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Emergency Department Triage Acuity Assignment in Patients with Sepsis at an Academic Tertiary Care Centre: Predictors and Outcomes

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Emergency Department Triage Acuity Assignment in Patients with Sepsis at an Academic Tertiary Care Centre: Predictors and Outcomes

by

Leon Daniel Petruniak

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ABSTRACT

Recognition and prioritization of septic patients in the Emergency Department (ED) is a fundamental component of the management of sepsis, a condition that is frequently encountered in EDs and causes significant morbidity and mortality. However, it is not known how triage nurses determine acuity level among this group. The purpose of this study was to examine the factors that predict triage acuity level among septic patients, and to examine how patients with high versus low acuity scores differed with respect to time until receipt of first antibiotic, and 28-day in-hospital mortality. Logistic regression analysis suggested that high acuity assignment was independently associated with communication barriers, acute confusion, unwell appearance, and hypotension. Further analysis suggested that those assigned high acuity triage scores had a lower mean time to first antibiotic and a higher risk of 28-day in-hospital mortality.

DEDICATION

To my loving, beautiful, and supportive wife, Julie Petruniak, who encouraged and supported me during this academic adventure. You gave up so much for me to continue with graduate studies, and I truly appreciate your sacrifices. Together, we are successful! You gave me strength, encouragement, and would not let me give up on myself. Your unconditional support has allowed me to achieve this academic goal.

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Introduction

Background

Sepsis is a complex cascade of physiological events characterized by the presence of a systemic inflammatory response syndrome (SIRS) in the setting of an identified or presumed focus of infection (Bone, Grodzin, & Balk, 1997; Dellinger et al., 2004; Levy et al., 2003). If sepsis is not recognized in a timely manner and treatment is delayed, it may transition to organ system dysfunction (severe sepsis), circulatory collapse (septic shock), and death. The incidence of sepsis and its sequelae are increasing (Angus et al., 2001; Angus & Wax, 2001; Martin, Minnino, Eaton, & Moss, 2003). There are reported to be 750,000 cases of sepsis per year in the United States with an expected increase in the number of cases by 1.5% per annum (Angus et al., 2001). In Canada, over 30,500 cases of sepsis were reported by hospitals during 2008 to 2009, of which, 40% transitioned to severe sepsis (Canadian Institute of Health Information a [CIHI], 2009).

Sepsis is responsible for 1,400 deaths per day worldwide (Robson, Newell, & Bevis, 2005), and is a leading cause of death in North America (Angus et al., 2001; Balk, 2000). In the United States, mortality rates associated with sepsis and severe sepsis range from 30% to 50% (Angus et al., 2001; Dellinger et al., 2008), while Canadian data suggests mortality rates are approximately 38% (Martin et al., 2009). These statistics exceed the mortality rates associated with stroke and heart attack (CIHI b, 2009).

Sepsis and its sequelae, significantly increase patient length of stay in acute care facilities, and carry a substantial personal burden. In Canada, sepsis and its associated complications increase considerably hospital resource utilization, are associated with approximately nine extra days of acute care in-patient stays (CIHI a, 2009), are commonly associated with unplanned intensive care unit (ICU) admissions (Frost et al., 2009), and account for an extra 4 days of care in the ICU (CIHI a, 2009). In addition to the family and personal hardships connected with prolonged hospitalization, there is a significant economic cost associated with sepsis treatment. Angus and colleagues (2001) estimated the average cost to treat a patient with sepsis in the United States is approximately $22,100, while Canadian data suggest a cost of $11,472 per case, with an estimated annual cost for treatment reaching as high as $73 million per year (Letarte, Longo, Pelletier, Nabonne, & Fisher, 2002).

The importance of time in the initial management of sepsis can be likened to the “golden hour” for a trauma patient, the necessity for rapid percutaneous coronary intervention for acute myocardial infarction, and the timely thrombolytic administration for an acute ischemic cerebral infarct. That is, research evidence supports that early recognition and timely treatment of sepsis is the hallmark of a successful multidisciplinary management of this syndrome (Funk, Sebat, & Kumar, 2009; Green et al., 2008; Nguyen et al., 2006; Raghavan & Marik, 2006; Rivers, McIntyre, Morro, & Rivers, 2005). Specific time dependent interventions that are associated with reduced morbidity and/or mortality among septic patients include: (a) early mobilization of emergency department (ED) initiated sepsis protocols (Gurnani et al., 2010; Shapiro et al., 2006), (b) early administration of antimicrobials (Gaieski et al., 2010; Kumar et al., 2006), and (c) timely implementation of goal directed therapy (Nguyen et al., 2007; Rivers et al., 2001), which involves adjusting cardiac preload, afterload, and contractility to balance oxygen delivery and demand (Rivers et al., 2001).

The impact of the aforementioned interventions is considerable. In terms of early antimicrobial therapy, evidence suggests that each 1 hour delay in antimicrobial administration is associated with an increase in mortality by 7.6 % per hour over a total six hour period (Kumar et al., 2006). Similarly, Gaieski et al. (2010) reported a significant reduction in mortality when time to antibiotic administration from triage assessment was less than 1 hour versus 1 hour or longer (19.2 % versus 33.2% respectively; *OR* 0.30; 95% *CI* = 0.11- 0.83; $p = 0.03$). Results of a randomized controlled trial (RCT) demonstrated the efficacy of early goal directed therapy (EGDT) in the ED setting, with a reduction of in-hospital mortality from 46.5% in a standard care/control group to 30.5% in the EGDT group (*RR* 0.58; 95% *CI* = 0.38 - 0.87; $p = 0.009$) (Rivers et al., 2001). Similarly, Nguyen et al. (2007) found that completion of EGDT in the ED within the recommended six hour time frame was significantly associated with decreased mortality (*OR* 0.36; 95% *CI* = 0.17 - 0.79; $p = 0.01$). Implementation of an interdisciplinary ED sepsis protocol has also been shown to save lives. Gurnani et al. (2010) found a reduction in the 28-day in-hospital mortality rate of patients after implementation of a sepsis protocol (61% versus 33% for the control verses protocol groups respectively; $p = 0.004$). Shapiro et al. (2006) reported a non-significant reduction in 28-day in-hospital mortality for sepsis protocol patients (20.3% versus 29.4% for control group; $p = 0.300$). Although the authors suggested that the study was not sufficiently powered, it has clinical merit.

Triage of Septic Patients

Patients with sepsis, are frequently encountered in the ED (Rivers, Nguyen, & Amponsah, 2003; Sands, et al., 1997; Shapiro et al., 2003; Strehlow, Emond, Shapiro, Pelletier, & Camargo, 2006; Wang, Shipiro, Angus, & Yealy, 2007), where they initially receive a triage assessment by an ED triage nurse. The Canadian Triage Acuity Scale (CTAS) is a tool that was introduced to Canadian EDs in 1999 (Beveridge et al., 1999) and is currently used in virtually every ED in Canada, with the primary aim of facilitating accurate and rapid prioritization of patients' medical needs (Bullard, Unger, Spence, & Grafstein, 2008). The CTAS model is based on a five level system that uses clinical indicators as informants for presumed acuity. Patients who are classified as Level 1 are in need of resuscitation and require immediate intervention by the ED nurse and physician to preserve life or limb. Levels 2 through 5 represent decreasing levels of acuity, with level 2 denoting emergent status and level 5 representing non-urgent status. Current CTAS guidelines stipulate that all patients who present to the ED with specific indicators of sepsis (SIRS response, a confirmed or suspected focus of infection, and an unwell appearance) should be assigned a high acuity triage score (CTAS Level 2 or CTAS Level 1) (Bullard et al., 2008).

Given that the triage nurse is the first health care professional to assess and prioritize medical care of all patients presenting to the ED, they play a key role in initiating the process that will lead to prompt and appropriate treatment for septic patients. Although ED triage nurses do not have the professional qualifications to diagnose a patient with sepsis, they do have the capacity and professional aptitude to identify the symptoms and objective physiological indicators that are indicative of sepsis. However, it is believed by some (Howell & Shapiro, 2004; Rivera, 2009) that ED triage nurses are not identifying all patients who present to the ED with clinical indicators that are suggestive of sepsis, and may also under-triage this group of ED patients (Yurkova & Wolf, 2011). Local data at an academic tertiary care hospital and regional trauma centre in London, Ontario, Canada support this concern. Over the period of April 1, 2009 to March 31, 2010, there were 137 cases of sepsis admitted to acute care through the adult ED. Of these, 46% (*n* = 63) (Appendix A) received a lower acuity triage score (CTAS 3 and 4). This is problematic because, by definition, patients who receive these lower acuity triage classifications may wait longer periods of time in the ED waiting room before they receive re-assessment, which is likely to lead to delays in receipt of potentially life-saving therapies.

In light of the evidence suggesting that receipt of early therapy is a critical component of care for patients with sepsis, and concerns that a significant proportion of septic patients receive low CTAS scores, it is important to understand why some septic patients receive lower acuity triage scores while others receive high acuity triage scores. In addition to specific triage guidelines, there is some evidence to suggest that factors related to the nurse (Andersson, Omberg, & Svedlund, 2006; Considine, Botti, & Thomas, 2007; Edwards, 2007), patient (Arslanian-Engoren, 2009; Cone & Murray 2002; Cooper, Schriger, Flaherty, Lin, & Hubbell, 2002), and environment (Chen et al., 2010; Richardson, 1998; Sloan et al., 2005) may influence the assignment of triage acuity scores to ED patients. Unfortunately, empirical evidence identifying the factors that contribute to the assignment of high or low acuity triage scores that is specific to patients with sepsis could not be found.

