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NURSING WORKLOAD AND ITS RELATIONSHIP TO PATIENT CARE
ERROR IN THE PAEDIATRIC CRITICAL CARE SETTING

BY

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Abstract

Patient care error has been identified as a leading cause of death and disability. Nurses have reported a perception that increased workload contributes to these errors. Although previous studies have added to the understanding of a possible relationship, the evidence has been inconclusive. This prospective observational study looked at identifying patient care error and assessing a possible correlation with a patient specific workload measurement tool. A statistically significant association between nursing workload hours and patient care error was identified. Further findings indicated that a significant number of patients required nursing care in excess of what was suggested that one nurse could provide. Understanding the complexity of the critical care environment and the implications of workload as a contributing factor to patient care error and its related human and fiscal cost can help inform organizations as they seek to deliver best-practice care for the patients and families that they serve.

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Nursing Workload and Its Relationship to Patient Care Error

Notwithstanding the recognition of underreporting (Rassin, Kanti, & Silner, 2005; Wilkins & Shields, 2008), patient care error has been established as a leading cause of death and disability (Baker, et al., 2004; Rothschild, et al., 2005). Much of the harm resulting from these errors has been shown to be preventable (Baker et al., 2004; Chard, 2010; O'Neill & Miranda, 2006; Rothschild, Bates, Franz, Soukup, & Kaushal, 2009; Rothschild et al., 2005). Nurses, who provide the majority of direct patient care in the hospital setting (Al-Kandari & Thomas, 2009; Rothschild et al., 2006), and have a responsibility for patient safety (Cook, Hoas, Guttmannova, & Joyner, 2004; Rogers, Dean, Hwang, & Scott, 2008; Rothschild, et al., 2006) have reported a perception that increased nursing workload contributes to the circumstances that lead to patient care error (Assadian, Toma, & Rowley, 2007; Ball & McElligot, 2003; Hickam et al., 2003; Needleman & Buerhaus, 2003; Ream et al., 2007; Roesler, Ward, & Short, 2009; Seki, 2008; Wilkins & Shields, 2008). However, evidence to support this presumed relationship is inconclusive (Kiekkas et al., 2008; Penoyer, 2010; Ream, et al., 2007; West, Mays, Rafferty, Rowan, & Sanderson, 2009; Wilkins & Shields, 2008).

Nursing practice within the critical care environment has been described as exceptionally challenging (Benner, Hooper-Kyriakidis, & Stannard, 1999), requiring rapid assessment of and intervention with fragile patients, using multiple technologies. This environment is thought to increase the risk for patient care error (Rothschild, et al., 2005; Valentin & Bion, 2007). Additionally, increasing patient acuity frequently requires the use of additional medications, therapies and invasive procedures, increasing the

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number of nursing responsibilities.

While it is recognized that increasing the number of tasks may contribute to patient care error, defining workload in the context of nursing has been problematic (Clarke, 2006). Carayon and Alvarado (2007) have described physical, cognitive, and emotional dimensions of workload encompassing both qualitative and quantitative components, all of which are subject to variability. Much of this work is unseen (Benner et al., 1999; Gordon & Nelson, 2006) and there is a lack of understanding of the complexity of thought process integral to completion of nursing responsibilities (Benner, et al., 1999; Clarke, 2006; Eisenhauer, et al., 2007). Work that is unseen is difficult to quantify and may be considered redundant or overlooked when evaluating the contributors to patient outcome. Previous studies have suggested that when nursing resources are strained, there is an inability to complete tasks diligently and surveillance of patients is compromised (Ball & McElligot, 2003; Rogers, et al., 2008; Rothschild, et al., 2009), potentially leading to an increase in patient care error.

There is a monumental toll associated with the increased morbidity and mortality caused by patient care error, including suffering of the patient and family (Delbanco & Bell, 2007), an emotional crisis of the health care staff involved (Rassin, et al., 2005; Roesler, et al., 2009; Scott, Hirschinger, & Cox, 2008) and increased cost to the health care system (Assadian, et al., 2007; Rothschild, et al., 2009). Increased knowledge of the relationship between nursing workload and patient care error may provide insight into error prevention (Tucker & Edmondson, 2003).

Penoyer (2010) and West and colleagues (2009), suggest an association between nurse staffing and patient outcomes in a critical care setting, but both researchers noted a

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marked variability in measurement of nurse staffing and patient outcomes suggesting the need for further research into the question. Many previous studies linking nursing workload and patient error use self reported, retrospectively collected data (Al-Kandari & Thomas, 2009; Cook, et al., 2004; Kalisch, 2006; Patrician & Brosch, 2009; Tibby, Correa-West, Durward, Ferguson, & Murdoch, 2004; Wilkins & Shields, 2008). These results may be influenced by response biases (Morgan, Gilner & Harmon, 2006, p. 59; Polit & Beck, 2012, p. 312-313) as details are forgotten over time or the nurse attempts to justify actions over a concern of repercussion for the error (Rassin, et al., 2005; Valentin & Bion, 2007; Wilkins & Shields, 2008). Researchers also report on varying singular, unfavourable patient outcomes (Assadian, et al., 2007; Kiekkas, et al., 2008; Mitchell, Kelly, & Kerr, 2009; Ream, et al., 2007; Wilkins & Shields, 2008). Frequently researchers assess nursing workload in terms of nurse patient ratio (Assadian, et al., 2007; Ream, et al., 2007; Tibby, et al., 2004) or use a therapeutic index score. Assessing workload in this way does not take into account the cognitive workload of the nurse, including emotional support of the patient and family (Kiekkas, et al., 2008; Mitchell, et al., 2009; Padilha et al., 2007). Although reports of these studies have added to the understanding of a possible relationship, using an objective measurement of patient care error and a comprehensive calculation of a patient specific nursing workload, would help strengthen the research in this area. Therefore, the purpose of this study is to advance understanding of the relationship between nursing workload and patient care error using a comprehensive, patient specific measurement of nursing workload and a more objective measurement of patient care error in order to provide a scientific basis for appropriate staffing to support safe care.

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The specific objectives of this project are to add to the body of evidence of: (1) the evaluation of nursing workload; (2) the evaluation of a measure of healthcare associated harm; (3) the evaluation of a relationship between nursing workload and potential healthcare associated harm, through the examination of the question: “Is there a relationship between nursing workload and the delivery of best-practice care in the paediatric critical care setting?”.

It is hypothesized that there will be a significant positive correlation between nursing workload and healthcare associated harm, defined as patient care error.

Definitions of Key Concepts

As identified in a study by Cook, Hoas, Guttmanova and Joyner (2004) and further discussed by Henneman (2007), a definition on what constitutes error in the healthcare setting is illusive. For the purpose of this study, *patient care error* includes all healthcare associated complications, whether through action or inaction result in increased morbidity or mortality or in an increased length of stay, pain, anxiety, discomfort or loss of trust, regardless of resulting in significant injury or not, and as suggested by Hawley and Jensen (2007); Henneman (2007); Proctor, Pastore, Gerstle and Langer (2003); and Valentin and Bion (2007). For the proposed study, patient care error will be identified by 13 patient events, used as positive triggers in a tool (Baker et al., 2004) known for its ability to assist with the identification of healthcare associated harm, which has been modified for the paediatric critical care environment.

Adverse event as defined by Baker et al. (2004, p. 1679) is “an unintended injury or complication that results in disability at the time of discharge, death or prolonged

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hospital stay and that is caused by health care management rather than by the patient's underlying disease process".

Nurse refers to registered nurse. Educational preparation for nurses at the proposed study site range from graduates of college based diploma programs to university-based masters' programs. Experience in nursing practice ranges from new graduates to those with greater than 25 years of experience.

Nursing workload refers to direct care of the patient including physical and emotional care, encompassing underlying cognitive activities. It also includes the indirect care which supports the patient including such responsibilities as communication with other members of the healthcare team, telephone calls, documentation, ordering supplies, transferring patients and preparing for admissions. In this study, nursing workload will be quantified in hours by use of the GRASP® (2011) workload measurement system (GRASP, 2006a).

Review of the Literature

In an effort to establish existent understanding of the relationship between nursing workload and patient care error, several online searches were conducted using the Medline, Cumulative Index of Nursing and Allied Health Literature (CINAHL) and Embase databases and the Google Scholar search engine. Search terms included, but were not limited to, "diagnostic errors or medical errors or medication errors or healthcare errors and workload or workload measurement", "health personnel/specialties, nursing/medical errors/or medication errors/workload", "workload/nursing manpower/intensive care units/pediatric intensive care units", "workload/nurses or nursing staff/intensive care units/pediatric task performance and analysis/intensive care

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units”, “workload, nurse, intensive care unit”, “psychological impact/health personnel/medical errors or diagnostic errors or medication errors”, “psychological impact/nursing/medical errors or diagnostic errors or medication errors”, and “nursing/medical errors/fatigue/stress/sleep/educational status/experience”. Pertinent literature was also identified through the review of reference lists of those articles previously identified in the online search. Literature was limited to publications in English.

Review of the literature revealed three central themes:

- 1) Error and harm in the hospital setting.
- 2) Nursing workload and its measurement.
- 3) Nursing workload and its presumed relationship to error and harm.

Error and Harm in the Hospital Setting

Patient care error has been established as a leading cause of death and disability (Baker et al., 2004; Institute of Medicine, 2000; Rothschild, Bates, Franz, Soukup & Kaushal, 2009; Rothschild et al., 2005). Reports estimate that as many as 45% of adverse events are preventable (Rothschild et al., 2005).

The seminal report, “To Err is Human: Building a Safer Health System” by the Institute of Medicine (2000) in the United States, suggested that between 44,000 and 98,000 Americans died each year as a result of adverse events in hospital. The publication of this report generated numerous international healthcare studies designed to identify and quantify error with the intent of preventing similar events in the future. Adverse event was defined by the report as an injury attributable to health care rather than patient diagnosis or condition.

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In Canada, a retrospective chart review of admissions to 20 hospitals across the country by Baker et al. (2004), identified that 7.5%, 95% CI (5.7%, 9.3%) of the patients studied suffered an adverse event. Physician reviewers using professional judgement on a scale of 1 to 6 determined that of these events, 36.9%, 95% CI (32.0%, 41.8%) were considered to be highly preventable. Furthermore, 20.8%, 95% CI (7.8%, 33.8%) of those adverse events resulted in death, with 9% of those deaths judged to be highly preventable. Adjustment for these results across the population suggests that a highly preventable adverse event occurs in 2.8%, 95% CI (2.0%, 3.6%) of hospital admissions, and death is associated with a highly preventable adverse event in 0.66%, 95% CI (0.37%, 0.95%) of hospital admissions.

Error identification. Identification of patient care error in the healthcare setting is challenging. As no standard definition of patient care error exists (Cook et al., 2004; Ferner, 2009; Henneman, 2007; Valentin & Bion, 2007), healthcare personnel may not recognize an action as error (Henneman, 2007). A 2007 case study by Henneman, demonstrated how an experienced nurse clinician, educator and safety researcher failed to report a series of errors. Further investigation revealed that errors were not reported as they were considered routine problems of daily practice rather than system failures in need of strategies for prevention.

Additionally, there is no national system for reporting healthcare error. In Ontario, hospitals are required to report critical incidents to the hospital administrator, the Medical Advisory Committee and the patient or the patient's representative (Ontario Hospital Association, 2010). However, only an incident that "results in death, or serious disability, injury or harm to the patient, and does not result primarily from the patient's underlying

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medical condition or from a known risk inherent in providing treatment” (Ontario Hospital Association, 2010, p.2) need be reported. Errors that result in outcomes that do not meet these criteria do not need to be reported. The only standardized system across Canada for measuring, reporting, analyzing and sharing healthcare error data is the National System for Incident Reporting (Canadian Institute for Health Information, 1996-2013), which reports only those incidents related to medications or intravenous fluids.

