($p \leq .007$). This pattern was true for medical patients ($p=.036$) but not the surgical patients ($p=.085$). Of the 68 events occurring during the daylight shift, 51% occurred during four particular hours (08:00, 13:00, 16:00 and 18:00), shown in Figure 4-2.

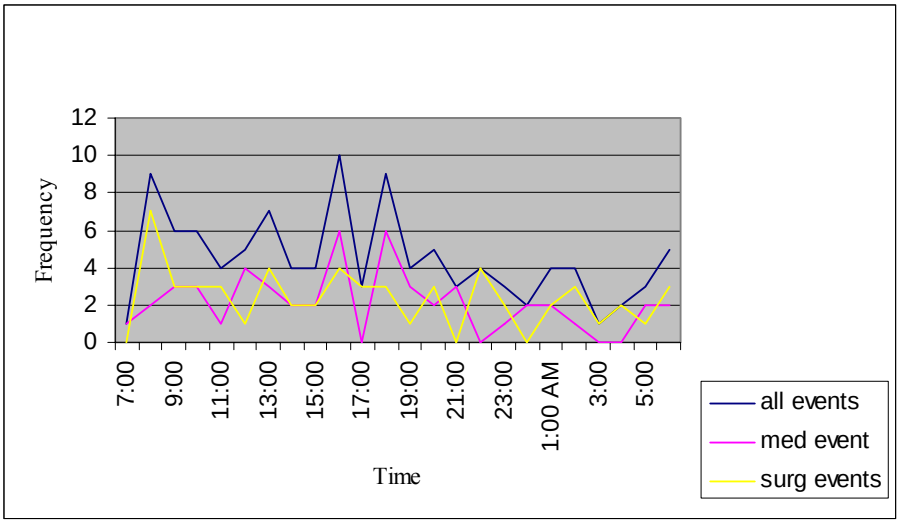

Figure 4-2 MET activation by time of day for medical and surgical groups

Of the 108 events, 47 (44%) were delayed events. Delayed events were unevenly distributed over time with the most frequent time of occurrence at 10 AM (n=5) and 6 AM (n=4), followed by 1:00 AM (n=3) and the 16:00 to 19:00 time period (n= 9). Delayed events were also examined in regard to the shift when they occurred and the number of patients assigned to the nurse when the event occurred (Table 4-5).

Table 4-5 Delayed events by shift and number of patients

	Shift			**Number of Patients**		
	7 AM -7PM	**7 PM -7AM**	**p**	**≤ 5 patients**	**> 5 patients**	**p**
Total	23/66 (35%)	24/40(60%)	p=.012	25/47 (53%)	22/47 (47%)	p=.747
Medical Patients	10/33 (30%)	9/18 (50%)	p=.164	9/19 (47%)	10/19(53%)	p=.858
Surgical Patients	13/33(39%)	15/22 (68%)	p=.036	16/28(57%)	12/28 (48%)	p=.599

Delayed events were found to have a significant relationship with shift, with more delays occurring on the 7PM–7AM shift (p=.012). There were also significantly more delays for surgical patients (p=.036) compared to medical patients (Figure 4-3). Delayed events were not significantly related to the number of patients assigned for medical or surgical patients (p= .608). However, there was a trend for more delays when more patients were assigned. Nurses assigned 4 patients accounted for 21% of the delays, compared to 36% with a 5 patient assignment, and 43% with a 6 patient assignment.