Although the cornerstone of all evidence-informed therapies for sepsis management is based on the hallmark of early identification of septic individuals, it is not completely clear on how assigned ED triage acuity level influences receipt of these proven therapies. ED triage practice is based on the assumption that those who receive higher acuity CTAS scores will be assessed/reassessed sooner than those who are classified as lower in acuity (Murray, Bullard, & Grafstein, 2004). The logical consequence is that higher acuity patients will receive important therapies in a timelier manner than they would if they are mis-classified at a lower level of priority, thus leading to better clinical outcomes. However, this may not always be the case. Due to ED environmental circumstances, lower acuity ED patients may sometimes be evaluated by a primary ED nurse or an ED physician sooner than higher acuity patients (Schull, 2005). For example, EDs often have fast-track or ambulatory care areas where lower acuity patients tend to be placed. In these areas, this sub-set of ED patients often move though the ED (i.e., receive evaluation, treatment, and be discharged/transferred) in shorter periods of time. In such circumstances, a septic patient who received a lower acuity triage score could be evaluated by a primary ED nurse or physician sooner, and if indicated, time-dependent and potentially life-saving therapies could be initiated more quickly. Although there is some evidence to suggest that higher acuity triage scores are in fact associated with earlier physician assessment (CIHI, 2007; Yoon, Steiner, & Reinhardt, 2003; Vlahaki & Milne, 2009), it is not known if this is the case among patients with sepsis. Further, although it is known that some patients with sepsis receive lower acuity triage scores, it is not known if the time to their first antibiotic is significantly lower, nor is it known if these patients have higher mortality rates than those who receive higher acuity scores.

Purpose of the Study

In light of the previously identified gaps in the state of knowledge, the primary aims of this study were to: (a) identify the factors that contribute to high versus low acuity triage scores for patients diagnosed with sepsis, and (b) determine the relationship between triage classification (high versus low) of patients with sepsis in terms of process of care and clinical outcomes. Specifically, the intent of this study was to examine patient characteristics, nursing characteristics, and ED environmental characteristics that may predict assignment of low versus high acuity triage scores to septic patients. With regard to process of care and clinical outcomes, this study examined the differences of triage acuity scores of septic patients with: (a) time to administration of first antibiotic, and (b) 28-day in-hospital mortality.

Significance of the Study

Sepsis and its associated syndromes render high mortality rates (Angus et al., 2001; Dellinger et al., 2008; Martin et al., 2009), are costly to treat (Angus et al., 2001; Letarte, Longo, Pelletier, Nabonne, & Fisher, 2002), and are common to emergency care settings (Rivers, Nguyen, & Amponsah, 2003; Sands, et al., 1997; Shapiro et al., 2003; Strehlow, Emond, Shapiro, Pelletier, & Camargo, 2006; Wang, Shipiro, Angus, & Yealy, 2007). Select therapies exist that positively impact patient morbidity and mortality (Gaieski et al., 2010; Gurnani et al., 2010; Kumar et al., 2006; Nguyen et al., 2006; Rivers et al., 2001; Shapiro et al., 2006; Trzeciak, et al., 2006). A large amount of published data is available demonstrating the benefit of evidence-informed multidisciplinary ED strategies for sepsis management, all of which highlight the imperative of rapid identification of potentially septic patients (Funk, Sebat, & Kumar, 2009; Green et al., 2008; Nguyen et al., 2006; Raghavan & Marik, 2006; Rivers, McIntyre, Morro & Rivers, 2005; Wilmont, 2009).

Given the importance of timely identification of patients with sepsis, and the likelihood that assigned triage scores influence the critical minutes that septic patients may spend waiting for potentially life-saving treatment in the ED, it is important to understand why some septic patients are assigned lower acuity triage scores while others receive higher scores. It is equally important to validate the assumptions that triage scores do indeed impact the timely delivery of care (i.e., antibiotic administration) as well as clinical outcomes, such as mortality. It is anticipated that the knowledge obtained from the results of this study will provide the basis for interventions that could lead to improved triage accuracy of potentially septic patients, and ultimately lead to more timely access to emergency care, which may possibly influence morbidity and mortality in this population.

Conceptual Framework

Overview of Patel's Model

The model (Figure 1) proposed by Patel, Gutnik, Karlin, and Pusic (2008) conceptualizes specific influential factors that impact ED triage nurses' decisions in Canadian paediatric ED settings. This model is based on a synthesis of published literature regarding general clinical decision making models, emergency nursing decision making methods, as well as the authors' (Patel et al., 2008) subjective understanding that ED triage is a dynamic decision-making process. It identifies four major factors of influence in the triage decision making process that culminate in the assignment of an acuity score to paediatric patients: (a) nursing factors, (b) patient factors, (c) contextual factors, and (d) CTAS guidelines.

Most contextual conditions, triage nurse responsibilities, and triage nurse decision making processes in an adult ED are similar to those of a paediatric ED setting. Hence, it can be argued that the model proposed by Patel and colleagues (2008) is applicable to an adult ED setting, and to adult triage nurse decision making. Accordingly, this model will be used as the conceptual framework for this research study. The following text provides an overview of the factors of influence that are addressed in the model.

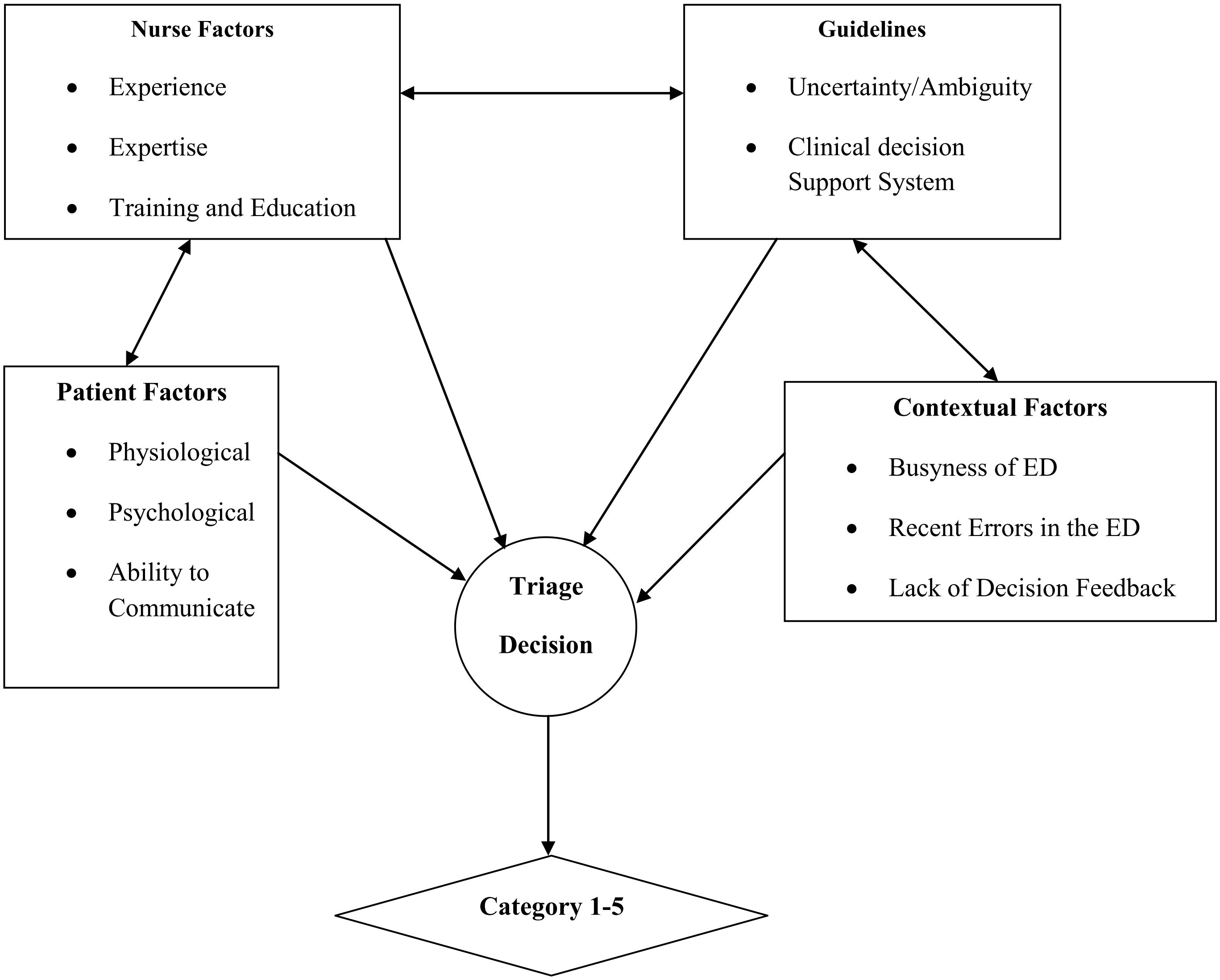

Figure 1. Framework of factors involved in triage decision making in paediatric ED's. (Patel, Gutnik, Karlin, & Pusic, 2008)

Nursing factors. Nursing factors of influence are based on a synthesis of published works regarding ED nurses' experience, clinical training, and decision making techniques (Patel et al., 2008). Edwards (1994) found that triage nurses use their previous nursing experience and patients' subjective descriptions of their chief complaint to establish clinical decisions. Similarly, Mardsen (1998) suggested that the accuracy of ED triage decisions is influenced by nurses' prior knowledge as well as previous experience. It is also believed that heuristics play an important role in the decision making process (Simmons, Lanuza, Fonteyn, Hicks, & Holm, 2003) and that novice ED nurses look to learned guidelines, while more seasoned nurses base their clinical decisions on past clinical encounters as well as patients' subjective histories (Cioffi, 1998). Hence, Patel et al. (2008) identified experience, expertise and training, and education as specific nursing factors that influence ED nurses' triage decisions (see Figure 1).

Patient factors. Patient factors are also believed to influence ED triage nurses' decision making and assignment of triage acuity. Patel et al. (2008) suggested that patient factors such as subjective complaints, physiological indices, and past medical history are variables that the ED triage nurse must consolidate during the decision making process. Communication barriers as well as the patient's ability to participate or cooperate during the initial triage interview (Hampers & McNulty, 2002) also influence the ED triage nurse decision making process. For example, in an adult ED, elderly patients with cognitive impairment who are unable to provide the necessary details of their presenting chief complaints (i.e., focus of infection) may challenge the ED triage nurse's ability to assign accurate CTAS scores. Consistent with the aforementioned discussion, Patel et al. (2008) have identified physiological and psychological indices, as well as ability to communicate, as the specific patient factors that influence ED nurses' triage decisions (see Figure 1).