Formal reporting of patient care error to hospital administration relies on input from healthcare providers. Both a 2008 study by Elder and colleagues, using focus groups and surveys of nurses practicing in intensive care units, and the results of a 2009 survey of nurses by Cohen & Shastay, led to the determination that nurses are more likely to submit reports when an error has the potential for significant risk or if the error results in actual patient harm. These nurses reported that a lack of feedback from error documentation, fear of blame or punishment, feelings of failure, time pressure and fear of loss of camaraderie resulted in a failure to report patient care error that would otherwise go undetected.

Further reinforcing this low rate of formal reporting, Flynn, Barker, Pepper, Bates and Mikeal (2002) evaluated 2556 medication doses, and found an 11.7% error rate through direct observation of provider practice. An error rate of 0.7% was detected through chart review, and a rate of 0.04% was detected through incident reporting of the same doses. Similar low reporting was found in a review of medication errors in ICUs by Kiekkas, Karga, Lemonidou, Diamanto and Karanikolas (2011).

Rothschild et al. (2005) described the critical care environment as highly technical, requiring expeditious care of acutely ill patients, increasing the risk for patient care error.

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This group conducted a prospective, observational study of adult patients admitted to an intensive care unit over a one-year period. Of the 391 patients observed, 20.2% suffered a serious adverse event and 6.4% suffered multiple serious events. Only 4% of these events were identified through formal incident reporting and 45% were judged to be preventable. Direct observation allowed this group to also identify serious errors that were intercepted before reaching the patient. 42% of these intercepted events, which are seldom reported or recorded, were discovered by the patient's nurse, 23% by another physician and 17% by the pharmacist. Rothschild et al. (2006), in a further observational study of nursing staff in a 10 bed critical care unit, proposed that more than two potentially serious adverse events per eight hour day were intercepted by nursing staff. The majority of intercepted errors were identified prior to reaching the patient (69%). Of those identified after reaching the patient, 13% were intercepted prior to resulting in harm and 18% prevented further harm. The capability of errors to reach a patient during continuous direct observation of nursing care, highlights the importance of nursing work that is unseen (Clarke, 2006; Eisenhauer, 2007).

Consequences of error. There are significant costs associated with the increased morbidity and mortality caused by patient care error, including suffering of the patient and family (Delbanco & Bell, 2007; Curtin, 2011), an emotional crisis of the health care staff involved (Rassin, Kanti & Silner, 2005; Roesler, Ward & Short, 2009; Scott, Hirschinger, & Cox, 2008) and a financial cost to the health care system (Institute of Medicine, 2000; Rothschild et al., 2009).

Consequences of error – patients. Curtin (2011), in an ethical case study, describes the pain, suffering, grief and anger experienced by both patients and families

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during and following patient care error. In addition, Delbanco and Bell (2007), in their interviews of affected family members, identified themes of guilt, fear and isolation. In these interviews, family members described feeling guilty that they had not, or could not prevent the error themselves. They further described feeling fearful that further harm would ensue if questions were raised about the care provided. Many described feelings of isolation as health care providers were perceived to avoid contact with affected families, possibly as a result of their own feelings of guilt and shame (Delbanco & Bell, 2007).

Consequences of error – providers. Several publications have noted that the psychological impact of error on the healthcare provider can have significant consequences for self esteem and the ability to continue working within the profession (Aleccia, 2011; Delbanco & Bell, 2007; Halpern, Gurevich, Schwartz & Brazeau, 2009; Harrison et al., 2015; Rassin et al., 2005; Laurent et al., 2014; Schwappach & Boluarte, 2009; Treiber & Jones, 2010; Waterman et al., 2007; Wolf & Serembus, 2004). Severity of consequences may be influenced by the resultant morbidity of the patient (Rassin et al., 2005; Waterman et al., 2007), with an error resulting in death being identified as having the potential for producing reactions as extreme as suicidal ideation or self harm (Aleccia, 2011; Rassin et al., 2005; Roesler et al., 2009), particularly if the patient involved is a child.

The focus of many studies has been the physician experience (Schwappach & Boluarte, 2009; Waterman et al., 2007), however Rassin et al. (2005) report the self described mental state of 20 nurses who had been identified as playing a role in a medication error. Their findings suggest that error can result in psychological symptoms similar to those seen in post traumatic stress disorder. As this phenomena has previously

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been reported as causing distress, humiliation, or fear of litigation (Aleccia, 2011; Delbanco & Bell, 2007; Rassin et al., 2005; Wolf & Serembus, 2004; Yopp, 1998), participants may withhold information, contributing to the low rate of formal reporting (Rothschild et al., 2005) and preventing the recognition and development of strategies to prevent recurrence.

Consequences of error – healthcare costs. A precise measurement of the financial cost of adverse events to the health care system has yet to be determined, however, the Institute of Medicine (2000) estimated a cost between 8.5 and 14.5 billion yearly to the American health care system. There is nothing to suggest that costs to the Canadian health care system would be dissimilar once adjusted for differences in population size.

In a matched case control analysis of data from the Critical Care Safety Study (Rothschild et al., 2005), Kaushal and associates (2007) determined that the cost of an adverse event for a medical intensive care unit patient was \$3,961 ($p = .010$) and for a cardiac intensive care unit patient \$3,857 ($p = .023$). Increased length of stay was determined to be 0.77 days ($p = .048$) and 1.08 ($p = .003$) respectively. In 2009, Rothschild et al. published a secondary analysis of data from previous studies (Rothschild et al., 2005; Rothschild et al., 2006) to determine potential costs and savings of adverse events intercepted by nursing staff. The reported costs of adverse events by Kaushal et al. (2007) were multiplied by the number of adverse events that were intercepted by critical care unit nurses during direct observation in the 2005 (Rothschild et al.) study. These costs were then compared to the costs for nurse staffing using nurse patient ratios of 1:1, 1:2, 1:3. Although analysis was determined through created models of personnel costs and potential savings, they found that the costliest staffing model provided savings over

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the least costly adverse event model.

Less serious healthcare errors, although not resulting in significant injury, or increased morbidity or mortality, have been shown to result in an increased length of stay, pain, anxiety, discomfort or loss of trust, all of which have previously been described to negatively affect patient care (Cook, Hoas, Guttmanova, & Joyner, 2004; Hawley & Jensen, 2007; Henneman, 2007; Kalisch, et al., 2009; Proctor, Pastore, Gerstle, & Langer, 2003). All would additionally increase the toll on patient and family, health care staff and the health care system. Edmondson's 2004 exploration of an example from Minneapolis Children's Hospital, and a further study by Kim and Bates in 2012, described how attention to smaller scale errors could provide opportunities for improvement that would lead to greater overall patient safety.

Nursing Workload and Its Measurement

Nurses provide the majority of direct patient care in the hospital setting (Al-Kandari & Thomas, 2009; Rothschild et al., 2006) however, a comprehensive description of nursing work is challenging. Carayon and Alvarado (2007) have reported different categories of nursing work including physical, cognitive, and emotional. Each of these categories is subject to qualitative and quantitative variations dependent on patient needs.

Invisible work. Much of this work is unseen (Benner et al., 1999; Gordon & Nelson, 2006), and there is a lack of understanding of the complexity of thought process integral to completion of nursing tasks (Benner et al., 1999; Clarke, 2006; Eisenhauer, Hurley & Dolan, 2007). Benner et al. (1999), in her influential work, "Clinical Wisdom and Interventions in Critical Care", describes this complexity chronicled through an interpretive phenomenology study of 205 nurses practicing in critical care. Expert nursing

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practice, characterized as “thinking-in-action and reasoning-in-transition” (Benner et al., 1999, p.10) is described as unseen until it is missing, resulting in patient care complications. Clarke (2006) in his discussion of nursing work, describes how nursing activity, seen as simple tasks to someone lacking nursing expertise, appear to have little effect on patient outcome. In further demonstration of this unseen work, Eisenhauer et al. (2007) used semi structured interviews and real-time tape recordings to study nurses’ thinking during medication preparation and administration. Results of the observations of 40 nurses practicing in American hospitals indicated a complex level of thinking and knowledge application during this familiar task. They identified ten categories describing nurses thought processes including: communication, dose-time, checking, assessment, evaluation, teaching, side effects, work around, anticipatory problem solving and drug administration. More frequent findings included communication of interpretation of patient data to ensure safety and efficacy of drugs; judgements concerning timing and dosing for as needed medications; and verification of the correct medication administration process. The least frequent finding for verbalized thinking was during the actual administration of the medication, the component of the skill visible to others. This same complexity of the invisible care provided in the preparation and administration of patient medication, was observed in a study by Jennings, Sandelowski and Mark (2011).

Nurse patient ratio. The majority of critical care patients are cared for using a nurse patient ratio varying from 1:1 for a patient with cardiac or respiratory failure requiring multiple therapeutic interventions; to 1:2 for those patients whose course is more predictable, yet still requires the intense monitoring available in a critical care setting. Staffing based on set nurse patient ratios does not take in to account variations in

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patient and family response to critical illness, or variations of patient needs over a particular shift (West, Patrician & Loan, 2012). Furthermore, staffing based on nurse patient ratios has been used since the inception of critical care units in the 1950's and 60's (Bray et al., 2010), despite indisputable changes in use of technology and patient acuity (Robnett, 2006). A possible reflection of this change was suggested by researchers in a six-year retrospective cohort study examining charts of paediatric intensive care patients between the years 2000 to 2005 by Manor-Shulman, Beyene, Frndova and Parshuram (2008). They revealed a 26% ($p < .001$) increase in the average number of clinical items documented per patient day. Nursing documentation accounted for 72% of items, which averaged one documented item of clinical information per minute. No workload value was assessed for the documented items therefore it could not be assumed that the results represented a proportional increase in nursing workload. However, those children receiving higher levels of medical and technological support had a significantly higher number of documented items suggesting an increase in patient acuity and patient associated workload. Minimally this suggests an increase in the amount of clinical information that needs to be recalled, analysed and communicated by nursing staff.

Workload measurement tools. Attempts to quantify nursing workload with scoring tools have been problematic (Clarke, 2006; Ferguson-Pare & Bandurchin, 2010; Registered Nurses Association of Ontario, 2005). Even those accounting for psychological workload do not take into account daily variations of personal stressors of the nurse (Scott, Hwang & Rogers, 2006) expertise, education (Ball & McElligot, 2003), the physical layout of the work environment (Simmons, Graves & Flynn, 2009) or the practice setting (Clarke, 2006). However, tools that attempt to provide a comprehensive

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quantification of nursing workload may provide a more useful guideline to requirements for nursing care than staffing ratios.

GRASP® (2011) is a workload management software system that endeavours to provide a comprehensive quantification of nursing work. GRASP® is an acronym for “Grace Reynolds Application and Study of PETO” (p. 24). This extended research was completed in 1973 at Grace Hospital in Morganton, North Carolina, funded by the Kate B. Reynolds Trust to study and extend the application of the PETO system. PETO is an acronym made from the initials of the members of the research group, Poland, English, Thornton and Owens (1970) who developed “A System for Assessing and Meeting Patient Care Needs” (Poland et al., 1970, p.1479). This system was developed through the direct observation and timing of nurses, who were unaware that they were being monitored, as they performed services under defined categories. Over several days, an unidentified number of nurses and assistants were observed and an average time was obtained to create a score. Based on these observations, estimations were made as to the number of patients that the unit could adequately care for. Estimations of workloads greater than what could be adequately cared for, initiated a request for additional nursing staff.