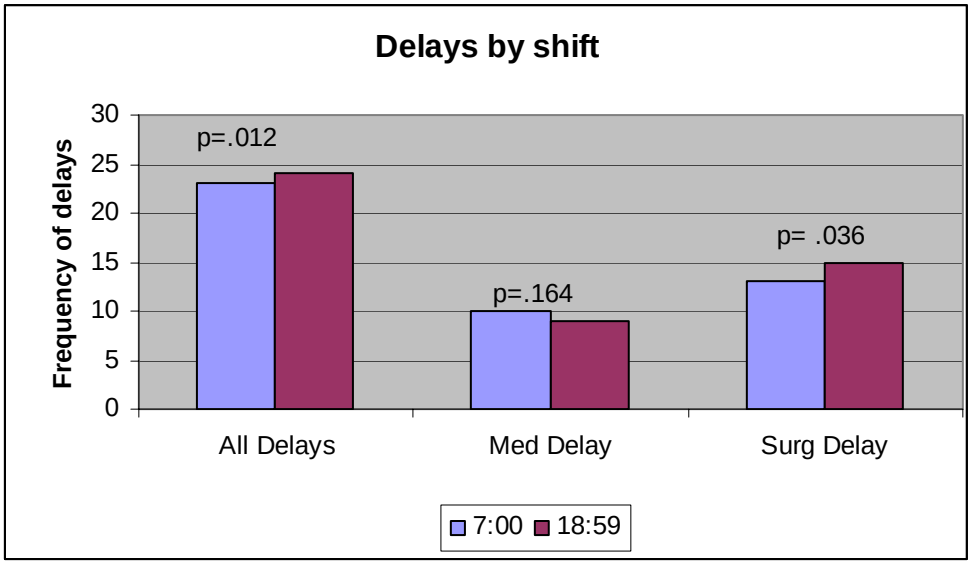

Figure 4-3 Delays of medical and surgical patients by shift

4.4.6 Relationship and predictors of delays

To determine if any of the variables examined could predict likelihood of a delayed event, 7 predictor variables were examined: shift (7AM-7PM,7PM-7AM); length of stay; case type

(medical, surgical); cardiac monitoring; pulse oximetry; number of patients assigned (≤5 patients, > 5 patients) and care provided on designated unit (yes, no). When analyzed using a forward stepwise method, shift and care provided on the designated unit were significant. No other variables added to the prediction of a delayed event. Shift was associated with a significance level of .009 and a 3.25 greater likelihood (95% CI, 1.34-7.9) of a delay occurring on the 7PM shift. The patient and unit type match was associated with a significance level of .014 (OR, .07; 95% CI, .009- .579). The model correctly predicted delayed event accurately 68% of the time.

4.5 DISCUSSION

Although the majority of patient care is delivered with successful outcomes, events which result from failure to detect or intercept events before they cause harm continue to occur. MET systems were developed in response to widespread evidence of that delay in responding to a sudden change in patient condition might result in a preventable death. While effective, the MET system does not address the events which precede the need to call for a response.

The aim in conducting this study was to identify differences in patient, nurse and organizational characteristics between medical and surgical patients requiring a MET intervention. Major findings of the study were: 1) MET activations occurred significantly more often on the 7AM shift than the 7PM shift; 2) delayed events occurred more often during the 7PM-7AM shift, with more delays for surgical than medical patients; and 3) there was a 3.2 greater likelihood the MET activation being delayed on the 7PM-7AM shift. Two variables were found to predict greater odds of a delayed event: shift and unit placement match. In addition,

significant differences between rescue events of medical and surgical patients were found for hospital length of stay, days in hospital prior to event, frequency of pulse oximetry monitoring and the use of patient controlled analgesia. Also, there was a small but statistically significant difference between the groups in the number of patients assigned.

The findings regarding the timing of MET activation events have implications for practice and further study. The events, whether delayed or not were more likely to occur during the 7AM-7PM shift for the total events and events of medical patients, but not for surgical patients. The explanation for the difference between the groups is not clear. However, the pattern of frequency, with 51% of the 7AM shift events occurring during 4 hours of the shift (08:00,13:00,16:00,18:00), leads to the conclusion that MET activation was associated with routine care patterns. In this study, only registered nurse–patient ratio was captured, so the influence of support staff was not available. Non clinical or support staff availability during the 7AM shift could influence the number of people who are supporting the registered nurse and in general be attributed to the higher number of hospital staff traffic in and out of patient rooms.

Findings regarding delayed activation of the MET system have implications for practice and further study. As might be expected, delayed events, defined as an event for which documented clinical criteria for MET activation was present for >30 minutes prior to the call, were more common during the 7PM-7AM shift. Like the pattern for total events, 45% of the delayed events are clustered around certain times. Of interest, the times associated with a greater number of delayed events (01:00; 06:00, 10:00, 16:00-19:00) correspond with times for routine nursing activities such as medication administration, charting, and between shift communication. Potentially, nursing personnel were occupied in the completion of routine activities for a group of patients and reduced the time for intensity of surveillance and response.