Contextual factors. Emergency care settings are highly dynamic environments that are often the initial entry point to acute care, and are intended to provide swift assessment, treatment, and stabilization in the background of competing patient needs. Individuals who present to the ED for emergency care are triaged by a Registered Nurse (RN) and are prioritized based on the urgency of their presenting medical condition, thus allowing for timely evaluation and treatment. Triage decisions are often made with limited objective data, ambiguous information, and are generally formed in isolation; as the triage environment is often too hectic to consult other emergency care team members (Gerdtz & Bucknall, 1999).

At the time of ED triage, nurses prioritize medical care for patients with undiagnosed conditions that may not have predicable outcomes. That is, an emergency patient's condition may change while in the ED waiting room and, through reassessment, the triage nurse may elect to re-classify the patient's level of acuity (CTAS score) based on deterioration or improvement of clinical indicators (Murray, Bullard, & Grafstein, 2004). Adding to the challenge of triage is the burden of overcrowding in Canadian EDs and lengthy ED wait times (Bond et al. 2007; Bullard et al. 2009), which may contribute to delays in timely assessment and treatment. Accordingly, Patel et al. (2008) have suggested that the busyness of the ED, recent errors in the ED, and lack of decision feedback are specific contextual factors that influence ED nurses' triage decision making.

Triage guidelines. The CTAS guidelines were introduced to Canada in 1999 (Beveridge et al., 1999) and are currently used as a national standard for triage across virtually all Canadian

EDs. These guidelines have undergone revisions over the past decade, with the most recent amendments adding two levels of clinical modifiers that guide acuity assignment decisions based on objective clinical findings (Bullard et al., 2008). Instead of basing clinical decisions solely on objective findings, Patel and colleagues (2008) have identified uncertainty/ambiguity, as well as clinical decision support system, as two specific contributors to the decision making process of ED triage nurses. Patel et al. (2008) maintain that in situations with clinical ambiguity, nurses with less experience tend to rely on the triage guidelines more regularly than more experienced triage nurses. Moreover, when an experienced triage nurse is uncertain about a triage decision they may "go with their gut feelings and disregard the guideline" (Patel et al., 2008, p. 512). However, when ED space is exhausted and capacity has exceeded capability, guidelines offer reassurance to ED triage nurses and provide guidance on which to base their clinical decisions and triage acuity assignments (Patel et al., 2008).

Modified Model

The model authored by Patel et al. (2008) was modified slightly (see Figure 2) for use in the current study. Of the four factors of influence in the original model, two were used to guide the selection of the study variables: patient factors and contextual factors. Although the original intent of the study was to include examination of how nurse factors are predictive of acuity assignment, a decision was made not to address nurse factors within the context of the current study (see limitations section). Because the study took place in a single setting, the guidelines factor (CTAS guidelines as per Bullard et al., 2008) was constant across all cases, and was therefore not used as a variable. In addition, data pertaining to perceptions about clinical decision support, and uncertainty or ambiguity pertaining to guidelines as a factor of influence were not available, due to the retrospective design of the study. The specific variables in Figure 2 that were used in the study are further discussed in the literature review.

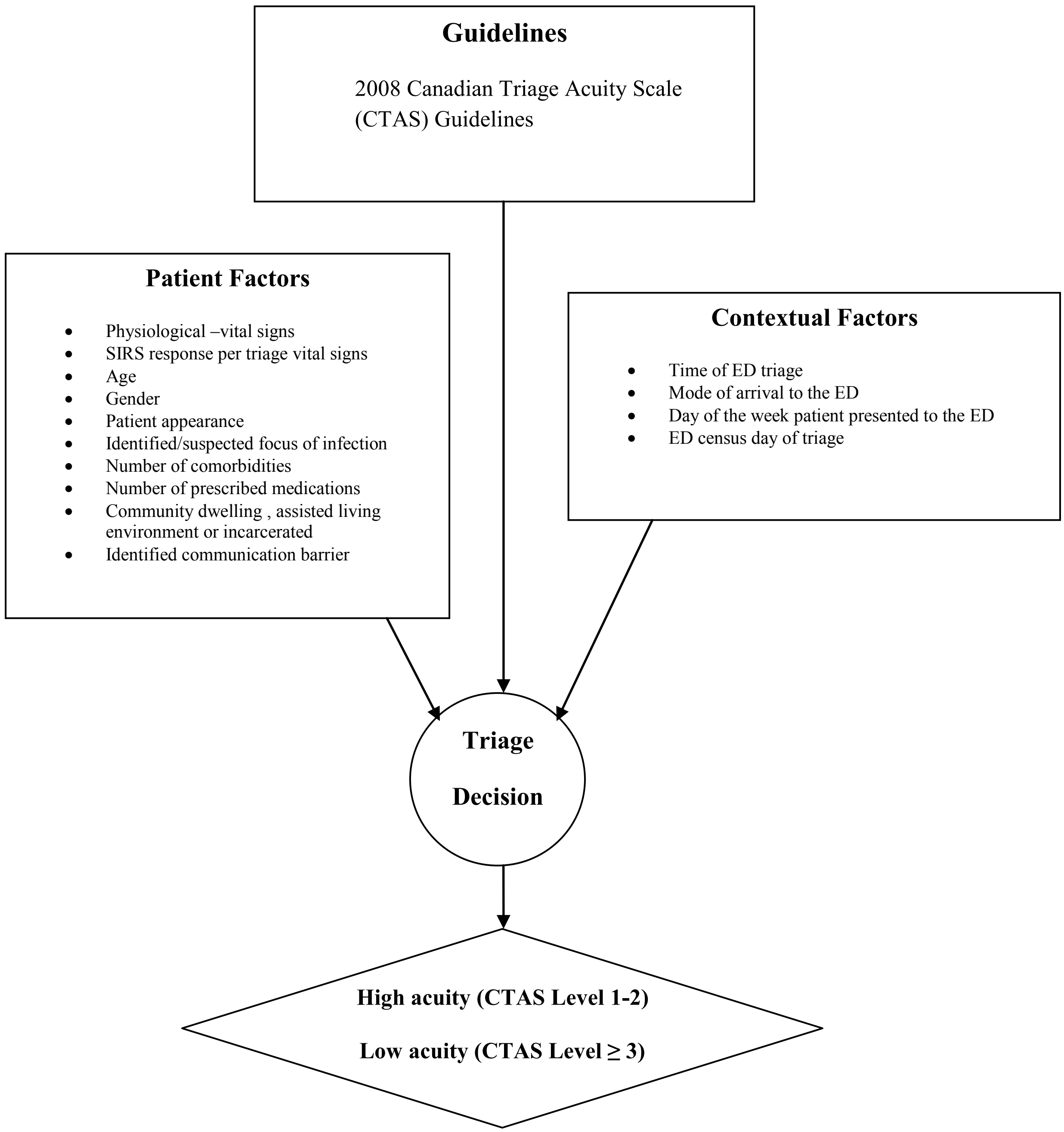

Figure 2. Framework of factors that may predict CTAS priority assignment of septic patients

Research Questions

1. What are the specific patient and contextual factors that contribute to the assignment of high acuity (CTAS Level 1 or 2) or low acuity (CTAS level ≥ 3) triage scores for ED patients with a most responsible medical diagnosis of sepsis?
2. Among emergency department patients with a most responsible medical diagnosis of sepsis, how do those with high versus low triage acuity scores differ with respect to 28-day in-hospital mortality?
3. Among emergency department patients with a most responsible medical diagnosis of sepsis, what is the difference in time to first antibiotic administration between those who received high versus low triage acuity scores?

Chapter II

Literature Review

The modified version of the framework proposed by Patel, Gutnik, Karlin, and Pusic (2008) is used as the conceptual underpinnings to structure the literature review for this study. A brief discussion of sepsis, the history of ED triage and CTAS precedes the review of literature regarding the influence of patient and contextual variables on ED nurse triage decision making. In this literature review, the terms triage score, CTAS score, triage acuity level, and level of priority are used interchangeably.

Sepsis, Severe Sepsis, and Septic Shock

Sepsis is defined by the presence of a systemic inflammatory response syndrome (SIRS) in the setting of an identified or presumed focus of infection (Bone et al., 1997; Green et al., 2008; Levy et al., 2003). A SIRS response can be caused by a variety of clinical conditions ranging from major trauma, an ischemic event (myocardial infarction), or an inflammatory process in an organ (Bone et al., 1997). SIRS is manifested by two or more of the following physiological criteria: (a) core temperature >38ºC or < 36ºC; (b) heart rate >90 beats per minute; (c) respiratory rate >20 breaths per minute; and (d) white blood cell count > than 12, 000/mm³ or < 4,000/ mm³ or the presence of more than 10% immature neutrophils (Bone et al., 1997; Levy et al., 2003; Kanji, Devlin, Piekos, & Racine, 2001).

Sepsis can transition to other more serious clinical states, namely severe sepsis and septic shock. Severe sepsis is differentiated from sepsis by the presence of organ system dysfunction (Bone et al., 1997; Green et al., 2008; Levy et al., 2003). Some clinical examples of organ dysfunction may include oliguria or increased creatinine levels (renal system), altered level of consciousness (central nervous system), or elevated liver enzymes (gastrointestinal system) (Green et al., 2008). The final and most serious condition on the sepsis continuum is septic shock, which is defined as hypotension in the presence of end organ dysfunction and perfusion abnormalities that is refractory to fluid resuscitation (Bone et al., 1997; Green et al., 2008; Levy et al., 2003).

ED Triage, CTAS, and the Septic Patient

ED triage is often the initial entry point into acute care. The purpose of ED triage is to prioritize an individual's need for emergency treatment based on objective clinical findings (Fitzgerald, Jelinek, Scott, & Gerdtz, 2010; Fry & Burr, 2002). The process of ED triage includes sorting, selecting, and categorizing every individual who presents to the ED for emergency care, with a primary goal of sustaining physiological function and life (Mezza, 1992).