The GRASP® (2011) methodology is now a computerized product of GRASP Systems International Companies, used by nurses internationally to collect data related to nursing work. The nurse providing patient care enters data daily and the system allocates a workload value in minutes for nursing responsibilities. A customized system is developed for each patient care setting in collaboration between GRASP® Systems International and the unit for which it is intended. Recommendations for composition of

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the instrument are elicited from the nursing staff of the targeted unit during the initial phase of preparation for use in an area and changes are made based on feedback following implementation. The intention of the methodology is to capture direct care of the patient including physical and emotional care, encompassing underlying cognitive activities (GRASP®, 2006a) as well as the indirect care which supports the patient including such responsibilities as telephone calls, documentation, ordering supplies, transferring patients and preparing for admissions (GRASP, 2006b). Reliability monitoring provides data credibility (GRASP®, 2011). Further control for errors of measurement with this tool is accomplished by direct computer entry of data by the nurse who provided the care (Morgan, Gilner & Harmon, 2006, p. 47, 135; Polit & Beck, 2012, p. 317-318, 330-331), and use of a standardized report form (Morgan, et al., 2006, p. 47; Polit & Beck, 2012, p. 317). However, results may be influenced by response biases (Morgan, et al., 2006, p. 59; Polit & Beck, 2012, p. 312-313) as the nurse attempts to justify his/her perception of a busy shift.

A large percentage of acute care hospitals that use a nursing workload measurement tool in Canada, use the GRASP® methodology (Hadley, Graham & Flannery, 2004). A study by Adams-Wendling (2003) compared the GRASP® tool to a patient classification tool in a long-term care facility. This study revealed a significant correlation between the workload scores, suggesting that estimated workloads might be comparable across different tools.

Nursing Workload and Its Presumed Relationship to Error and Harm

Nurses have a responsibility for patient safety (Cook et al., 2004; Rogers, Dean, Hwang, & Scott, 2008; Rothschild, et al., 2006) and a duty to protect patients from harm

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(Cook et al., 2004; Hawley & Jensen, 2007; Rogers et al., 2008; Rothschild, et al., 2006).

In Canada, this duty is explicitly expressed in the Code of Ethics for Registered Nurses (Canadian Nurses Association, 2008), providing a guide for professional responsibility.

Nursing perception. Nurses have reported a perception that increased nursing workload contributes to errors (Assadian, Toma, & Rowley, 2007; Ball & McElligot, 2003; Hickam et al., 2003; Needleman & Buerhaus, 2003; Ream et al., 2007; Roesler, Ward, & Short, 2009; Seki, 2008; Treiber & Jones, 2010; Wilkins & Shields, 2008). Evidence to support this presumed relationship is inconclusive (Kiekkas et al., 2008; Penoyer, 2010; Ream, et al., 2007; West, Mays, Rafferty, Rowan, & Sanderson, 2009; Wilkins & Shields, 2008). In literature reviews of English language, original research investigating nurse staffing and patient outcomes in the critical care setting by Penoyer (2010), and West, Mays, Rafferty, Rowan and Sanderson (2009), they suggest an association between nurse staffing and patient outcomes in a critical care setting, but both reviewers noted a marked variability in the literature for measurement of nurse staffing and patient outcomes, suggesting the need for further research into the question.

Many previous studies linking nursing workload and patient error use retrospectively collected data that is self reported (Al-Kandari & Thomas, 2009; Cook, et al., 2004; Kalisch, 2006; Patrician & Brosch, 2009; Tibby, Correa-West, Durward, Ferguson, & Murdoch, 2004; Wilkins & Shields, 2008). These results may be influenced by response biases (Morgan, Gilner & Harmon, 2006, p. 59; Polit & Beck, 2012, p. 312-313) as details are forgotten over time or the nurse attempts to justify actions over a concern of repercussion for the error (Rassin, et al., 2005; Wilkins & Shields, 2008). Studies also report on a variety of identified unfavourable patient outcomes such as

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mortality, blood stream infections, postoperative complications or unplanned extubations (Assadian, et al., 2007; Kiekkas, et al., 2008; Mitchell, Kelly, & Kerr, 2009; Ream, et al., 2007; Wilkins & Shields, 2008). Frequently they use nursing workload measured as nurse patient ratio (Assadian, et al., 2007; Ream, et al., 2007; Tibby, et al., 2004) or use a patient therapeutic index score which does not take into account the cognitive workload of the nurse, including emotional support of the patient and family (Kiekkas, et al., 2008; Mitchell, et al., 2009; Padilha et al., 2007). Although these studies have added to the understanding of a possible relationship between nursing workload and patient care error, inconsistency in variables and measurement make objective comparisons difficult.

Nurses' contribution to the prevention of harm. A significant number of reported errors occur during the execution of nursing responsibilities (Baker et al., 2004; Rothschild et al., 2005) however, vigilant nursing care, practiced since the establishment of intensive care units (Fairman, 1992), has been shown to identify and prevent many errors before they occur (Ball & McElligot, 2003; Hawley & Jensen, 2007; Needleman & Buerhaus, 2003; Rogers et al., 2008; Rothschild, et al., 2009; Rothschild, et al., 2006; Rothschild, et al., 2005). Benner et al. (1999) describe vigilance as "...attentiveness: to monitor for changes in the patient's condition, to anticipate and prevent undesirable events, to keep track of the patient's responses in order to create new beneficial transitions, and to be prepared for emergent intervention as needed" (p. 139). In Ball & McElligot's (2003) multi-centred report of interviews with 231 critical care nurses and 51 patient relatives, vigilance was described as an important attribute to assist with identifying potential complications and maintaining patient safety. Nurses further reported having difficulty maintaining vigilance when staff resources were limited. In

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Rothschild et al.'s (2006) observational report on nursing in a 10 bed cardiac critical care unit, data collected during direct continuous observation noted that nurses frequently recovered medical errors during patient surveillance. It was estimated that if the results of this study were extrapolated to an eight-hour shift, each nurse would recover slightly more than two errors per shift.

Nurses experience a heavier workload in times of staff shortages, higher patient acuity or staff reductions used to mitigate costs (Kiekkas, et al., 2008; West, Patricia & Loan, 2012). It is suggested that this increase in workload prevents nurses from providing the vigilant care that is thought to allow nurses to identify healthcare error, or alterations in patient status, and intervene in a timely manner to prevent or mitigate patient compromise (Assadian, et al., 2007; Ball & McElligot, 2003; Hawley & Jensen, 2007; Needleman & Buerhaus, 2003; O'Neill & Miranda, 2006; Rothschild, et al., 2009; Rothschild, et al., 2006; Rothschild, et al., 2005).

Analysis of data retrieved from the logbooks of 502 critical care nurses by Scott et al. (2006), found that nurses continued working past their scheduled hours 86% of the time, regardless of the length of the shift, suggesting that planned nursing care could not be completed during the scheduled shift. Lucero, Lake and Aiken (2009) further confirmed this inability to complete work in the time allotted, as they reported nurses leaving an average of two of seven ($r = 0.2-3.5$) nursing care activities undone due to time constraints. Interviews conducted by Weinberg (2006), found that nurses would frequently abstain from eating or relieving themselves in addition to staying late in their efforts to provide the care that could not be completed during the assigned hours. Time limitations lead to priority setting by nursing staff, with basic nursing responsibilities

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such as assessment, bathing, feeding and mobilization omitted in favour of immediate concerns (Kalisch, 2006; Kalisch, Landstrom & Williams, 2009; Kalisch, Tschannen & Lee, 2011; Lucero, Lake & Aiken, 2010; Weinberg, 2006)), despite the known repercussions to patient outcomes. Some tools designed to avert error, such as peer corroboration, have contributed to a further increase in nursing workload (Jennings, Sandelowski & Mark, 2011; Seki, 2008; Treiber & Jones, 2010) and as a result, may contribute to the patient care error that they are designed to avoid. The interviews of Eisenhauer et al. (2007) provide insight into how these safety tools and protocols are sometimes consciously overlooked for the sake of expediency. In a descriptive study using focus group interviews, Dickinson, McCall, Twomey and James (2010), discovered that while all participants validated the significance of the use of independent double-checking to minimize medication error, use of the process was mixed. Practice varied both within the group and within the practice of individual practitioners. Subjects described a lack of staff and competing responsibilities as rendering the process impractical, leading to limited use.

The patient in the critical care environment has an increased risk for acute deterioration requiring rapid intervention, increasing the risk for patient care error (Rothschild, et al., 2005). As patient acuity increases, the nurse must perform an increasing number of tasks, increasing the risk for error (Rothschild, et al., 2005). Previous studies have suggested that when nursing resources are strained, there is an inability to complete these tasks diligently and surveillance of patients is compromised (Ball & McElligot, 2003; Rogers, et al., 2008; Rothschild, et al., 2009). Increased knowledge of the relationship between nursing workload and patient care error can

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provide insight into error prevention (Tucker & Edmondson, 2003).

Additional variables. It should be recognized that patient error has also previously been reported to be associated with nurse fatigue (Dean, Scott & Rogers, 2006; Parshuram et al., 2008), stress (Rassin, et al., 2005; Scott, Hwang & Rogers, 2006), working hours (Scott et al., 2006; Lockley et al., 2007), nursing staff inexperience (Morrison, Beckmann, Durie, Carless & Gillies, 2001), skill mix (Tibby et al., 2004), physical environment (Simmons, Graves & Flynn, 2009), interruptions and multitasking (Kalisch & Aebersold, 2010; Redding & Robinson, 2009), use of concentrated solutions and recent exposure to tasks.

Theoretical Framework

The theory of complex adaptive systems (Begun, Zimmerman & Dooley, 2003; Chaffee & McNeill, 2007; Davidson, Ray & Turkel, 2011; Lindberg, Nash & Lindberg, 2008), a theoretical framework from complexity science (Lindberg & Lindberg, 2008), will serve as a conceptual framework for this study. Complexity science is a scientific approach that utilizes varied theoretical frameworks from different disciplines to explain how relationships between different agents give rise to the collective behaviours of a system (Lindberg & Lindberg, 2008). Complex adaptive systems (CAS) are characterized as a group of interconnected individual components, each of which may react in an unpredictable fashion, influencing the other members of the group creating adaptation and evolution (Lindberg et al., 2008). Each component of the system is itself a CAS, embedded within another system. Lindberg & Lindberg (2008, p. 36) have further explained this concept as it relates to healthcare by identifying the nurse as a CAS, embedded within the CAS of a nursing unit, embedded within the CAS of a hospital,

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embedded within the CAS of a healthcare system, further embedded within the CAS of a community etc.. Every CAS is influenced by its environment and interactions with connected CASs, making each unique (Begun et al., 2003). CAS are dynamic and unstable, with changes in one system affecting and shaping all the systems to which it is connected (Smith, 2011). These changes are described as nonlinear, or unpredictable, where small changes have the potential to have large effects on the CAS or inversely, large changes may only create small effects. CAS are further described as self-organizing in that they have the ability to adjust or adapt (Begun et al., 2003).

The purpose of this correlational inquiry is to increase the knowledge of the relationship between nursing workload and patient care error in the intensive care setting. Several authors have demonstrated how the CAS theory can enhance understanding of nursing (Chaffee & McNeill, 2007; Davidson et al., 2011; Lindberg et al., 2008; Ebright, 2010), patient care (Chaffee & McNeill, 2007; Davidson et al., 2011; Kernick, 2003), health care organizations (Begun et al., 2003; Chaffee & McNeill, 2007; Davidson et al., 2011), education (Chaffee & McNeill, 2007; Davidson et al., 2011) and research (Chaffee & McNeill, 2007; Davidson et al., 2011; Jordon, Lanham, Anderson & McDaniel, 2010).

Kirsch, VanSell and Grant (2002) found the ICU environment of constant change, instability, unpredictability and technological advances particularly suited to the presupposition of the dynamic, nonlinear, adaptive and unpredictable nature of the CASs of complexity theory.