The surgical patients enrolled in this study tended to be long–stay patients, with an average length of stay of 12±15.3 days prior to the event. Conversely, medical patients had a shorter length of stay (5.6±7.3days) and may have been more acutely ill. At the time of the event, there was a significant difference between the groups for use of pulse oximetry, with surgical patients more likely to receive this monitoring. This finding raises questions regarding the sense of security that potentially might be provided by this technology which in turn, might lead to less urgency in summoning help or substitution of monitoring or direct patient observation and assessment. In addition, the results add to the existing research by demonstrating the association of delayed events to circadian patterns with more delays occurring on nights than days.

Significant differences in MET activations were associated with whether care was provided on a designated unit. More than 20% of the events for medical patients occurred while they were not being cared for on a medical unit. Conversely, less than 5% of events for surgical patients occurred when they were not on a surgical unit. Specialization of nursing care provides patterns of knowing and recognition of clinically pertinent findings for particular patient types. The lack of familiarity of patient problems and anticipated response could influence the nurses' recognition or realization of the need for immediate intervention. This finding highlights the vulnerability of patients when cared for by nurses who are less familiar with providing care to that population. This is particularly noteworthy at a time when hospital overcrowding is a growing issue, resulting in an interruption of patient flow and off unit placement.

There were no differences in education level or years of experience in the nurses caring for medical and surgical patients experiencing a MET event. In essence, medical and surgical patients in this study received care by a group of nurses with equivalent training and experience. The small percent of nurses (< 20%) who cared for the patient the day before the event, though

not significant, is of interest in terms of the potential beneficial influence of continuity in recognizing and responding to patient needs. This finding requires further exploration.

Although a statistically significant difference in the mean number of patients assigned between the medical and surgical groups was found, the difference was small and judged likely not to be clinically significant (5.6± vs 5.2± patients, respectively). Also, when events were categorized into ratios of ≤5 or >5 patients, there was no significant relationship with delays. However, there was a trend for more delays with larger assignments, e.g, nurses assigned 4 patients had 21% of the delays, compared to 36% with a 5 patients and 43% with a 6 patients. Further, 75% of the events occurred when the patient: nurse ratio was 5:1 or 6:1. These findings suggest the need to further examine the relationship between the number of assigned patients and delayed events.

Our findings differ from those of Aiken and colleagues (2002) and Needleman and colleagues (2002) who found significant differences in failure-to-rescue rates related to education and the number of patients assigned. The reasons for this, in addition to the lack of variability, may be related to the difference in the design of the study. These prior studies examined outcomes in large retrospective sample of patients with specific diagnoses, whereas our study compared differences in medical and surgical patients in a single institution with an established MET system.

The lack of difference in nurse characteristics does supports the aspect of Aiken et al (2002) and Boyle (2004) findings which suggests that organizational culture can be a primary determinant of patient outcomes. Though the factor of nurse autonomy was not measured in the current study, it may well explain a portion of the findings. In addition, it supports the notion that structural and procedural variables alone are not responsible for the differences. In part, the

differences associated with autonomy, which are attitudinal and cultural values of the organization, also contribute to the delivery of effective clinical care.

Despite not supporting prior findings regarding the relationship between staffing and outcomes, findings suggest that relationships of structure, process and outcomes differ between shifts and, in particular, that patients placed on units outside their designated areas may be at greater risk for delayed rescue. Accuracy of patient assessment would likely be more difficult and time consuming and may not identify all relevant details when the patient's diagnosis is unfamiliar, leading to time constraints (Hendrickson & Doddato, 1989; Sochalski, 2001). An evaluation of cognitive proficiency, clinical expertise and critical thinking skills was outside the scope of this study. However, each of these variables could potentially influence nursing response. The finding of delayed rescue events, irrespective of number of patients assigned, suggests that specific actions, not just staffing numbers, influence the ability of the nurse to respond to clinical findings.