The fundamentals of current ED triage are historically derived from military medicine, disaster medicine, pre-hospital transport, and civilian medicine (Mezza, 1992). Traditionally, ED triage and the prioritization of an individual's need for emergency medical care was an emergency physician's duty (Weinerman & Edwards, 1964; Weinerman, Rutzen & Pearson, 1965). However, over the past decades, ED nurses have shouldered this challenging responsibility (Beveridge et al., 1999, Bullard, Unger, Spence, & Grafstein, 2008; Estrada, 1979).

CTAS originates from the National Triage Scale (currently known as the Australasian Triage Scale) (Beveridge, Ducharme, Janes, Beaulieu, &Walter, 1999; Fernandes et al., 2005; Manos, Petrie, Beveridge, Walter, & Ducharme, 2002), a 5-level triage system that was initially developed in Australia in the mid-1990's (Australasian College for Emergency Medicine, 1994).

The CTAS triage system was introduced to Canada in 1999 as a national standard for triage across all Canadian EDs, and is endorsed by the Canadian Association of Emergency Physicians and the National Emergency Nurses Affiliation (Beveridge, 1998; Beveridge et al., 1999). CTAS continues to exist as a 5-level scale (Appendix B) that provides guidance for ED RNs who prioritize the need for medical evaluation of patients in Canadian EDs. The original guidelines have been augmented to account for new clinical knowledge and challenging contextual influences that impede access to emergency care (Bullard, et al., 2008; Murray, Bullard, & Grafstein, 2004).

As shown in Appendix B, patients who are assigned a Level 1 (resuscitation) CTAS score require immediate nursing and medical assessment with continuous nursing evaluation. Patients classified as CTAS Level 2 (emergent) require immediate nursing assessment, and ED nurse re-evaluation every 15 minutes until deemed stable. CTAS Level 3 (urgent) applies to patients with conditions that require nursing attention and reassessment every 30 minutes. Patients assigned a CTAS Level 4 (less-urgent) require nursing evaluation every 60 minutes. Finally, CTAS Level 5 (non-urgent) represents conditions that can be assessed every two hours (Murray, Bullard, & Grafstein, 2008). It is important to note that an assigned triage score is not static and may change based on improvement or deterioration of clinical condition (Fry & Burr, 2002; Gerdtz & Bucknall, 2001).

The reliability of CTAS has been tested in a number of studies. Manos and colleagues (2002) studied inter-observer agreement among 20 emergency care providers (5 physicians, 5 RNs, 5 basic life support paramedics, and 5 advanced life support paramedics) using 41 case scenarios, and found good reliability ($\kappa = 0.77$; 95% $CI = 0.76 - 0.78$). Using a sample of triage nurses, Worster et al. (2004) assessed the inter-observer reliability of two 5-level triage systems, the Emergency Severity Index (ESI) and CTAS, and reported a high level of reliability ($\kappa = 0.91$; 95% *CI* = 0.90 - 0.99) for the CTAS triage model. Finally, Beveridge and associates (1999) investigated the reliability of the CTAS system among 10 physicians and 10 nurses who triaged 50 cases. Again, a high level of agreement ($\kappa = 0.83$; 95% *CI* = 0.81 - 0.85 and $\kappa = 0.84$; 95% *CI* = 0.83 - 0.85, respectively) was reported.

The validity of the CTAS model has also been assessed. Some maintain that it is difficult to evaluate the validity of a triage scale as there is no true benchmark or criterion to use as a standard for comparison (Twomey, Wallis, & Myers, 2007; Worster, Fernandes, Eva, & Upadhye, 2007). However, a number of surrogate indicators of acuity such as ED resource utilization, acute care admission rates, mortality rates, and workload indices have been used to assess the validity of a number of triage scales (Fernandes et al., 2005). The CTAS has demonstrated excellent predictive validity for all of these outcomes (Dong et al., 2007; Jimenez et al., 2003; Worster, Fernandes, Eva, & Upadhye, 2007).

Current CTAS guidelines recommend that patients with suspected sepsis be assigned an emergent priority level (Level 2), thus allowing for timely assessment and intervention. This is consistent with the existing paradigm that early recognition of suspected sepsis is the cornerstone of sepsis management and improves patient outcomes (Funk, Sebat, & Kumar, 2009; Green et al., 2008; Nguyen et al., 2006; Raghavan & Marik, 2006; Rivers, McIntyre, Morro, & Rivers, 2005; Wilmont, 2009). CTAS guidelines (Bullard, et al., 2008) stipulate that a patient is to be considered septic when: (a) three vital signs (heart rate, respiratory rate, and core temperature) measured at triage are consistent with the SIRS criteria, (b) the patient appears unwell, and (c) there is evidence of a source of infection. If these three conditions are met at the time of initial ED triage or during re-assessment of clinical state, the triage nurse must assign a CTAS score of level 2 (emergent), reflecting the patient's presumed acuity level (Bullard et al., 2008). However, there may be clinical situations in which a higher level of priority (i.e., level 1 or resuscitation) would be more appropriate for a patient who is suspected of having sepsis. Such cases would involve clinical indicators that suggest an imminent threat to the patient's life which, for example, might occur in the presence of significant hypotension or altered level of consciousness with potential airway compromise.

Although all septic patients should ideally receive a high acuity CTAS score, there may be instances when patients with sepsis present to ED triage without all of the clinical indicators, which would preclude a high priority assignment. For example, an adult with sepsis may present to ED triage with symptoms consistent with lower respiratory tract infection and all three SIRS criteria, but not appear unwell. Alternatively, an elderly patient with sepsis may present with all of the criteria for sepsis except that of an elevated temperature. Despite their need for early therapy to prevent the possible complications of sepsis, these patients would likely receive a lower priority CTAS score (Level 3 or Level 4) and may subsequently experience poorer health outcomes due to delays in receipt of life-saving therapies.

Factors Influencing ED Nurse Triage Decisions

The following is a review of the literature pertaining to the factors that may influence ED nurses' triage decisions and priority assignment for septic patients. This review is organized according to the theoretical framework that is being used for this study.

Patient Factors

Given that the primary objective of the ED triage is to identify the order of medical priority for each patient before their condition worsens (Twomey, Wallis, & Myers, 2007), patient factors should be the most important determinant in priority selection. Although a limited amount of research exists regarding the influence of patient factors on ED triage nurse decision making, a small number of studies have investigated the influence of patient visual cues (i.e., general appearance), physiological markers of urgency (i.e., vital signs), and communication barriers on ED triage nurse decision making. Studies pertaining to each of these variables are presented in the following text.

Patient visual cues/general appearance. The complex process of triage decision making involves assessment of a constellation of variables. Some authors suggest that patient appearance and visual cues have an effect on ED triage nurses' decision making processes and the subsequent assignment of triage acuity.

Qualitative studies. Cone and Murray (2002) conducted a qualitative study using focus group methodology to describe the decision making characteristics of expert ED nurses ($N = 10$) with at least five years of ED experience. Participants were presented with six questions regarding triage decision making capacity. Patient appearance emerged as one of the themes that were involved in triage decision making. This is congruent with CTAS guidelines such that an "unwell" appearance is one criterion necessary for a patient to qualify for a higher level of priority (i.e., emergent) in the context of suspected sepsis (Bullard et al., 2008).

Edwards (2007) sampled 14 ED triage nurses from the United Kingdom and video-taped 38 live triage encounters from this cohort. The nurses then viewed their own triage encounters and were asked to reflect on, and describe their thought processes. The nurses' annotations were then analysed using grounded theory methodology. The author found that the "initial look" of the patient was a central component of the ED triage nurses' clinical reasoning processes, and was used to assess the general degree of urgency of a patient's condition.

In another qualitative study, Arslanian-Engoren (2009) explored the decision making processes of ED nurses who triaged individuals with symptoms consistent with acute myocardial infarction (AMI). Using focus group methodology, the author interviewed 12 ED triage nurses and analyzed their audio-recorded descriptions. Results of this study indicate that ED triage nurses consider many factors when making triage decisions pertaining to patients with symptoms suggestive of AMI. One particular factor identified was the patients' general appearance.

Quantitative studies. Salk and associates (1998) carried out a 2-phase, prospective, observational study using a randomized crossover design to compare triage priority assignment based on in-person versus telephone interviews with patients. The investigators were interested in identifying the effects of patient visual cues and vital signs on nurses' ($N = 34$) triage decisions. In the each phase, patients ($N = 409$) were triaged by two different nurses; one in-person and one by telephone. Each triage nurse made two triage decisions, one before knowledge of vital signs, and one after being told the patients' vital signs. Hence, there were four cells in each phase: telephone interview with and without knowledge of vital signs (conducted by the same nurse), and in-person interview with and without knowledge of vital signs (conducted by a different nurse). In phase one of the study, clinical decisions in each of the four situations were based entirely on the nurses' clinical expertise. In phase two, decisions were based on complaint-based protocols. The authors found the inter-rater reliability between in-person and telephone triage, for both phases, was poor (43.1% to 48.8%; $\kappa = 0.19$ to 0.26); knowledge of vital signs did not improve agreement. In comparing in-person versus telephone triage, the authors suggested that in-person interviews resulted in the identification of more patients requiring admission as being of a highly acute nature. Although the authors did not identify the "correct" triage categories, they implied that in-person triage results were more accurate, and thus concluded that patient visual cues play an important role in the triage process.