Ebright (2010) used CAS theory to describe the work of an ICU nurse faced with multiple conflicting patient responsibilities. Adaptation to time constraints, requiring the prioritization of some tasks while omitting others, had implications for multiple

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interconnected CASs within his/her sphere, including his/her patient, other patients on the unit, colleagues and the work environment. For this reason the theory of complex adaptive systems will be used to provide a basis for understanding the potential implications that adaptations to a changing workload have on the nurse as a CAS, including vigilance, recognition, timely response and adherence to protocol. Adaptations that within a dynamic environment may contribute to patient care error, and have implications for multiple CASs within the ICU, including the patient and family, the nurse, the healthcare team, and the healthcare system.

Ethical Considerations

The Research Ethics Board of Athabasca University approved this study.

This study required the collection of data from a nursing workload tool (Grasp Systems International, 2006a) used by nursing staff in the Paediatric Intensive Care Unit (PICU), in addition to using a subset of data of a larger study; Safety, fatigue and continuity in ICU: A pragmatic mixed method study (Parshuram, 2008). Creation of acceptable scores used for imputation of missing data required retrospective chart reviews.

The Research Ethics Board of the collection site granted approval for this study. The Principal Investigator, the director of the unit where the study occurred, and the hospital's Research Ethics Board have approved a Research Ethics Board amendment for the collection of this data. The Research Ethics Board of the hospital has indicated that the amendment, along with the original approval for the larger study, provides sufficient approval from the site for the data collection required by this study. All healthcare staff, including nursing staff, in the unit where the larger study was conducted signed a consent

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to participate in the study following an explanation of the research. There was no indication that involvement in the study produced any harm or discomfort. All research conducted or involving personnel employed by this institution must be reviewed and approved by the hospital's Research Ethics Board. All research personnel working within the institution are required to conduct a full review of the Tri-Council Policy Statement on Ethical Conduct for Research Involving Humans (Canadian Institutes of Health Research, 2010), successfully complete the hospital's Research Ethics Board training seminar and the hospital's orientation session for introduction to clinical research.

Method

This prospective observational study used a correlational design in seeking to understand the relationship between nursing workload and patient care error. As there was no direct control of nursing workload as the independent variable, or randomization, there can be no assumption of a causal relationship between nursing workload and patient care error as the dependent variable (Polit & Beck, 2012). A statistician (H. Frndova, Senior Data Analyst, Critical Care Medicine, Hospital for Sick Children, personal communication, September 6, 2011; January 9, 2013; October 21, 2014; January 5, 2015; February 12, 2015; April 23, 2015; September 10, 2015) was consulted for assistance with study design, data analysis and evaluation of the results of the analysis (Adams-Huet & Ahn, 2009).

Participants

To address the research question, a subset of data, collected as part of a large multicentre, multimodal design study, Safety, Fatigue and Continuity in ICU: A Pragmatic Mixed Methods Study (Parshuram, 2008), was used. The goal of that study

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was to describe the optimal scheduling pattern for frontline physicians working in ICUs (Parshuram, 2008) through examining the relationship between patient safety, fatigue, continuity and scheduling alternatives in frontline physicians caring for critically ill patients. Participants for the study were recruited using a consecutive method of nonprobability sampling (Polit & Beck, 2012), which included all patients requiring at least 24 hours of care, admitted to an 18 bed, Paediatric Intensive Care Unit in a large tertiary center from June 2009 through January 2010. Participants, and their assigned nursing staff, recruited over a period of 5 months, from June to October 2009, were recruited into this study. Patients admitted exclusively for overnight observation were excluded as they frequently did not require 24 hours of care, a time period that facilitated standardization.

Data Collection

To aid in the detection of adverse events for the larger study, two trained research nurses with three or more years experience caring for children in the study unit, employed strategies to identify the presence of 13 patient related events, considered screening criteria, previously established as credible for use in detection of adverse events (Baker, et al., 2004) with modifications to allow for use in the Paediatric Intensive Care Unit. Strategies to identify the presence of the 13 patient related events, which determined patient care error and were the main patient outcome for this study included: direct observation of morning rounds on the study unit, including a handover discussion between oncoming and outgoing responsible physicians. Direct observation has previously been shown to aid in the identification of medication errors and events (Flynn et al., 2002; Kiekkas, Karga, Lemonidou, Aretha & Karanikolas, 2011; Kopp, Erstad,

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Allen, Theodorou & Priestley, 2006). Additional identification strategies included daily review of the patient chart; and daily discussion with care providers including questions specific to previously undisclosed knowledge of any circumstances related to the screening criteria.

The recorded presence of any one of these events determined patient care error, the main outcome variable, for the purpose of this study.

The 13 patient related events, or patient care errors, included: 1) Unplanned extubation. 2) Unplanned removal or loss of central venous or intra-arterial line. 3) Intensive care unit incurred patient injury including any harm, injury or trauma occurring during the ICU stay. 4) Adverse drug reaction. 5) Unplanned return to the operating room. 6) Patient complication including acute myocardial infarction, cerebral vascular accident, pulmonary embolism etc. that is not a natural progression of the patient's disease. 7) Unplanned re-admission to intensive care within 7 days of discharge. 8) Development of neurological deficit not present on ICU admission. 9) Unexpected death. 10) Cardiac/respiratory arrest (successful resuscitation). 11) ICU acquired infection/sepsis. 12) Dissatisfaction with care documented in the medical record. 13) Any other undesirable outcomes not covered above (Parshuram, 2008).

Any of these events could be expected to result in an increased length of stay, pain, anxiety, discomfort or loss of trust, all of which have previously been described to negatively affect patient care (Cook, et al., 2004; Hawley & Jensen, 2007; Henneman, 2007; Kalisch, et al., 2009; Proctor, Pastore, Gerstle, & Langer, 2003) regardless of whether the error resulted in significant injury, or increased morbidity or mortality.

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Information outlining patient therapy and results of patient screening were recorded daily for each patient on a standardized case report form which was held securely for future data analysis (Parshuram, 2008).

Direct observation allowed for the recognition of some errors identified and intercepted (Rothschild et al., 2005). However, only those errors that actually reached the patient were recorded.

Control for errors of measurement was accomplished through the use of a limited number of observers familiar with the environment and population being studied, who had been tested for interrater reliability through intermittent review of established guidelines for data collection and performance rating of collected data (Morgan, Gilner & Harmon, 2006, Polit & Beck, 2012). Additional controls included use of a structured case report form (see Appendix A) (Morgan, et al., 2006, Polit & Beck, 2012) and use of screening criteria previously established as credible (Polit & Beck, 2012).

A record of the presence or absence of errors was recorded for each study participant over a period of 24 hours. Further data included the type and the number of errors identified for each study participant where more than one error was recorded. A brief description of the events surrounding the error was also recorded. It was not practical to determine a severity rating for the events as the study design did not seek to establish participant outcomes, which could be anticipated to be variable. In order to facilitate standardization, errors were attributed to the day in which they were discovered, although it is recognized that an error discovery can reflect care previously provided (Rogers, et al., 2008).

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Corresponding nursing workload scores for each study participant were collected retrospectively from data entered daily into a validated, workload management software system (GRASP®, 2010; GRASP® Systems International Companies, 2011) as part of the standard of care performed by critical care nurses providing patient care on the study unit. Scores were collected for every 24-hour period that the subject remained in the study, reflecting data from two 12-hour nursing shifts.

This workload management system, which allocates a workload value in minutes for nursing responsibilities, was developed in collaboration between GRASP® Systems International and the unit for which it is intended. Recommendations for composition of the instrument are elicited from the nursing staff of the targeted unit during the initial phase of preparation for use in an area and changes are made based on feedback following implementation. The intention of the tool is to capture direct care of the patient including physical and emotional care, encompassing underlying cognitive activities (GRASP®, 2006a) as well as the indirect care which supports the patient including such responsibilities as telephone calls, documentation, ordering supplies, transferring patients and preparing for admissions (GRASP®, 2006b). To maintain reliability and validity of the data, the GRASP® (2010) methodology recommends that interrater reliability monitors provide a check and review process. Further control for errors of measurement with this tool is accomplished by direct computer entry of data by the nurse who provided the care (Morgan, et al., 2006, p. 47, 135; Polit & Beck, 2012, p. 317-318, 330-331), and use of a standardized report form (Morgan, et al., 2006, p. 47; Polit & Beck, 2012, p. 317). However, results may be influenced by response biases (Morgan, et al., 2006, p. 59;

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Polit & Beck, 2012, p. 312-313) as the nurse attempts to justify his/her perception of a busy shift.

Files where no nursing workload data was recorded by the nurse assigned to the study participant were examined to determine if there was a threat to conclusion validity (Trochim & Donnelly, 2008, p. 263). Once it was determined that a significant number of entries were missing, methods to address the missing data (Horton & Kleinman, 2007) were evaluated.

A small percentage of missing data would not likely have a significant effect on the outcome of the study. However, bias could be created if a substantial amount of data were missing or if the missing data were “missing not at random” (Polit & Beck, 2012, p. 466), or missing related to the variable (Horton & Kleinman, 2007; Polit & Beck, 2012). Missing data raises the concern that the nurse with the heavier workload might have been too busy to enter the score (Hadley, Graham & Flannery, 2004). A large number of missing scores for this reason creates the potential for a type II error, or the acceptance of the null hypothesis; that there is no relationship between nursing workload and patient care error; when it is false (Morgan, et al., 2006, p. 149). Imputation methods might also create bias (Horton & Kleinman, 2007; Polit & Beck, 2012). If mean substitution were used, again the results would be erroneously skewed towards the lower scores. Last value carried forward for the study subject (nurse) again might yield biased results as the subject may have had a reduced workload (and therefore time to enter a value) in the previous entry. Use of computer-generated scores would affect the internal validity (Polit & Beck, 2012, p. 236, 468) of the study as it is presumed that the variability of the workload scores is impacting the number of errors. It was determined that a retrospective

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calculation of workload scores through chart review for each missing entry by an expert (Polit & Beck, 2012, p. 330-331), would provide a more valid score for imputation (Horton & Kleinman, 2007; Polit & Beck, 2012, p. 468).

To further explore the potential for creating valid scores for imputation through retrospective chart review, 33 charts that had previously been assigned nursing workload scores were examined, and a nursing workload score was created based on the information contained within the permanent record. A chart, recording all the created scores was constructed. This chart was then compared to a chart containing the workload scores originally created by the nurse assigned to the patient.

It was hypothesized that workload scores created at the time care was delivered would be higher than that created through a retrospective chart review, as not all care would be documented on the permanent record. To test this hypothesis, a paired sample *t* test, comparing the means of the original nursing workload scores with those scores created through retrospective chart review, was run. Results of the test are shown in Table 1.

Table 1

Comparison of Workload Scores

	Mean	N	Std. Deviation	Std. Error Mean
Original data	8.8491	33	2.32289	.40436
Retrospective score	8.1521	33	2.44092	.42491

The mean workload score for the original data ($M = 8.85$, $SD = 2.32$) was greater than the mean for the retrospective score ($M = 8.15$, $SD = 2.44$). A related-samples *t* test

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showed significance beyond the .001 level: $t(32) = 3.98$; $p = .000$ (two-tailed). The 95% confidence interval on the difference was [.34, 1.05]. Cohen's $d = .29$, which is a small effect. Value of the correlation coefficient is 0.91. These results suggest that reliable data for imputation can be created using retrospective chart review.

A retrospective chart review was performed for all nursing shifts where no workload data was recorded and a score for imputation was created wherever it was appropriate. A total of 678 scores were created for imputation, impacting 31.99% of the workload scores for the 24 hour period related to each study participant. It was further determined that some data were missing related to timing of study participant admission or discharge. No entry was made for these missing scores as the workload score for the one 12-hour period reflected all the nursing work for that study participant in 24 hours.

Rigor and Validity

Shadish, Cook and Campbell (2002) identified four categories of validity: statistical conclusion validity, internal validity, construct validity and external validity. Regardless of controls implemented to manage these threats, they argue that cause and effect can never be definitively tested and proven. Polit and Beck (2012) note that heightening against one threat to validity may compromise another.