In this study, the influence of support from the multidisciplinary team was not examined. Non clinical or support staff availability could influence the time the registered nurse spends on direct patient observation and assessment, potentially allowing for a more immediate response from the nurse. Also, there were likely differences in the availability of physician consultation at different times of the day. In addition, the availability of respiratory care personnel tends to vary throughout the day, a factor that could be critical given the most common reasons for calling a rescue event were cardiopulmonary related. These considerations suggest deciding the appropriate number of patients assigned to a nurse may require the evaluation of multiple factors in addition to the nurse-patient ratio.

4.6 LIMITATIONS

There were several limitations of this study. First, the sample was moderate in size and was a convenient sample and determined by the availability of the independent reviewer. It is possible that findings might differ if a larger sample of consecutive patients were examined. Second, the study examined outcomes on general medical and surgical units. Findings might differ if specialty units, such as cardiology, were included in the study. Third, the setting was a single university affiliated hospital with well defined criteria for activating the MET system. Findings might differ if events were examined in institutions with a teaching and non teaching or community setting. Expanding this study to a multi-hospital study would provide stronger evidence of the associations found. The lack of variability in the data regarding number of patients prevents conclusions to be drawn regarding the influence on nurse staffing on events or delayed events.

4.7 CONCLUSIONS

The findings of this study have implications for the safety of medical and surgical patients outside the intensive care by demonstrating that patients are experiencing avoidable and preventable delays in responding to clinical deterioration. Study findings suggest that patient, nurse and organizational characteristics can influence the timely rescue of hospitalized medical-surgical patients. Patient safety and efforts to reduce preventable errors and deaths in hospitalized patients are a high priority. Findings from this study add to the body of evidence that suggest that characteristics other than nurse-patient staffing ratios influence patient

outcomes. At a time when states are developing policy on nurse staffing ratios, studies such as this demonstrate the need to more critically examine patient, nurse and organizational characteristics such as shift, unit, and time related factors, that have the potential to increase the risk of a rescue event and, in particular, delayed events. This body of research has important implications for clinical practice and administrative decision-making regarding the organization and delivery of medical-surgical patient care.

APPENDIX A

APPROVAL FOR QUALITY IMPROVEMENT PROJECT

Date of Submission: October 28th 2005

Title of Study: Understanding Differences of Failure to rescue events between medical and surgical patients
Sponsor: Andrea Schmid Department: Nursing
Co-Sponsors: Michael DeVita
Anticipated Start Date: January 2006 Anticipated End Date: April 2006
Estimated Duration of Entire Study: 4 months

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1. **Goal(s) of study: The goal of this study is to examine what if any differences there are in failure to rescue events between medical and surgical patients using a retrospective review of patient records of known Condition C events.**

2. **Is there a commitment to implementing a corrective plan based on the outcomes of the study (**check one**)?**
   No ☐ **Yes ***

3. **Is the study being funded by an external agency (**check one**)?**
   No * Yes ☐ if yes, specify agency**:**

4. **What is the primary intent of the study (answer one):**
   Publication ☐ **or Quality Improvement ***

5. **If patient data is being collected, please indicate how data is going to be collected (**check all that apply**):**
   *** Chart review through medical records (***i.e.,* **Access Anywhere™ and hardcopy records)**
   *** Chart review through electronic medical records (***i.e,* **Powerchart™,MARS, Stentor™)**
   State the name of the system you will be using for data retrieval: Powerchart;MARS

All patient identifiable data collected and stored for this study needs to comply with UPMC Policy HS MR1000 regarding the privacy and security of clinical data.

6. Provide a brief summary (one page) or abstract of your proposed study and attach it to this page.

7. If the study involves a therapeutic intervention, is the intervention to be delivered in a blinded fashion? No * Yes ☐

8. Does the study involve "withdrawing" or holding back any needed and generally accepted treatments for the patients' condition:

No * Yes ☐

9. Does the study involve prospective assignment of patients to different procedures or therapies based on predetermined plans such as randomization?