Physiological markers/vital signs. According to CTAS guidelines (Bullard et al., 2008), physiological markers and vital signs are the fundamental basis from which ED nurses' triage decisions are made. Moreover, changes in vital signs provide the triage nurse with objective clinical indicators of acuity so that they can modify or adjust a patient's original triage score to represent a change in status and need for more timely medical intervention. Contrary to the intent of the CTAS guidelines, research demonstrates that objective data such as vital signs have limited influence on triage nurses' clinical decision making. In fact, the authors (Gerdtz & Bucknall, 2001) of an observational study that described the information that triage nurses (N = 26) use when assigning priority levels to patients reported that nurses made triage decisions without assessing vital signs in 77% of 404 triage encounters. Inferential statistics revealed that triage nurses collected more vital signs on patients in higher urgency categories ($\chi^2 = 62.4$, p = 0.00). These findings suggest that ED triage nurses frequently base their acuity decisions on other markers, possibly subjective ones.

Two quantitative studies (Cooper et al., 2002; Salk et al., 1998) examined the effect of knowledge of vital signs on the assignment of triage acuity. In the previously described study by Salk et al. (1998), nurses made triage decisions before and after knowledge of patients' vital signs. Knowledge of vital signs produced changes in only 8.8% of telephone decisions and 5.6% of in-person decisions. Unfortunately, inferential statistics pertaining to these changes were not provided.

In a much larger multi-site study conducted by Cooper and associates (2002), patients (N = 14,285) attending 24 EDs from the United States were triaged by 625 different ED triage nurses. The nurses triaged each patient twice using a five level hypothetical triage scale. First, the patients were triaged and assigned a level of acuity without knowledge of the patient's vital signs. They were then triaged with knowledge of the patients' vital signs. The main outcome measure was change in triage decision after knowledge of the patients' vital signs. The authors reported that a very large proportion of triage decisions (92.1%) were not affected by the triage nurses' knowledge of the patients' vital signs. Of the other 7.9%, knowledge of vital signs produced more upgrades than downgrades in assigned triage acuity level.

Other patient related factors. Studies have examined the influence of language barriers (Hampers & McNulty, 2002) as well as a patient's gender and age on ED triage decision-making (Arslanian-Engoren, 2001, Platts-Mills et al., 2010).

Hampers and McNulty (2002) prospectively investigated the impact of interpreters and bilingual physicians on ED resource utilization of 4,146 patients. The main outcome measures were incidence and cost of diagnostic imaging, length of stay in the ED, admission rate, and use of intravenous hydration. Four cohorts, defined in terms of language barrier and use of interpreters were used in this study: (a) English speaking, (b) non-English speaking, (c) non-English speaking/barrier, and (d) non-English speaking/interpreter. In the group of ED patients defined as having a language barrier who were interviewed without a professional medical interpreter, there was a higher incidence of diagnostic imaging (*OR*, 1.5; 95% *CI* = 1.04 - 2.2), and hospital admissions (*OR*, 2.6; 95% *CI* = 1.4 - 4.5). The authors concluded that language barriers may influence clinical decision making. Although this study did not measure the influence of communication barriers on ED triage nurses' decisions, the findings suggest that language barriers may create a need for additional sources of information (i.e., imaging studies and admission to hospital) to fill in gaps in information that may occur. This has relevance for ED triage nurses, who are in the difficult position of assessing the urgency of patients' needs for medical evaluation based on limited information. In the background of communication barriers, triage nurses need to rapidly assess patients' levels of acuity. It is difficult to ascertain a level of medical urgency when important clinical history could be lost or misinterpreted due to communication barriers. Hence, it is highly possible that communication barriers complicate the triage process and may contribute to ED nurse triage decisions.

Although no studies were found that investigated the impact of gender on triage decisions among patients with sepsis, Arslanian-Engoren (2001) conducted a descriptive study to examine if gender differences influence ED nurses' triage decisions among patients with symptoms of MI. The author mailed three pairs of clinical vignettes to 500 randomly selected members of the Emergency Nurses Association and asked the respondents to: (a) identify relevant clinical cues, (b) rate how urgently the hypothetical patient should be evaluated by a physician, and (c) identify if the patient should be admitted to hospital. Of these clinical vignettes, two of the case pairs were of cardiac origin, while the third was considered to be a distracter case. The only difference in each of the three pairs of cases was the gender of the patient. Nurse participants (*N* = 260) tended to rank a cardiac vignette involving a middle aged male patient to be in need of a higher priority triage score than an identical vignette involving a female patient ($t = 2.58$; $p = 0.01$). In addition, ED nurse participants were more likely to think that the male had a cardiac diagnosis than the same aged female counterpart with the identical vignette presentation ($\chi^2 = 37.49$; $p < 0.001$).

Existing research on ED nurse triage decision making and assignment of urgency for vulnerable populations, such as elderly patients and those with complex medical conditions (i.e. polypharmacy, multiple comorbidities, and institutional dwelling), is scarce. Platts-Mills et al., (2010) examined the sensitivity and specificity of the Emergency Severity Index (ESI) for identification of elder patients (< 65 years) receiving an immediate life-saving intervention in the ED. Within the context of this study, investigators selected a sub-sample of 50 elderly patients from a larger group of 782 consecutive elder patients presenting to the ED. For these 50 cases, the ESI designation assigned by the triage nurse was compared to that of an expert triage nurse who assigned an ESI score via retrospective chart review. Of the 50 cases, there was disagreement in 17 ED presentations: 13 were deemed to have been under-triaged, while 4 were considered over-triaged. In addition, more than half of the patients who received immediate interventions were incorrectly assigned ESI scores of greater than 1, indicating that their status was less urgent (by definition, all patients in need of immediate intervention should be assigned Level 1). Although the authors did not use a comparison group of non-elder patients, they concluded that accurate triage of elder patients is more difficult than it is for non-elder patients. They cited three reasons for this phenomenon: (a) high rates of chronic illness in this population make it more difficult to identify acute illness, (b) larger proportions (40% in this study) of cases in which the primary source of triage information was someone other than the patient, and (c) physiological and pharmacological factors among the elderly may limit changes in vital signs in response to illness and injury. This limits the utility of vital signs in helping to identify serious illness.

Given that the criteria for sepsis are heavily dependent on vital signs, triage of elderly patients presenting with this problem may be especially difficult. Specifically, the typical indicators of a SIRS response, such as fever and heart rate over 90 beats per minute, may not be evident at triage because the elderly often have an absent or blunted febrile response to infection (Krabbe et al., 2001; Norman & Yoshikawa, 2000) and are more likely to be on medications, such as beta-adrenergic blocking agents, that inhibit a chronotropic response to infection. Hence, triage nurses may be challenged when screening for markers of suspected sepsis, and this may result in inappropriately low acuity triage scores for this specific population. The conclusion that elderly patients are difficult to triage is concerning, as it is known that Canada's demographics are shifting to include an increasingly large and disproportionate percentage of elderly individuals (Statistics Canada, 2010), many of whom will suffer from chronic diseases and present to the ED with atypical presentations (Rutschmann et al., 2005).

Contextual Factors

Although there is a dearth of research in this area, a small number of studies have investigated the influence of contextual factors on triage decisions. Specific variables that were studied include ED busyness and patient volume, time of day and day of the week of ED presentation, and mode (e.g., ambulance versus ambulatory) of arrival. Research pertaining to each of these factors is presented in the following text.

ED busyness and patient volume. Accurate assignment of an ED triage code requires that the triage nurse be able to listen attentively to the patient's subjective history with limited interruption. However, many Canadian EDs are often in a state of saturation with considerable overcrowding (Bond et al., 2007; Bullard et al., 2009) that results in frequent interruptions in the ED triage nurses' clinical decision making process. The concern is that interruptions may interfere with collection of relevant clinical data and with the thought process associated with interpreting this data, thus contributing to errors in nurses' triage decisions.

Despite the apparent absence of studies that investigate the relationship between ED busyness and accuracy of triage decisions, research (Brixey et al., 2008; Chisholm, Dornfeld, Nelson, & Cordell, 2001; Kosits & Jones, 2011; Woloshynowych, Davis, Brown, & Vincent, 2007) has demonstrated that ED nurses are frequently interrupted. Studies have also identified relationships between busyness and errors in other aspects of nursing practice. Specifically, as nurses' workload, interruptions, or "busyness" increase; medication errors (Biron, Loiselle, & Lavoie-Tremblay, 2009; Palese, Sartor, Costaperaria, & Bresadola, 2009; Scott-Cawiezell et al., 2007; Westbrook, Woods, Rob, Dunsmuir, & Day, 2010), procedural errors (McGillis-Hall, Pedersen, & Fairly, 2010; Westbrook, Woods, Rob, Dunsmuir, & Day, 2010), and charting/transcription errors (Balas, Scott, & Rodger, 2004; McGillis-Hall, Pedersen, & Fairly, 2010; McGillis-Hall et al., 2010) also tend to increase. These findings suggest that there may also be a link between the indicators of nurse busyness and errors in other aspects of nursing practice, such as ED triage.

Using a prospective observational design, Richardson (1998) investigated the relationship between daily ED activity (i.e., busyness) and ED triage categorization (i.e., triage acuity level) of 94,681 patients at a large tertiary care Australian ED. A "busy" weekday was defined as greater than 140 patient visits in a 24 hour period, while a busy weekend day was greater than 100 ED presentations over the same time frame. Non-busy days were defined as having less than 140 and 100 ED patient visits over a 24 hour period on weekdays and on the weekend, respectively. The author reported that assigned triage acuity scores did not vary with daily ED activity/busyness. However, the author did not support this conclusion with inferential statistics. Instead, statistics that were provided suggested that *admission rates* within each triage category on busy and non-busy days were not significantly related to ED busyness.

Chen et al. (2010) also concluded that ED volume (or busyness) does not influence the accuracy of ED nurses' triage decisions. In this study, ED triage nurses (N = 279) from 14 different EDs were presented with 10 written adult based scenarios. Departmental busyness was defined as less than 3600 visits per month (< 120/day) or greater than 3600 visits per month (> 120/day). It was reported that there was no significant relationship between patient volume and the accuracy of triage score ($F = -0.51$; $p = 0.06$). That is, the triage decisions of nurses who worked in EDs with typically large patient volumes were not significantly different from those nurses from EDs with smaller volumes. It appears that busyness in this study was measured in terms of *average* patient volumes. Thus, we cannot conclude that individual nurses in hospitals with higher average patient volumes were actually busier or had to cope with more interruptions than those in EDs with lower patient volumes because it is likely that the respective hospitals staffed their EDs in relation to their average levels of busyness. In addition, triage decisions in this study were made in relation to written scenarios and were not conducted within the context of an actual working day. Thus, the nurses were not subject to true ED “busyness” while they were making their triage decisions.