The sample for the study consisted of 2119 data pairs. This large sample provides adequate statistical power (Polit & Beck, 2012) to show if there is a correlation between the variables. Adequate statistical power will help manage statistical conclusion validity.

This observational study looks at the relationship between two variables. Correlational studies are particularly sensitive to threats to internal validity (Polit & Beck, 2012) however; ethical considerations would preclude a true experimental model

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(Shadish, Cook & Campbell, 2002). There was no manipulation of what is described as the independent variable, nor was there any randomization, which would be considered the best control over confounding variables. This creates the potential that the dependent variable could be as a result of a cause other than the named independent variable, in this case, nursing workload. Although homogeneity (Polit & Beck, 2012) can be an effective control for confounding participant characteristics and there will homogeneity in that all the workload data is the product of registered nurses, there is a variability in age, health, education status and experience among the group. Variability within this group, while decreasing internal validity, improves the generalizability of the results to other nursing groups. Control for additional threats to internal validity, errors of measurement, was accomplished through the use of a limited number of observers familiar with the environment and population being studied, who had been tested for interrater reliability (Morgan, Gilner & Harmon, 2006, p. 47, 135; Polit & Beck, 2012, p. 318, 330-331). Additional controls for errors of measurement included use of a structured case report form (see Appendix C) (Morgan, et al., 2006, p. 47; Polit & Beck, 2012, p. 317) and use of screening criteria previously established as credible (Polit & Beck, 2012, p. 331). There was no assumption of causation and the potential for the relationship to be affected by confounding variables has been presented with the results (Polit & Beck, 2012).

As the collection of nursing workload data was retrospective, there was no influence on responses, assisting with management of threats to construct validity (Polit & Beck, 2012). However, some of the nursing workload scores may have been influenced by response biases (Morgan, et al., 2006, p. 59; Polit & Beck, 2012, p. 312-313) as the nurse attempted to justify his/her perception of a busy shift.

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As the study was conducted in a single centre, paediatric critical care unit, generalization to other areas of nursing practice where lower acuity and fewer comorbidities exist may not be possible, compromising external validity (Morgan, et al., 2006, p. 134; Polit & Beck, 2012, p. 279; Trochim & Donnelly, 2008, p. 34-36).

Statistical Methods

Statistical analyses were undertaken with IBM SPSS (version 23). Data were examined for the presence or absence of screening criteria representing patient care error, providing nominal data for analysis, with a calculation of the number of errors in a 24 hour period for each study participant, providing categorical data for measurement (Polit & Beck, 2010, p 379; Trochim & Donnelly, 2008, p. 96). The numeric value of the work in hours provided ratio data for measurement (Polit & Beck, 2012, p. 380; Trochim & Donnelly, 2008, p.96).

Similar to other investigations (Mitchell, et al., 2009; Scott, et al., 2006), descriptive statistics (Polit & Beck, 2012, p. 389) were used to summarize both the workload and the error data.

A Spearman correlation was used to analyze the nominal and ratio data. In addition, also similar to other investigations (Arimura, Imai, Okawa, Fujimura & Yamada, 2010; Kiekkas et al., 2008; Ream et al., 2007; Scott et al., 2006; Westbrook, Woods, Rob, Dunsmuir & Day, 2010), a logistic regression model of analysis (Morgan, et al., 2006, p. 229-235; Polit & Beck, 2012, p. 447-450) was used for further analysis. Although the use of the logistic regression model of analysis cannot determine that errors are caused by an increase in workload (Morgan, et al., 2006, p. 234), it may be possible to

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predict whether errors will or will not occur with an increase in workload (Morgan, et al., 2006, p. 229; Polit & Beck, 2012, p. 448-449).

The workload score in hours, considered the independent variable (Morgan, et al., 2006, p. 32; Polit & Beck, 2012, p. 51), was measured against the dependent variable (Morgan, et al., 2006, p. 33; Polit & Beck, 2012, p. 51), the absence or presence of the patient care error, as well as the number of errors identified for each patient.

Results

There were 2119 entries, each representing 24 hours of nursing work during the study period. A boxplot graph of the data as shown in Figure 1 identified 2 outliers. One outlier indicated a nursing workload of 90.2 hours, and the second a workload of 4.8 hours, in a 24-hour period. Further investigation of the 2 entries indicated that the data was correct. The workload of 90.2 hours represented the care of an extremely unstable patient who required multiple nurses to provide needed nursing care. The workload of 4.8 hours represented the care of a patient who was discharged early in the 24-hour period by a nurse who did not provide any additional nursing care in the 24-hour period. As both outliers represented extreme, atypical events, they were not included in the analysis.

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Figure 1. Boxplot identifying outliers.

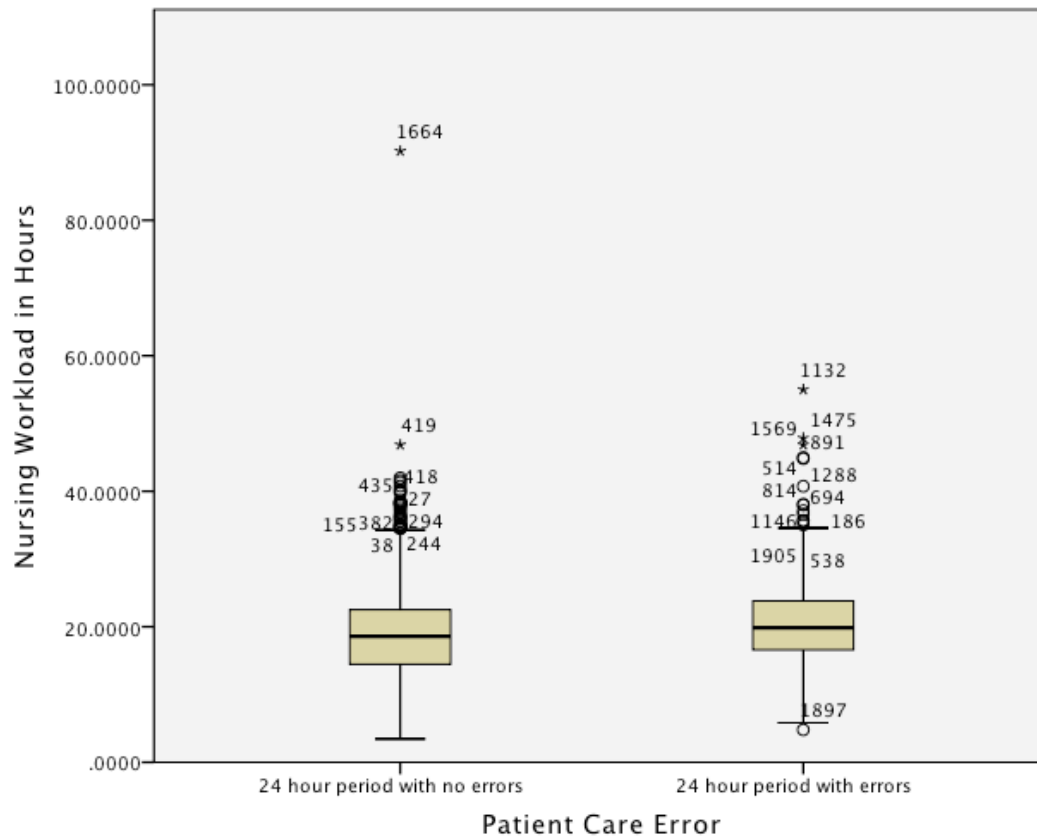


Figure 1. Boxplot identifying two outliers, entry number 1664, which scored 90.2 hours of nursing work and entry number 1897, which scored 4.8 hours of nursing work in 24 hours.

Thus, there were 2117 entries, representing work delivered by 165 registered nurses with varying levels of age, experience and education, over 3845 nursing shifts. Among the 2117, 24-hour periods, there were patient care errors identified on 497, which represents 23.5% of the total. As illustrated in Table 2, of the 497, 126 had between 2 and 5 patient care errors identified in the 24-hour period, for a total number of 665 errors.

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Table 2

Frequency of Patient Care Error

Number of Errors per entry	<i>n</i>	%	Total
0	1621	76.5	0
1	370	17.5	370
2	90	4.3	180
3	30	1.4	90
4	5	.2	20
5	1	.0	5
Total	2117	100.0	665

As demonstrated in Table 3, of the 13 screening criteria, the only category of error not reported during the study period was unexpected death. The most frequently reported category, representing 52% of the total was other undesirable outcomes. Further examination of the notes detailing each error, provided the following examples of other undesirable outcomes:

- patient bleeding – CBC sent but platelet result not available – following day platelet result range 34 – 41 – Hg dropped to 66.
- burn patient very agitated – being held down by RT, MD & RN following decrease in morphine.

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- patient left in rocking chair in room unsecured (by Mom) – patient fell from chair on to floor – no apparent injury.
- RN overnight expressing concern that DKA protocol not followed resulting in rapid drop in serum glucose requiring IV fluid and insulin manipulation.
- mom expressing concern/surprise that she had not been told that her daughter was positive for H1N1.

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Table 3

Categories of Patient Care Error

Category of Error	<i>n</i>
Unplanned extubation	18
Unplanned removal of CV or arterial line	35
Patient injury	46
Adverse drug reaction	92
Unplanned return to the OR	3
Patient complication that is not a natural progression of the disease (MI, CVA, PE etc.)	27
Unplanned readmission within 7 days	2
Development of neurological deficit	3
Unexpected death	0
Cardiac/respiratory arrest	11
ICU acquired infection	48
Dissatisfaction with care (documented)	33
Any other undesirable outcomes not covered above	347
Total	665

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As shown in Table 4, the median number of nursing workload hours recorded for all 24-hour periods in the study period was 18.952 (range 3.434-55.019). This compares to the median of 18.569 (range 3.434-46.868) for those periods where there was no identification of errors, and the median of 19.915 (range 5.830-55.019) for those periods where errors were identified. S. Langelaan, a Workload Specialist in Clinical Informatics and Technology Assisted Programs (personal communication, August 15, 2011), suggests that there are no reasonable expected time values for a GRASP workload score as the result is patient dependant. She further suggested that if a nurse was taking the breaks to which they were entitled, the number of nursing workload hours would realistically be between 4.00 and 9.00 for a 12 hour shift for one patient, or between 8.00 and 18.00 for a 24 hour period.

Other results, including the similarity between mean and median values, and the outcomes for skewness and kurtosis, indicate that the distribution is symmetrical. A histogram confirmed a normal distribution.

A Mann-Whitney test indicated that the nursing workload scores were higher where an error occurred ($M = 1,021.41$) than in those entries where an error did not occur ($M = 1,181.53$). The Mann-Whitney U test showed this difference to be statistically significant with $p < .001$. The Glass rank biserial correlation = + .15, a small effect in Cohen's (1988) classification.

This same small effect is seen in other tests measuring statistical association such as Kendall's tau (.091) and Spearman's rho (.111). All showing as statistically significant with p values $< .001$ as shown in Table 5.

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Table 4

Nursing Workload in Hours

Statistics	Total	No Errors	Errors
<i>n</i>	2117	1620	497
<i>M</i>	19.144	18.728	20.500
<i>SEM</i>	.148	.171	.287
<i>Median</i>	18.952	18.569	19.915
<i>SD</i>	6.821	6.895	6.395
Variance	46.523	47.538	40.898
Skewness	.461	.367	.983
Std. Error of Skewness	.053	.061	.110
Kurtosis	.918	.313	3.257
Std. Error of Kurtosis	.106	.122	.219
Range	51.585	43.434	49.189
Minimum	3.434	3.434	5.830
Maximum	55.019	46.868	55.019
Percentiles 25	14.955	14.473	16.613
50	18.952	18.569	19.914
75	22.827	22.513	23.824

Note. Statistics are for nursing workload for a period of 24 hours representing two 12-hour shifts. Hours include all patients that the nurse cared for during the shift, including any care required of additional patients assigned.