No * Yes ☐

10. Is the study evaluating a drug, biologic or device which is not currently FDA approved (*i.e.*, off label use)? No * Yes ☐

11. Are Patients involved in the study exposed to additional risks or burdens (ie. Other than the completion of patient satisfaction surveys) beyond standard clinical practice

No * Yes ☐

12. What outcomes are being evaluated?

Failure to Rescue Events/ Condition C Events

For completion by Total Quality Council (TQC) designee:

Date of Review: Nov 8, 2005 Date Approved: Nov 11, 2005

Approved as Quality Improvement Study - Yes

Agree: X

Date to be presented to Total Quality Council: Nov 2005

Prospective date for feedback to TQC on outcomes: June 2006

Comments:

Completed by: Dr.Juliet Jegasothy

APPENDIX B

CRITERIA FOR INITIATING A MET RESPONSE

RESPIRATORY:

- rate <8 or >36
- new onset difficulty breathing
- new pulse oximetry reading less than 85% for more than 5 minutes (unless patient known to have chronic hypoxia)
- new requirement for >50% O_2 to saturation >85

HEART RATE:

<40 or >140 with new symptoms; or any rate >160

BLOOD PRESSURE:

<80 or >200 systolic or 110 diastolic with symptoms: (neurologic change, chest pain, difficulty breathing)

ACUTE NEUROLOGIC CHANGE:

- acute loss of consciousness,
- new onset lethargy or difficulty waking,
- seizure (outside of seizure monitoring unit)
- sudden loss of movement (or weakness) of face, arm or leg

OTHER:

- more than 1 stat page required to assemble team needed to respond to a crisis
- patient complaint of (cardiac) chest pain, (unresponsive to nitroglycerine, or MD unavailable)
- color change (of patient or extremity): pale, dusky, gray or blue
- unexplained agitation more than 10 minutes
- suicide attempt
- uncontrolled bleeding, large acute blood loss or bleeding into airway
- Narcan use without immediate response
- Crash carts must be used for rapid delivery of medications

APPENDIX C

CONDITION DATA COLLECTION TOOL

	YES	NO
At the time of event was the patient on:		
Monitor		
PCA		
Pulse Ox		
Restraints		
Event occurred with 24hrs of admission		
Altered State on Admission		
Altered state at time of event		
Within the last Shift did the patient:		
Have a procedure		
Transfer from an ICU		
Fall		

Nurse caring for patient at the time of the event:	
Cared for the patient the day before	YES NO
If yes, how many consecutive days prior to the event did the nurse care for the patient	
Did the RN ever care for the patient prior to this condition?	
Number of patients assigned to the nurse at the time of the event	

Years of RN experience	
Year of RN experience on the unit of event	
RN Education (state degree)	Dip Associate BSN MSN

Respiratory review at the time of the event:	
Was there a respiratory consult	YES NO
Was the patient on 02	YES NO
Did the patient have any respiratory treatments ordered	YES NO

APPENDIX D

CONDITION REVIEW MATRIX

Condition Review Matrix				***PART ONE: Patient Event Demographics***								
				Admit : ED		Day in Stay	Day/Time	At time of event - patient was on:				
Patient Name	Med Record #	Age	DC State	YES	NO			Monitor	PCA	Pulse Ox	Restraint	within 24h

Condition Review Matrix			***Part Two: Patient Event Demographics***						
1 = delirium 2 = confusion			Altered State on Adm?		Altered State at time of event?		Within the last shift did the patient		
3 = decreased level of consciousness	Med Record #	Age	Yes	No	Yes	No	Have a procedure	Tx from ICU	Fall

Condition Review Matrix				***Part Three: Nurse***							
			Did RN care for the pt the day before?		If yes, how many consecutive days prior to the event	Did the RN ever care for the patient prior to this condition?	# of pts assigned to the RN at the time of the event	Years of RN Exp	Years of RN exp on the unit of event	RN Educe Degree	Passed PBDS?	
Patient Name	Med Record #	Age	YES	NO							YES	NO

Condition Review Matrix			***Part Four: Respiratory Review at the time of the Event***					
			Was there a respiratory consult?		Was the patient on 02?		Did pt have respiratory tx's ordered?	
Patient Name	Med Record #	Age	YES	NO	YES	NO	YES	NO

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