Some believe that temporal ED activity and transient crowding in the triage area influences ED triage decision making and subsequent acuity assignment. In a report commissioned by the Ontario Hospital Association on ED triage practices and procedures in Ontario, the Centre for Rural and Northern Health Research (CRaNHR) at Laurentian University conducted a study on triage, use of CTAS in Ontario, and the factors affecting its use. The study included: (a) a survey of hospital EDs, and (b) an analysis of data from the National Ambulatory Care Reporting System (NACRS). It was reported that there may be some degree of purposeful “down-triaging” or “under-triaging” that is associated with ED volumes and overcrowding, particularly with level 2 (emergent) cases (Sloan et al., 2005). This is unfortunate because Level 2 is the priority level to which septic patients should be assigned (Bullard et al., 2008).

Dello-Stritto (2007) conducted a qualitative study in order to better understand the phenomenological experiences of ED triage nurses and the factors involved in their decision making. She interviewed 10 triage nurses using 12 open-ended questions and found that overcrowding and high patient volumes may influence decision making processes. However, the nature of this influence (i.e., triage score/priority level) was not identified. Fry and Burr (2001) surveyed ED triage nurses ($N = 412$) from 47 different Australia hospitals in order to describe the factors that influence the clinical decision-making of triage nurses. Participants were asked to complete a 50-item questionnaire consisting of demographic, professional, training, practice, and policy questions. Department activity (or ED busyness) was identified by 28% ($N = 111$) of the participants as an external/contextual factor that most influences triage code allocation. Again, the specific nature of this influence was not reported in the study.

ED presentation: time of day/day of the week. Specific daily ED metrics or hourly ED surges are difficult to predict. Nevertheless, transient surges in ED volumes lead to crowded triage areas. Increased numbers of emergency patients with undiagnosed and unpredictable conditions requiring triage amplify the burden of care for ED triage nurses. However, regardless of the unpredictable nature of ED patient presentation, trends in ED utilization have been identified. Studies (Canadian Institute of Health Information, 2005; Elkum, Fahim, Shoukri, & Al-Madouj, 2009; McCaig & Burt, 2004) have documented that volumes in the ED tend to be greatest during daytime hours (07:00 until 18:00) as well as during certain days of the week (Sundays, Mondays and Wednesdays) (Canadian Institute of Health Information, 2005; Elkum, Fahim, Shoukri, & Al-Madouj, 2009; Goodacre & Webster, 2005). Although these studies did not specifically address triage acuity categorization of presenting patients, this form of ED busyness may impact triage decision making and hence, it is important to consider this factor when investigating triage decision making and triage acuity assignment.

One study was found that investigated the relationship between triage acuity assignment and day/time of ED arrival. Atzema and colleagues (2010) explored the predictors associated with ED triage scores assigned to 3,088 patients with an acute myocardial infarction (AMI) from 102 acute care hospitals in Ontario. They were particularly interested in determining why a large proportion (50%) of AMI patients was assigned inappropriately low triage scores. According to CTAS guidelines, if a patient presents to an ED with classic subjective symptoms and objective signs consistent with AMI, the patent should be assigned a triage score of level 2 (emergent) or level 1 (resuscitation) (Bullard et al., 2008). In this study, the authors defined low acuity ED triage score as level 3 (urgent), level 4 (less urgent), or level 5 (non-urgent). Logistic regression modelling demonstrated that neither time of arrival nor day of the week were significant predictors of triage score for AMI patients. Given that this study is limited to a homogeneous population of AMI patients, it is not known if similar results would be found with septic patients.

Mode of arrival. A patient's mode of arrival (i.e., ambulance or ambulatory) to the ED is another contextual factor that may influence the assignment of triage acuity level. Atzema et al. (2010) reported that arrival to ED by ambulance was associated with the assignment of higher priority CTAS levels (*OR* 0.60; 95% *CI* = 0.52 - 0.70; p = <0.0001) for individuals experiencing symptoms of AMI. Similarly, Chung (2005) reported that triage decision making can be influenced by pre-hospital individuals (i.e., ambulance staff) as they corroborate subjective history and physiological markers that may influence the assigned triage category.

Richards and associates (2006) conducted a secondary analysis of the National Hospital Ambulatory Medical Care Survey from the United States in order to determine if mode of arrival to ED influences wait time. The authors examined 61,130 ED patient records and defined mode of arrival as: ambulance, public (i.e., police, social service vehicle, department of corrections), walk-in, or unknown. Wait time was determined in minutes and triage category was based on a four level system with emergent, urgent, semi-urgent, and non-urgent categories. It was found that arrival to the ED by ambulance resulted in shorter wait times across all triage categories. The authors suggested that ED triage nurses may incorrectly assign a higher level of priority to patients who arrive by ambulance, and that this may not reflect their true acuity level. It is important to note that this study did not directly address the relationship between ED mode of arrival and assignment of acuity score/triage classification. In fact, it controlled for triage classification by examining wait times within each triage level. Although this study precludes us from making conclusions about whether or not triage category differed according to mode of arrival, the results raise the possibility that some triage nurses may assume that patients transported to hospital by ambulance must be very ill, and require more timely assessment and medical intervention than those who do not arrive via ambulance. Future research is needed in this area.

Outcomes of Low Acuity Triage Assignment

Triage systems are designed with the intent of ensuring that the most acutely ill patients receive higher priority triage scores so that the time to physician assessment and subsequent treatment are established sooner. Hence, one of the most likely outcomes of low acuity triage assignment is delayed receipt of care in comparison to patients with higher acuity triage scores. However, some patients may present with conditions that appear benign at triage, when in fact they are quite serious. Assignment of low acuity triage scores to such patients could delay time-sensitive care and may lead to poorer outcomes.

In the case of sepsis, one important time-sensitive care modality is the timely receipt of antibiotics, which, as previously discussed, impacts mortality. Unfortunately, no studies were found that examined outcomes such as antibiotic administration or mortality in relation to triage classification among septic patients. However, Yurkova and Wolf (2011) conducted a correlational study in order to identify the factors that influence transfer delays from the ED to the intensive care unit (ICU). The investigators collected data from the charts of 75 ED patients and found that 58.7% ($N = 44$) of these ED patients experienced a delay in transfer. A “delay” was defined as a transfer occurring more than 4 hours after ED arrival. Delay in transfer was significantly correlated with higher ESI scores ($r = -0.339$; $p = 0.004$), such that the lower acuity triage scores (ESI 3, 4, or 5) were associated with greater delays in transfer to the ICU. Seventy six percent ($N = 19$ out of 25) of those who were delayed had an (ESI) score of 3 (i.e., lower acuity triage assignment). In this study, septic patients ($N = 11$; 25%) made up to the largest group of delayed transfers to the ICU. In light of this finding, the author recommended that further research be conducted to explain why triage acuity levels of patients with sepsis are underestimated.

Atzema et al. (2009) conducted a large retrospective cohort analysis of individuals with acute myocardial infarction (AMI) from 102 Ontario EDs. One of the main objectives of the study was to examine the relationship between acuity triage scores and delays in treatment (initial electrocardiogram/ECG and administration of fibrinolytics). Of 3,088 AMI patients, 50.3% received inappropriately low acuity triage classifications. Low acuity triage was independently associated with a 4.4 minute delay in receipt of initial ECG (95% $CI = 3.3 - 5.6$ minutes; $p < 0.001$) compared to those who were assigned a high priority triage score. Assignment of low acuity triage scores was also independently associated with an increase of 15.1 minutes in the median time to fibrinolytic administration (95% $CI = 8.1 - 22.0$ minutes; $p < 0.001$). Although the authors did not directly investigate mortality rates associated with these delays, they estimated that there would be 11 lives lost per 1,000 patients because of the observed 15 minute delay in fibrinolysis.

Other treatment delays have been linked to low acuity triage scores. Ducharme et al. (2008) conducted a multicentre prospective observational study at 20 US and Canadian EDs to examine the association between triage scoring systems and triage priority scores on time to analgesic administration. In general, patients with lower acuity triage scores regularly had longer median wait times for analgesic administration, despite reporting high pain scores at triage. Among hospitals using CTAS, patients assigned lower acuity triage levels waited a considerable amount of time to receive analgesia (CTAS level 3; median wait time 236 minutes; 95% *CI* = 163 - 284; CTAS level 4; median wait time 323 minutes; 95% *CI* = 163 - 483).

Summary of Findings

A considerable amount of research has demonstrated the benefits of time-sensitive interventions on the treatment of sepsis (Gaieski et al., 2010; Gurnani et al., 2010; Kumar et al., 2006; Nguyen et al., 2007; Rivers et al., 2001; Shapiro et al., 2006). Literature also states that the fundamental basis of all of these proven therapies remains early recognition and prompt treatment (Funk, Sebat, & Kumar, 2009; Green et al., 2008; Nguyen et al., 2006; Raghavan & Marik, 2006; Rivers, McIntyre, Morro, & Rivers, 2005). The CTAS triage system provides explicit criteria to guide triage nurses' decision making among patients suspected of having sepsis and recommends that these patients be assigned a high level of priority (Bullard et al., 2008). However, some believe that ED triage nurses do not recognize septic patients (Howell & Shapiro, 2004; Rivera, 2009; anonymous, 2007) or may in fact, under-triage this sub-group of ED users (Yurkova & Wolf, 2011), thus delaying receipt of care. Little is known about the factors that contribute to the acuity assignment of septic patients by ED triage nurses. Moreover, it is not known if triage acuity assignment is a significant determinant in receipt of care (i.e., time to antibiotics) or if there is a significant relationship between assigned triage acuity and mortality rates among septic patients. Despite a comprehensive literature search, no empirical studies have been found to addresses this void in knowledge. The following text provides a brief overview of the main findings of the literature review and highlights the major gaps in the state of knowledge pertaining to ED triage among septic patients.