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Table 5

Correlations Between Nursing Workload and Patient Care Error

Kendall's tau_b		Nursing Workload	Entries with Errors	Number of Errors
Nursing Workload	Correlation Coefficient	1.000	.091**	.091**
	Sig. (2-tailed)	.	.000	.000
	N	2117	2117	2117
Spearman's rho		Nursing Workload	Entries with Errors	Number of Errors
Nursing Workload	Correlation Coefficient	1.000	.111**	.114**
	Sig. (2-tailed)	.	.000	.000
	N	2117	2117	2117

Note. Nursing workload is for a period of 24 hours representing two 12-hour shifts. Number of errors is from zero to five per 24-hour period. **Correlation is significant at the 0.01 level (2-tailed).

A logistic regression analysis was conducted to predict presence of error, using nursing workload for a period of 24 hours as a predictor. As illustrated in Table 6, test of the full model against a constant only model was statistically significant, indicating that the predictor reliably distinguished between presence and absence of error (chi square = 234.346, $p < .001$ with $df = 1$). However, Nagelkerke's R^2 of .009 indicated a very small relationship between prediction and grouping. Prediction success overall was 74.9% (100% for no error and <1% for error).

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In Table 7, the Wald criterion demonstrated that workload made a statistically significant contribution to prediction ($p < .001$), with $Exp(B)$ value indicating that if workload is raised by .025 hours, the odds ratio is 1.025 times as large, and therefore 1.025 more times likely to produce an error.

Table 6

Nursing Workload as a Predictor of Error – Statistic Significance

	Chi-square	df	Sig.(p)*	Nagelkerke R ²
Step 1 Step	234.346	1	.000	.009
Block	234.346	1	.000	
Model	234.346	1	.000	

Note. N = 2117. *Significant at $p < .001$

Table 7

Nursing Workload as a Predictor of Error – Odds Ratio

	B	S.E.	Wald	df	Sig. (p)*	Exp(B)
Step 1 ^a Nursing workload	.025	.002	235.934	1	.000	1.025
Constant	-1.636	.038	1881.689	1	.000	.195

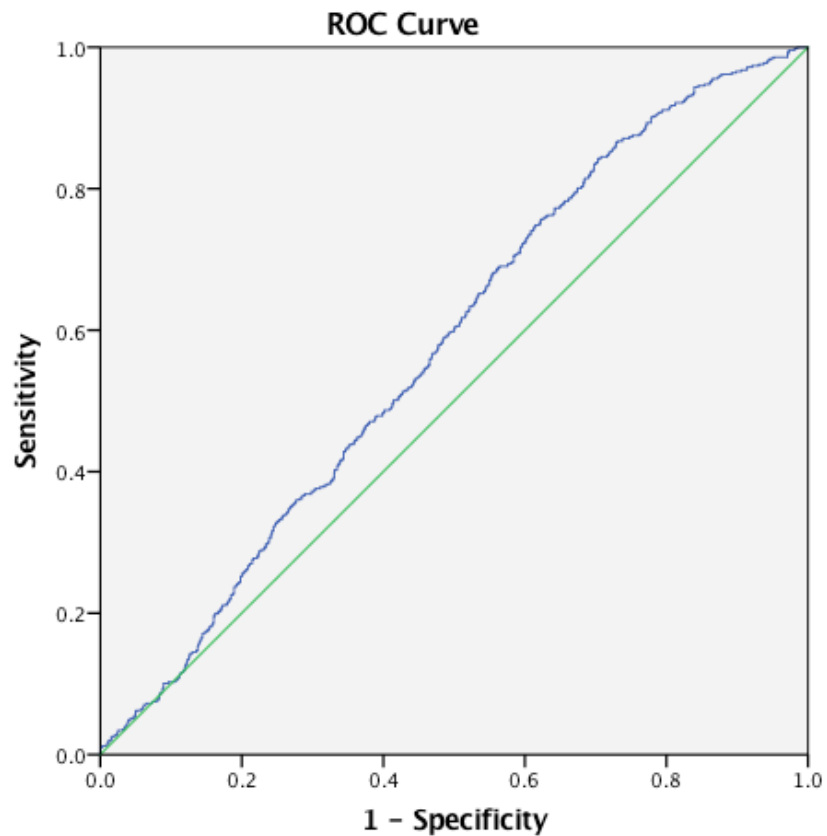
a. Variable entered on step 1: nursing workload over 24 hours. N = 2117. *Significant at $p < .001$

To further investigate whether workload can be used to discriminate between presence and absence of error, and to determine what cut-off point should be adopted,

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a receiver-operating-characteristic curve (ROC) graph was created as shown in Figure 2. Although statistically significant ($p < .001$), the results demonstrated a sensitivity of .575 (58%) with a false alarm rate of .425 (43%). Examination of the graph indicated that as nursing workload increased, it appears that there is an increase in the sensitivity of the detection of the presence of error around the 20th percentile.

Figure 2. Probability of Nursing Workload in Detecting Error

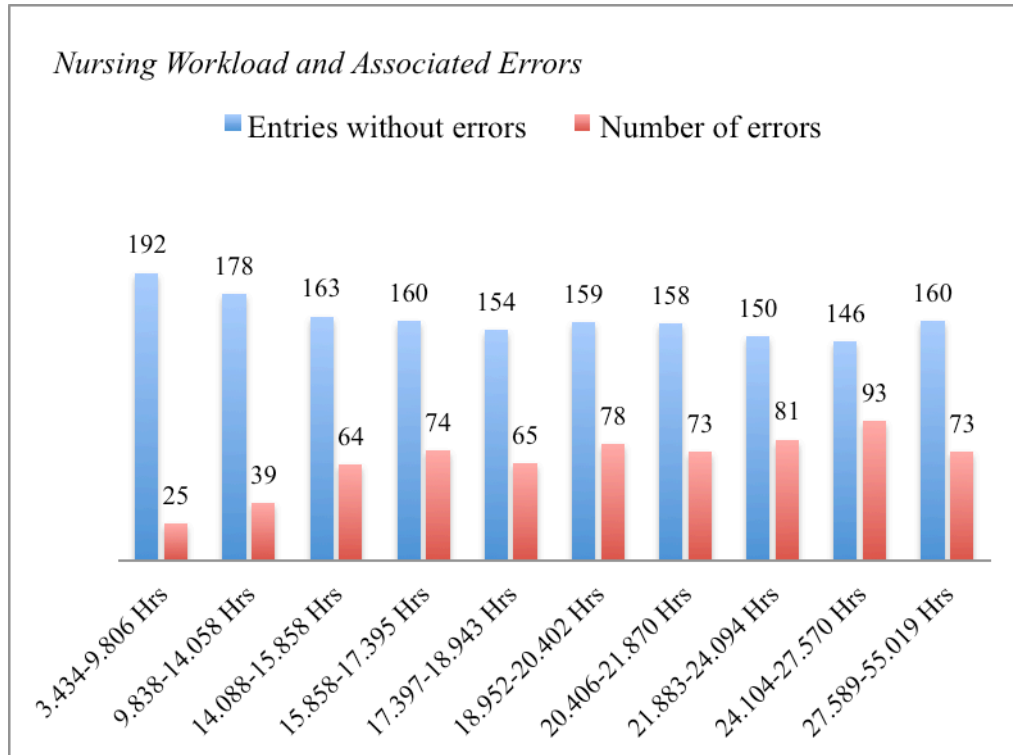


Diagonal segments are produced by ties.

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Further inquiry produced a graph displayed as Figure 3. This graph illustrates the number of errors discovered, shown against the number of cases in percentile ranges of nursing workload hours, from 1 – 10.

Figure 3. Range of Nursing Workload Hours and Associated Errors



Note. Nursing workload was grouped by hours (24 hour periods) from the 10th percentile through to the 100th percentile.

Discussion

This objective of this study was to examine if there was a relationship between an increasing number of recorded nursing workload hours with the presence of a patient care error in the patients assigned to that nurse, during the same time period.

Among the 2117, 24-hour periods, there were a total of 665 patient care errors identified. Any of these events could be expected to result in an increased length of stay,

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pain, anxiety, discomfort or loss of trust. Each event represents a failure in the delivery of best practice care.

This ratio of 665 errors to 2117 PICU days (0.31%) was similar to results that were reported in the adult critical care sites (Parshuram et al., 2015) of the Safety, Fatigue and Continuity in ICU Study (Parshuram, 2008), which had a ratio of 1602 positive screens to 5894 ICU days (0.27%), using the same screening tool. Of the 1602 positive screens, that study identified 464 adverse events, defined as any unplanned injury arising as a consequence of medical care during the ICU stay that was associated with morbidity that required treatment, that prolonged the hospital stay or that resulted in disability at discharge. Although differences in settings makes comparisons uncertain, if these results were extrapolated to the current study, it could be estimated that 167 adverse events may have occurred over the course of the study.

This study did identify a statistically significant association between nursing workload hours and patient care error, and the findings suggest that although the effect was small, the odds of error increased as the nursing workload increased. The difference in mean workload hours between those entries in where an error was identified and those where it was not, was 1.77 hours over 24. This increased probability for error with a seemingly small increase in nursing workload was previously demonstrated by West, Patrician and Loan (2012) where a decrease in one hour of nursing care over a shift in a critical care unit increased the probability of a fall by 51%, a needle stick injury to a nurse by 52%, and a medication error by 13%. As calculated by the GRASP^R (2006a) workload tool, nursing skills frequently required in an intensive care setting including continuous assessment of a critically unstable patient (77.04 minutes), multiple blood

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sampling from an invasive line (11.26 minutes each), frequent suctioning to clear an endotracheal tube (7.88 minutes each), maintenance of multiple infusions (78.14 minutes), initiation of continuous renal replacement therapy (50.68 minutes), or management of peritoneal dialysis (168.95 minutes), can quickly magnify the amount of time required for patient care.

Further findings indicate that although there were large variances in workload scores, a significant number of patients in the study required nursing care in excess of what was suggested that one nurse could provide. One possible explanation for this finding relates to multitasking. Nurses working in the intensive care environment have previously been reported to multitask, or fulfill several duties at the same time in an effort to complete all required work (Kalisch & Aebersold, 2010). Concerns with excessive workload, investigated in studies of military performance (Chen & Joyner, 2009), have shown that increasing the number of tasks to perform negatively effects reaction time and the ability to scan the working environment to identify objects of concern. It was also reported that increased visual and auditory stimulation, typically seen in ICUs, added to these negative effects (Chen & Joyner, 2009; Riemer, Mates, Ryan, & Schleder, 2015; Watson et al., 2015). Studies in human information processing have demonstrated that simultaneous performance of 2 or more tasks leads to compromise in at least one of the tasks (Tombu et al., 2011). It was further demonstrated that there are limits to what can be perceived, affected by the rate at which the information was received, the number of items and the complexity of the information (Marois & Ivanoff, 2005). Competing demands were shown to increase reaction time and error rate (Hein, Alink, Kleinschmidt & Muller, 2007); results which have implications for the rapid pace and complex

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environment of critical care. Negative effects of attempting to multitask have also been reported in the use of media. Ophir, Nass and Wagner (2009) found that attempting to multitask led to a decreased ability to concentrate and a significant decrease in performance of all the attempted tasks. Findings were not influenced by gender, creativity or intelligence performance.

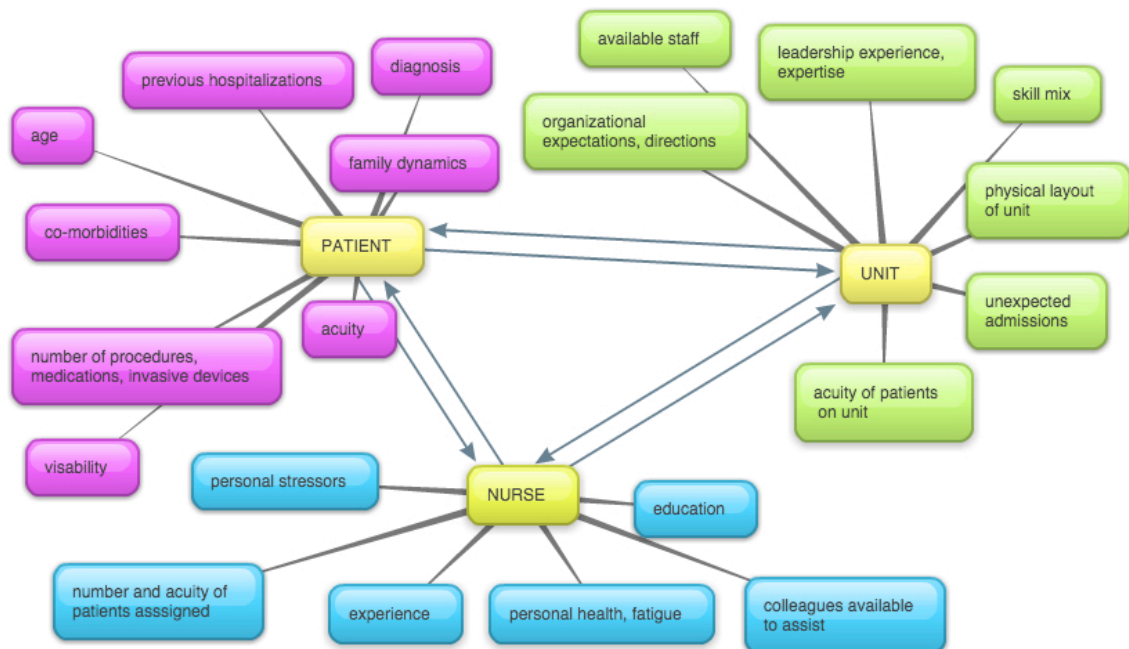
Another possible explanation is peer and leadership support. On the study unit, nurses providing direct patient care are aided by a Clinical Support Nurse, an expert in critical care who does not have an assignment and who assists nurses and patients throughout the unit as needs arise. This ‘floating staff’ is particularly important in an environment where patient numbers are unpredictable due to the nature of the population; units whose admissions are associated with trauma or transfers from units where deterioration has occurred have difficulty accurately predicting staffing needs. This environment also encourages peer-to-peer support, where a nurse with a patient requiring fewer interventions would assist a colleague caring for a patient with increased demands.

Ten years after “To Err is Human: Building a Safer Health System” was published by the Institute of Medicine (2000) in the United States, the Consumers Union published a review of the evidence of the success of interventions to create a safer health care system. Jewell and McGiffert (2009) noted that many of the recommendations to improve patient safety from the original Institute of Medicine report, had not been implemented, resulting in continuing preventable morbidity and mortality as a consequence of medical care. It has been suggested (Vogel, 2015) that safety initiatives are only successful in increasing patient safety in a supportive environment with strong teamwork, communication, situational awareness and adequate resources.

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As demonstrated in Figure 4, the ICU is a highly complex environment with a large number of interconnected components or CAS's, which react and influence each other. Nursing workload is one of these components. If the results of this study are examined from a CAS theoretical perspective, a workload in excess of what one nurse can provide will give rise to adaptation. The nurse may attempt to multitask, set priorities or leave work undone. The response of the nurse to these adaptations may include increasing stress, fatigue, increased rate of error, decreased ability to recognize and react to patient changes and a decreased ability to assist colleagues (Ebright, 2010). The patient may adapt to error with an increase in pain and suffering, increased morbidity and mortality or loss of trust. These adaptations in turn may have implications for the unit by increasing costs, delaying patient discharges, or creating an increased staffing turnover.

Figure 4. Complex adaptive systems of the intensive care unit.



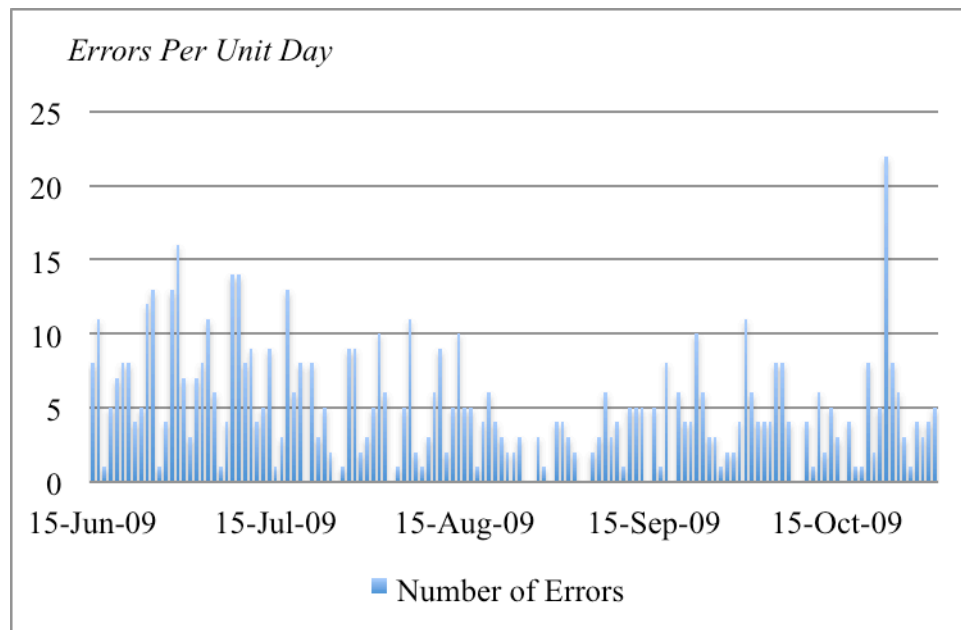
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Figure 4. A condensed overview of the complex adaptive systems within an intensive care unit with possible influencing variables. Adapted from “Critical Care Nursing: Embedded Complex Systems,” by R. Trinier, L. Liske, and V. Nenadovic, 2016, *Canadian Journal of Critical Care Nursing*, 27(1), p. 13. Copyright 2016 by the Canadian Association of Critical Care Nurses. Reprinted with permission.

The nonlinear, unpredictable nature of adaptation by each CAS requires attention to all components within the system, as interventions or changes to one CAS will impact all CAS’s to which it is connected (Smith, 2011). Modifications implemented for improvement in any one of the components or CAS’s may create unanticipated effects that negatively impact other CAS’s within the system.

In consideration of this interconnectedness, it is reasonable to consider that other components within the system impacted the presence of patient care errors. As demonstrated in Figure 5, some days were error free whereas clusters of errors occurred on others.

Figure 5. Patient Care Errors Per Unit Day

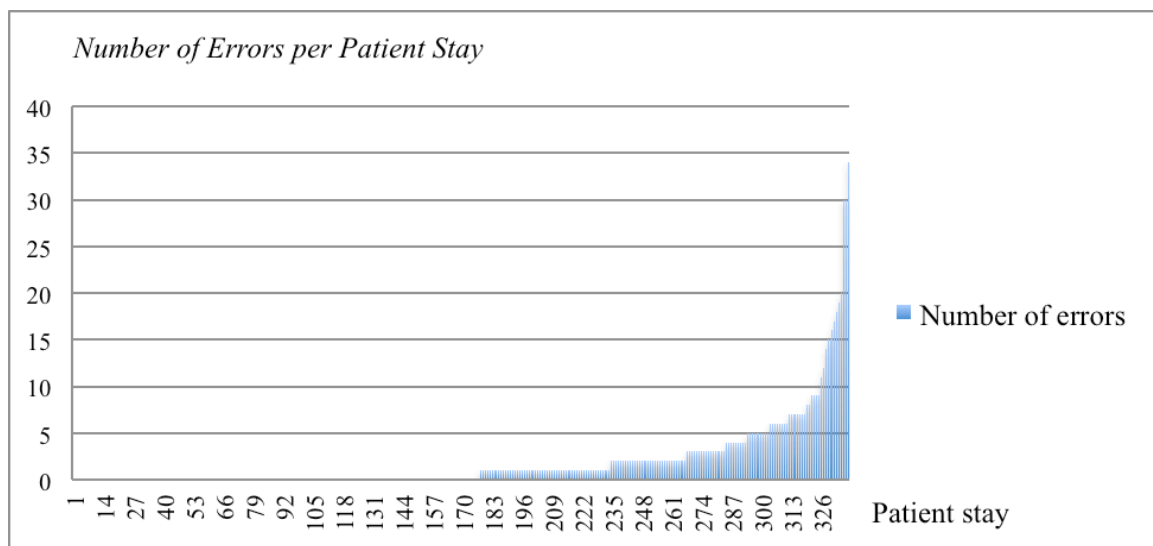


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Note. Total of 139 days. Range of errors per unit day, 0 to 22. Number of days with no errors, 13.

Similarly, characteristics of the patient, also a CAS within the system, may impact the presence of errors. As demonstrated in Figure 6, some patient stays were error free, whereas other patient stays incurred multiple errors.

Figure 6. Number of Errors Per Patient Stay



Note. Total of 338 patient stays. Range of errors per patient stay, 0 to 34. Number of patient stays with no errors, 177.

Consequently, in addition to nursing workload, unit factors, such as staffing, patient census or a large number of high acuity patients on a particular day; or patient characteristics including acuity, existing comorbidities, number of treatment modalities and family dynamics may impact the number of patient care errors that occur. Further research into unit staffing, nursing expertise and experience, patient census, acuity, length of stay and family dynamics as it relates to patient care error during this time period will add to the findings correlating nursing workload and patient care error.

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In an effort to manage costs, some institutions have considered a reduction in nursing care hours. However, there is evidence to suggest (Pappas, 2008; Rothberg, Abraham, Lindenauer & Rose, 2005; Rothschild, Bates, Franz, Soukup & Kaushal, 2009) that increasing nurse staffing and thus decreasing nursing workload, results in cost savings through a reduction in errors and health care complications.

Staffing models responsive to the nursing care needs of individual patients (Beswick, Hill & Anderson, 2010; Connor, LaGrasta, Hickey, 2015; Ebright, 2010; Fasoli, Fincke, & Haddock, 2011; Neuraz et al., 2015; Valentin, 2007) have been suggested as a method to reduce the potential for error and increase the nurse's ability to complete appropriate patient care in the time allotted. Arbitrary staffing models such as nurse patient ratios based on the number of patients in the unit and the nurses available to care for them, or staffing requirements based on the number of inpatients in the unit at a particular time of day (midnight), ignore the impact of workload on the potential for error and its related human and fiscal cost.

Limitations

This study has a number of limitations. Using a nonprobability sample allows for cost effective accessibility to subjects and data (Morgan, et al., 2006, p. 125; Polit & Beck, 2012, p. 274). However, as the study was conducted in a single centre, paediatric critical care unit, generalization to other areas of nursing practice where lower acuity and fewer comorbidities exist may not be possible (Morgan, et al., 2006, p. 134; Polit & Beck, 2012, p. 279; Trochim & Donnelly, 2008, p. 34-36). It should be recognized

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however, that an increase in nursing workload could occur in any setting utilizing nursing care.

Use of this single centre was also advantageous. Study staff, as colleagues to the staff on the unit of study, had already established a relationship of trust. This relationship allowed for open communication and a willingness to report errors that might not have otherwise been reported. Research nurses' familiarity of the environment also facilitated the identification of errors.

Attributing errors to the day they are discovered may reflect a threat of history (Morgan, et al., 2006, p. 119; Polit & Beck, 2012, p. 244) to the internal validity of the study as there is a possibility that an identified error may be the result of care that occurred prior to the observation period or in area of the hospital other than the PICU. However, the use of this period facilitated standardization.