Patient factors. Variables related to the patient should be the only factors that determine their assigned acuity levels. Although physiologic markers, including vital signs, are the fundamental basis from which such decisions should be made, two studies (Cooper et al., 2002; Gerdtz & Bucknall, 2001) suggest that vital signs may not play a large role in how patients are triaged. Both qualitative (Arslanian-Engoren, 2009; Cone & Murray, 2002; Edwards, 2007) and quantitative (Salk et. al., 1998) studies have reported that patient appearance also plays a role in the triage decision-making process. However, the nature of how patient appearance impacts triage acuity needs to be explicated, especially among septic patients. Although there is indirect and/or weak evidence to suggest that age (Arslanian-Engoren, 2001; Platts-Mills et al., 2010), gender (Arslanian-Engoren, 2001) and communications barriers (Hampers & McNulty, 2002) may also influence triage categorization, the body of literature in these areas is very small.

Contextual factors. Due to the scarcity of research investigating ED triage decisions in relation to contextual factors, further research is also needed in this area. Only one study (Chen et al., 2010) was found that directly assessed the relationship between ED busyness and accuracy of triage acuity score. Although no relationship was found, this study also used written scenarios rather than actual triage situations. Atzema and colleagues (2010) were the only investigators who directly examined the relationships of triage category with day, time, and mode of ED arrival in actual triage encounters. Although neither day nor time of arrival was related to triage category, arrival by ambulance was associated with higher triage acuity classification.

Outcomes associated with triage acuity classification. Only three quantitative studies (Atzema et al., 2009; Ducharme et al., 2008; Youkova & Wolf, 2011) were found that measured outcomes of triage acuity classification. Although none of these studies directly assessed outcomes in septic patients, two studies (Atzema et al., 2009; Youkova & Wolf, 2011) found that low acuity triage scores were a determinant of quality of care indicators.

Overall, there is a body of research that suggests that triage decisions are influenced by patient-related, and contextual factors; and that triage classification may subsequently impact clinical outcomes. However, this body of literature is quite small, provides inconsistent findings, and is characterized by the following additional limitations:

1. None of the studies that were reviewed were specific to the population of septic patients.
2. Few studies (Atzema et al., 2009; Atzema et al., 2010) were conducted in Canada and few (Atzema et al., 2009; Atzema et al., 2010; Goransson et al., 2006) used CTAS to establish links between the independent variable(s) and triage decisions (i.e., acuity assignment).
3. Few studies (Atzema et al., 2009; Atzema et al., 2010, Chen et al., 2010) used multivariate statistics to examine relationships between triage code allocation independent variables.
4. Few studies (Atzema et al., 2010; Edwards, 2007; MacGeorge & Nelson, 2003; Salk et al., 1998) used actual ED patient encounters to examine relationships between triage code allocation and independent variables.

Chapter III

Method

Research Design and Sample

A retrospective chart review of ED patients with a most responsible admitting medical diagnosis of sepsis was conducted to: (a) explore the independent predictors of low versus high acuity triage assignment, and (b) compare the 28-day in-hospital mortality, and time to administration of first antibiotic between those who received high versus low triage acuity scores. In this study, the term sepsis refers to patients diagnosed with sepsis, severe sepsis or septic shock. Data were collected on 155 patients who were admitted to Victoria Hospital campus via its adult ED at London Health Sciences Centre (LHSC) with these medical diagnoses. After data screening, one case was deleted because it was missing data on an outcome variable, yielding a total number of 154 cases.

Inclusion criteria. Charts of patients were included in the study if the patients were: (a) assigned a most responsible admitting medical diagnosis of sepsis, severe sepsis, or septic shock; (b) 18 years or older; (c) triaged by an ED nurse at Victoria Hospital adult ED; (d) evaluated by an emergency physician at Victoria Hospital adult ED; and (e) admitted to Victoria Hospital.

Exclusion criteria. Charts were excluded if the patient was transferred to Victoria Hospital ED from another hospital/facility directly to a receiving service or specialty (i.e., patients who were sent to the ED direct to a service or specialty with the most responsible physician not being the ED physician).

Sample size calculation. Power analysis for logistic regression requires estimations of the relative proportions of predictor variables in each level of the outcome variable. Given that estimates of these proportions are not available in relation to the outcome variables in this study, Stevens' (2002) rule of thumb of 15 cases for each predictor variable was used to estimate the sample size. Thus, a sample of 150 cases was deemed to be adequate, assuming that the final regression model would include a maximum of 10 predictor variables. A decision was decided to oversample by 5 cases to account for unforeseen unusable cases.

Setting

LHSC is a university affiliated tertiary care teaching centre in London, Ontario, Canada. LHSC had 149,482 ED visits spread over its two campuses (Victoria Hospital and University Hospital) during the 2009 to 2010 fiscal year. Data were collected from the Victoria Campus adult ED. The adult/paediatric EDs at the Victoria Hospital campus accommodate a combined annual volume of 90,000 ED visits. The adult ED at Victoria hospital has a 49 bed capacity, and has approximately 67,000 registered ED visits annually.

Protection of Human Subjects

Prior to data collection, ethical approval was obtained from the Research Ethics Boards (REBs) at the University of Windsor, the University of Western Ontario, and the Lawson Health Research Institute at London Health Sciences Centre. Given that this study did not involve any patient contact, and required only data abstraction from the patients' medical records, a waiver of patient consent was obtained. To ensure confidentiality, each patient case was assigned a study code that corresponded to the completed data collected record (Appendix C). A log linking patients' identities to their study codes was stored in a locked cabinet in the investigators office at LHSC, and was destroyed upon completion of data analysis. Completed data collection records were transcribed onto to an electronic database. The electronic data was saved in a password protected computer in the investigator's office at Victoria Hospital. Electronic data will be destroyed three years after publication of the study.

Data Collection Procedures

Following clearance from the relevant Research Ethics Boards (University of Windsor and The University of Western Ontario), the Health Records Department at Victoria Hospital was asked to identify the charts of patients from the National Ambulatory Care Reporting System (NACRS) database of all patients who were admitted to Victoria Hospital through the Victoria campus adult ED with a most responsible medical diagnosis of sepsis, severe sepsis or septic shock. The corresponding international classification of disease codes (ICD-10 CA) for these cases are: A40, A41.0 - A41.9, R65.0, and R65.1. The ICD-10 classification system is an international standard for reporting diseases and related health problems, and is endorsed by the World Health Organization. Starting on March 31, 2010, and working backward in time, all charts were reviewed until 155 charts of eligible patients were accrued.

Once the eligible cases were identified, the researcher abstracted patient and contextual data from the patients': (a) ED medical records, (b) ED triage records, and (c) medical charts pertaining to the index hospitalization. The required data pertaining to patient and contextual factors were transcribed onto corresponding data collection records (Appendix C) that were developed by the researcher. The Quality and Performance Department at LHSC provided information pertaining to ED census statistics as needed.

Variable Definitions

The following text provides conceptual and operational definitions for the variables used in this study. In terms of the triage guidelines outlined by CTAS, the most recent update

(Bullard, et al 2008) was applied to this study. Details pertaining to the 2008 CTAS guidelines and clinical examples for each category are discussed earlier in this paper and can be found in Appendix B.

Patient factors. Patient factors refer to characteristics of the patient that may influence the triage acuity designation. The specific patient factors examined for this study were: (a) vital signs, (b) presence/absence of vital signs (heart rate, temperature, respiratory rate) consistent with a SIRS response, (c) presence/absence of documentation of a focus of infection by the triage nurse, (d) appearance identified by the ED triage nurse, (e) number of co-morbidities, (f) number of prescribed medications, (g) place of residence, (h) presence of a communication barrier, (i) patient gender, (j) age, and (k) actual focus of infection as documented by the ED physician.

Vital signs at triage were defined as the assessment measures obtained by the triage nurse and included: (a) heart rate, (b) temperature, (c) respiratory rate, (d) blood pressure, and (e) oxygen saturation. Ideally, the patient's vital signs should be taken by the nurse during the initial triage encounter. However, for the sake of clinical time management, there are occasions when the triage nurse may defer this assessment component, and use the most recent set of vital signs reported by the ambulance medic. When this was the case, data for this variable were abstracted from the "ambulance vital signs" section of the ED triage note. Heart rate, temperature and respiratory rate were dichotomized according to whether or not they met the SIRS criteria (Levy et al., 2003), as these are the physiological parameters that nurses should use in their determination of triage acuity. Although the original intent was to categorize temperature into three levels (< 36°; 36.0° – 38.0°; > 38° C), only four cases had temperatures below 36°C. Thus, it was decided to collapse the higher and lower temperature categories into one, as both levels were consistent with SIRS. Because blood pressure and oxygen saturation are not components of the SIRS criteria, they were operationalized as continuous variables. However, systolic and diastolic blood pressure values were collapsed into a single continuous variable (i.e., mean arterial blood pressure [MAP]) to avoid potential multicollinearity/singularity.

Presence/absence of a SIRS response corresponds only to the indicators of the SIRS criteria that can be identified through assessment of the patient's triage vital signs. A true SIRS response is manifested by two or more of the following physiological criteria: (a) core temperature >38ºC or < 36ºC; (b) heart rate > 90 beats per minute; (c) respiratory rate > 20 breaths per minute; (d) white blood cell count > than 12, 000/mm^3 or < 4,000/ mm^3 or the presence of more than 10% immature neutrophils (Bone et al., 1997; Levy et al., 2003; Kanji, Devlin, Piekos, & Racine, 2001). Given that blood cell counts are not available at the time of triage (Bullard et al., 2008), they are not used in the CTAS guidelines as an indicator of a SIRS response. In contrast to the requirement of a minimum of two physiological criteria as indicative of a SIRS response as defined above, the current CTAS guideline requires the presence of all three physiological markers. Consistent with the CTAS guidelines, which are used in most Canadian EDs, a SIRS response was operationalized as: (a) temperature >38ºC or < 36ºC, (b) heart rate >90 beats per minute and, (c) respiratory rate >20 breaths per minute. This variable was recorded as a dichotomous (yes/no) variable, indicating whether or not the composite of the patient's vital signs (heart rate, temperature, and respiratory rate) were reflective of a SIRS response as defined in this study.