The adequacy of nursing workload tools to accurately measure nursing work remains controversial (Clarke, 2006; Fasoli, Fincke & Haddock, 2011; Hadley et al., 2004). The tool used to measure nursing workload for this project, the GRASP methodology (GRASP Systems International Companies, 2011), is used in a large number of organizations in Canada, the United States and the United Kingdom (Hadley et al., 2004). This method of measuring nursing workload has been in use since the early 1970s (GRASP Systems International Companies, 2011), with yearly reviews to address changes in practice, technology or governmental requirements (GRASP Systems International Companies, 2011).

Errors to patient care are also influenced by patient acuity and co morbidities and may not be exclusive to the workload of the nursing staff. It should be recognized that

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patient error has previously been noted to be associated with nurse fatigue (Dean, et al., 2006; Parshuram et al., 2008), stress (Rassin, et al., 2005; Scott, Hwang & Rogers, 2006), working hours (Scott et al., 2006; Lockley et al., 2007), nursing staff inexperience (Morrison, Beckmann, Durie, Carless & Gillies, 2001), skill mix (Tibby et al., 2004; West, Patrician & Loan, 2012), physical environment (Gurses, Carayon & Wall, 2009; Simmons, Graves & Flynn, 2009), interruptions and multitasking (Gurses, Carayon & Wall, 2009; Kalisch & Aebersold, 2010; Redding & Robinson, 2009), use of concentrated solutions and recent exposure to tasks (Parshuram et al., 2008), all of which may have an influence on patient care. Further, the workload score was attributed to the nurse(s) assigned to the patient, assistance from colleagues was not considered. In addition, the sample may reflect seasonal variations in illness (Polit & Beck, 2012, p. 278) not seen during other time periods.

None of these potential confounding variables (Morgan, et al., 2006, p. 34; Polit & Beck, 2012, p. 177-179) was addressed or controlled for by this study, which may be considered a threat to internal validity (Morgan, et al., 2006, p. 114-117; Polit & Beck, 2012, p. 244-249) as the identified error may have been influenced by one of these confounding variables.

Conclusions

Patient care error is a leading cause of death and disability. Nurses, have reported that increased workload contributes to these errors. Previous studies examining nursing workload and patient care error are inconclusive. This prospective observational study in

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the critical care setting examined the correlation between patient care error, and nursing workload as determined by the GRASP® tool for workload measurement.

A statistically significant association between nursing workload hours and patient care error was identified, and the findings suggest that while the effect was small, the odds of error increased as the nursing workload increased.

Further findings indicated that although there were large variances in workload scores, a significant number of patients in the study required nursing care in excess of what was suggested that one nurse could provide, implying that multitasking, priority setting, leaving work undone or depending on support from colleagues was necessary to provide patient care. The inability of a nurse to provide the care that is perceived to be necessary has implications for the level of stress experienced by nurses (Halvorsen, Forde, & Nortvedt, 2008; Vryonides, Papastavrou, Charalambous, Andreou, & Merkouris, 2015), which may not only have deleterious effects on the nurse herself (Donovan, Doody, & Lyons, 2013) but may also negatively effect retention and staff turnover (Rushton, Batcheller, Schroeder, & Donohue, 2015).

Understanding the complexity of the critical care environment and the implications of workload as a contributing factor to patient care error and its related human and fiscal cost can provide insight into its prevention, and it may encourage the candid dialogue necessary to promote the organizational change that can result in innovative strategies to assess staffing requirements and workload assignments. These changes will potentially benefit patients, their families, nurses, and the health care system.

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Appendix A:
Athabasca University Research Ethics Approval

MEMORANDUM

DATE: November 12, 2012

TO: Ruth Trinier

COPY: Debbie Fraser (Supervisor)
Janice Green, Secretary, Athabasca University Research Ethics Board
Dr. Sharon Moore, Chair, CNHS Research Ethics Review Committee
Simon Nuttgens, Chair, Athabasca University Research Ethics Board

FROM: Dr. Sharon Moore, Chair, CNHS Research Ethics Review Committee

SUBJECT: **Ethics Proposal #CNHS-2012-04:** *“Nursing Workload and its Relationship to Patient Care Error in the Paediatric Critical Care Setting”*

Thank you for providing the additional information requested by the Centre for Nursing & Health Studies (CNHS) Research Ethics Review Committee.

I am pleased to advise that the above-noted project has now been awarded **APPROVAL TO PROCEED**. **You may begin your research immediately.**

This approval of your application will be reported to the Athabasca University Research Ethics Board (REB) at their next monthly meeting. The REB retains the right to request further information, or to revoke the interim approval, at any time. Please note that since the REB approval from Toronto Sick Kids Hospital expires in March 2013, you are required to submit the re-approval letter to Athabasca University for file purposes.

As implementation of the proposal progresses, if you need to make any significant changes or modifications prior to receipt of a final approval memo from the AU Research Ethics Board, please forward this information immediately to the CNHS Research Ethics Review Committee via Dr. Sharon Moore sharon.moore@athabascau.ca for further review.

We wish you all the best with your research.

If you have any questions, please do not hesitate to contact sharon.moore@athabascau.ca

Centre for Nursing & Health Studies Research Ethics Review Committee

(A Sub-Committee of the Athabasca University Research Ethics Board)
1 University Drive, Athabasca, AB, Canada T9S 3A3
e-mail: cnhsreb@athabascau.ca
Telephone: (780) 675-6747
Fax: (780) 675-6468

Appendix B:
Case Report Form

NURSING WORKLOAD AND PATIENT CARE ERROR

centre	ICU Patient	Data Report Form: In-House ICU physical schedule study	patient study number
ICU Admission Demographics for Screening		date <input type="text"/> <small>day month year</small>	
<p>1- Please indicate whether this is a</p> <p><input type="checkbox"/> [1] First study admission <input type="checkbox"/> [2] Re-admission</p>			
<p>2- Please indicate whether this is an</p> <p><input type="checkbox"/> [1] Emergency - non-scheduled admission <input type="checkbox"/> [2] Elective admission</p>			
<p>3- Admission date and time</p> <p>time 24 hrs. : date ..</p> <p style="text-align: center;"><small>day month .. year</small></p>			
<p>4- Diagnosis:</p>			
<p>5- Age in years</p>			
<p>6- APACHE score <i>NOT USED</i></p>			
<p>Elective admissions are planned admissions following or as part of an elective procedure. Emergency admissions are unplanned admissions to the ICU that are admitted within 12 hours of the decision to admit to the participating ICU.</p>			

NURSING WORKLOAD AND PATIENT CARE ERROR

OBJ:

Centre	ICU Patient	Case Report Form: In-house ICU physician schedule study																																																				
		<small>patient study number</small>																																																				
In-ICU daily observations		<small>start date</small>																																																				
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[2] Please, indicate whether the patient was receiving the following treatments: <table border="1" style="width: 100%; margin-top: 10px;"> <tr> <td style="width: 50%;">Mechanical Ventilation</td> <td style="width: 25%;">[1] Yes</td> <td style="width: 25%;">[2] No</td> </tr> <tr> <td>High Frequency Oscillation</td> <td>[1] Yes</td> <td>[2] No</td> </tr> <tr> <td>Non- Invasive Ventilation</td> <td>[1] Yes</td> <td>[2] No</td> </tr> <tr> <td>Dialysis (at any stage)</td> <td>[1] Yes</td> <td>[2] No</td> </tr> <tr> <td>Intravenous vasoactives/inotropes</td> <td>[1] Yes</td> <td>[2] No</td> </tr> <tr> <td>Code status/DNR</td> <td>[1] Yes</td> <td>[2] No</td> </tr> </table>			Mechanical Ventilation	[1] Yes	[2] No	High Frequency Oscillation	[1] Yes	[2] No	Non- Invasive Ventilation	[1] Yes	[2] No	Dialysis (at any stage)	[1] Yes	[2] No	Intravenous vasoactives/inotropes	[1] Yes	[2] No	Code status/DNR	[1] Yes	[2] No																																		
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Intravenous vasoactives/inotropes	[1] Yes	[2] No																																																				
Code status/DNR	[1] Yes	[2] No																																																				
[3] Please, indicate whether the following procedures were performed, by choosing one of the following options: Y=Yes, N=No, A=Arranged, P=Pending <table border="1" style="width: 100%; margin-top: 10px;"> <thead> <tr> <th rowspan="2">Procedure</th> <th>Planned</th> <th>Completed</th> <th rowspan="2"></th> <th>Planned</th> <th>Completed</th> </tr> <tr> <th>AM round</th> <th>PM round</th> <th>PM round</th> <th>AM round</th> </tr> </thead> <tbody> <tr> <td>Insert CVL</td> <td>[Y] [N]</td> <td>[Y] [N] [A] [P]</td> <td></td> <td>[Y] [N]</td> <td>[Y] [N] [A] [P]</td> </tr> <tr> <td>Insert PAC</td> <td>[Y] [N]</td> <td>[Y] [N] [A] [P]</td> <td></td> <td>[Y] [N]</td> <td>[Y] [N] [A] [P]</td> </tr> <tr> <td>Insert IA</td> <td>[Y] [N]</td> <td>[Y] [N] [A] [P]</td> <td></td> <td>[Y] [N]</td> <td>[Y] [N] [A] [P]</td> </tr> <tr> <td>Insert Chest tube</td> <td>[Y] [N]</td> <td>[Y] [N] [A] [P]</td> <td></td> <td>[Y] [N]</td> <td>[Y] [N] [A] [P]</td> </tr> <tr> <td>Other:</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table>			Procedure	Planned	Completed		Planned	Completed	AM round	PM round	PM round	AM round	Insert CVL	[Y] [N]	[Y] [N] [A] [P]		[Y] [N]	[Y] [N] [A] [P]	Insert PAC	[Y] [N]	[Y] [N] [A] [P]		[Y] [N]	[Y] [N] [A] [P]	Insert IA	[Y] [N]	[Y] [N] [A] [P]		[Y] [N]	[Y] [N] [A] [P]	Insert Chest tube	[Y] [N]	[Y] [N] [A] [P]		[Y] [N]	[Y] [N] [A] [P]	Other:																	
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[4] Please, indicate AE screen results: <table border="1" style="width: 100%; margin-top: 10px;"> <tr> <td style="width: 30%;">[1] Screen Positive</td> <td>> complete AE Screen form</td> </tr> <tr> <td>[2] No positive AE Screen</td> <td>> do not complete AE screen form</td> </tr> </table>			[1] Screen Positive	> complete AE Screen form	[2] No positive AE Screen	> do not complete AE screen form																																																
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NURSING WORKLOAD AND PATIENT CARE ERROR

ICU Patient		Case Report Form: In-house ICU physician schedule study				patient study number <table border="1" style="display: inline-table; border-collapse: collapse; width: 60px; height: 15px;"> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> </table>							
In-ICU Daily Screening Form					date <table border="1" style="display: inline-table; border-collapse: collapse; width: 60px; height: 15px;"> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> </table>								
from observations in the ward round +													
	event	AM Round	other source	PM Round	# of text below	Possible Proximal Event & Location							
1	Unplanned extubation												
2	Unplanned removal /loss of CV/ IA line												
3	ICU-incurred patient injury												
4	Adverse Drug Reaction												
5	Unplanned return to OR												
6	Patient complication including AMI, CVA, PE, that is not part of the natural progression of the patients disease												
7	Unplanned re-admission to ICU within 7 days of discharge												
8	Development of neurologic deficit not present on ICU admission												
9	Unexpected death												
10	Cardiac / Respiratory Arrest (ROSC)												
11	ICU-acquired infection / sepsis												
12	Dissatisfaction with care documented in the medical record including litigation												
13	Any other undesirable outcomes not covered above												
free text description													