A suspected focus of infection was defined as the documented presence of symptoms/signs that may reflect evidence of a source of an infection (i.e., cough/shortness of breath would be linked to the pulmonary system; dysuria/indwelling Foley catheter would be linked to genitourinary system). Operationally, a suspected focus of infection was recorded as a dichotomous (yes/no) variable indicating whether or not such signs/symptoms were written in the triage history note. The source of the suspected focus of infection was defined in terms of body systems: pulmonary, genitourinary, gastro-intestinal, dermatological (i.e. wound), haematological (i.e. neutropenia), musculoskeletal, or other. As it was anticipated that some patients may not have an identified source of infection in the triage history note, additional data were collected on the suspected source of infection as identified by the ED physician.

An unwell appearance was defined as the presence of descriptive data derived from inspection of the patients' general appearance that was suggestive that they appeared unwell. Given the subjective nature of labelling one as having an "unwell appearance," alternative adjectives were accepted to describe a similar appearance. For example, terms such as, "looks pale," "appears in distress," "looks septic," or "appears weak," were considered equivalent to an unwell appearance. This variable was recorded as a dichotomous (yes/no) variable indicating whether or not there was documentation in the triage history note that was indicative of an unwell appearance.

Number of patient comorbidities identified at triage was defined as the number of medical conditions identified by the nurse at the time of triage. These data were abstracted from the significant medical history portion of the triage note. In certain circumstances (i.e., patient presents obtunded) the ED triage nurse may record "unknown" for significant medical history. When this was the case, a conservative approach favouring the null hypothesis was used in which "unknown" medical history was coded as no comorbidities.

Number of prescribed medications identified at triage was defined as the number of recorded medications on the triage medication history note. In the essence of time management, triage nurses may occasionally write “see list” when a patient has several prescribed medications. When this was the case, the data for this variable was abstracted from the list of medications provided by the patient, which was found on the patient’s medical chart.

Place of residence was defined as community dwelling (i.e., living independently in the community), community dwelling/social (i.e., mission, Salvation Army, or equivalent) or assisted living (i.e., long-term care or retirement home). Presence of a communication barrier was defined as impaired communication between the triage nurse and the patient, and was recorded as a dichotomous variable (yes/not noted). If a communication barrier exists, triage nurses are expected to qualify the type of communication barrier encountered at the time of triage. Hence, data were also collected on the specific type of communication barrier identified by the triage nurse: (a) confusion (i.e., acute confusion), (b) presence of a language barrier, and (c) historian status (i.e. poor, difficult, or vague [relating to chronic confusion/dementia]). Type of communication barrier was dichotomized to reflect the acuity of the barrier: (a) acute communication barrier (i.e., acute confusion), and (b) non-acute communication barrier (i.e., language barrier/chronic cognitive impairment [language barrier, dementia]. This information was abstracted from the triage history note.

Contextual factors. Contextual factors were defined as characteristics specific to the environment that may influence triage acuity assignment, including temporal ED patient census and mode of arrival to the ED. The specific contextual factors of interest for this study were: (a) time and date of ED triage, (b) day of the week the patient sought emergency care, (c) mode of arrival to the ED, (d) daily ED census, and (e) time from triage to physician first assessment. These variables were be operationalized as items on the data collection record, and were abstracted from the patients' medical records by the researcher. ED census was defined in terms of the number of registered ED patients in a 24-hour period, and was recorded as a continuous variable. Mode of arrival to the ED was defined as the method of transportation to the ED and was operationalized as: (a) self-presentation, (b) by ambulance, (c) by police, or (d) other. After data collection, it was found that all cases presented to the ED either by self-presentation or by arrival by ambulance.

Dependent variables. Triage acuity score is a categorical ranking assigned to an ED patient and refers to their level of priority/need for emergency nursing/medical care. A high acuity triage score was defined as a CTAS triage score of Level 1 (resuscitation) or Level 2 (emergent). A low acuity triage score was defined as a CTAS triage score of Level 3 (urgent), Level 4 (less urgent) or Level 5 (non-urgent). A similar strategy was used in other research (Atzema et al., 2009; Atzema 2010). Additionally, ten ED triage nurses and ten ED staff physicians in the research setting were randomly consulted in regards to the CTAS triage scores that represent a high acuity status and a low acuity status. The majority of responses from both disciplines support this direction. Lastly, the variables were dichotomized based on the understanding that current CTAS guidelines recommend that suspected septic patients be triaged at least as level 2 (high acuity). Data was abstracted from the patient's ED triage note/ED medical record and transcribed on to the data collection (Appendix C).

In-hospital mortality refers to whether or not the index patient died during the first 28 days of their sepsis-related hospital admission. Given that mortality was analyzed using time-to-event approach, the endpoint was reached if a patient died within 28 days of admission, was lost to follow-up (e.g., discharged) during these 28 days, or survived the 28-day follow up period. Patients who were lost to follow up and those who survived the entire follow up period were censored cases, while those who died were event cases. The time to first antibiotic administration, a process of care variable, was defined as the time frame between ED triage and receipt of the first antibiotic. This variable was calculated from the times that were recorded in the patients' ED records, and was transcribed on the data collection record (Appendix C) in terms of minutes.

Data Screening and Analysis Procedures

Data were analysed using the Statistical Package for the Social Sciences (SPSS) version 19.0. Data were screened for missing data, outliers, normality, and multi-collinearity, and were handled according to established guidelines (Curran, West, & Finch, 1996; Field, 2009, Munro, 2005, Tabachnick & Fidel 2007). Descriptive statistics were used to summarize the characteristics of the sample, and included frequencies of the discrete and categorical variables as well as means and standard deviations of continuous variables. A significance level of $p \leq 0.25$ was used during univariate analysis to determine which potential independent variables to include in the multivariate analysis (Hosmer & Lemshow, 2000). A two-tailed alpha of .05 was used to determine significance of multivariate statistical findings. The specific analyses that were conducted to address the research questions are described below.

Research question 1. *What are the specific patient and contextual factors that contribute to the assignment of high acuity (CTAS Level 1 or 2) or low acuity (CTAS level ≥ 3) triage scores for ED patients with a most responsible medical diagnosis of sepsis?*

Binary logistic regression analysis using a forward stepwise approach was performed to determine the independent predictors of high versus low acuity triage acuity assignment, and the odds ratio associated with each predictor. Logistic regression analysis is the test of choice to describe the relationship between a dichotomous dependent variable and multiple independent variables with different levels of measurement (Munro, 2005). Prior to the multivariate analysis, univariate statistical procedures including independent sample *t*-tests comparisons for continuous variables and chi-square comparisons for categorical variables was used to compare the crude differences between patients who were assigned high acuity (CTAS 1 or 2) versus low acuity (CTAS ≥ 3) triage scores. This preliminary assessment of the independent variables determined potentially important variables for inclusion in the multivariate logistic regression analysis. Hosmer and Lemeshow (2000) recommend that variables from the univariate analysis having a p-value ≤ 0.25 be considered for the logistic regression analysis to avoid removal of potentially significant predictors. Accordingly, the patient and contextual factors identified as having a relationship with acuity triage assignment ($p \leq 0.25$) were included in the multivariate regression analysis.

Research question 2. *Among emergency department patients with a most responsible medical diagnosis of sepsis, how do those with high versus low triage acuity scores differ with respect to 28-day in-hospital mortality?*

This question was addressed using Kaplan-Meier time-to-event analysis. The median time to event (i.e., in-hospital 28-day mortality) was incalculable because neither group reached a point during the 28-day follow-up period at which at least 50% of the cases had died. Hence, Cox-regression analysis was conducted to assess the hazard ratio of mortality among both groups.

Research question 3. *Among emergency department patients with a most responsible medical diagnosis of sepsis, what is the difference in time to first antibiotic administration between those who received high versus low triage acuity scores?*

Given that the dependent variable (time to first antibiotic administration) is a continuous variable, independent samples t-test was conducted to determine the difference in mean time to antibiotic administration among both groups.

Chapter IV

Results

Data Screening

Accuracy of input. Following initial data entry, the entire dataset was proof read for accuracy, such that each case in the dataset was compared to its corresponding data collection record. All errors were corrected and the dataset was proof read a second time for accuracy in the same manner to ensure it was free of errors.

Management of missing data. The complete dataset was screened for missingness. Overall, only six variables had missing data points (see Table 1). The extent of missingness ranged from a low of 0.65% (n = 1 missing data point) to a high of 9.7% (n = 15). One case had missing data on an outcome variable, time between triage and first antibiotic administration. This case was deleted from the data set, leaving the sample size at 154. The remaining five variables with missing data were physiologic variables that were continuous in nature. Missing values analysis was used to assess the pattern of missingness. Little's MCAR test yielded a χ^2 of 71.0 (p = .802), indicating that the pattern of missingness was not significantly different from random missingness. The missing data were then imputed via expectation maximization.

Deleted variables. One dichotomous variable (triage vital signs obtained by ED triage nurse or ambulance medic) was excluded from the analysis due to lack of variability (i.e. 96:4 split). Tabachnick and Fidell (2007) suggest that dichotomous variables with extremely uneven splits (i.e ., > 90:10) should be removed from the analysis because the category with fewer cases may be more influential than the category with a larger number of cases.

Table 1

Summary of variable missingness for the dataset

Variable	Count	% Missing	Replacement
Systolic Blood Pressure	1	<1%	Expectation maximization
Diastolic Blood Pressure	2	1.3%	Expectation maximization
Temperature	5	2.5%	Expectation maximization
Respiratory Rate	14	9.0	Expectation maximization
Oxygen Saturation (SpO2)	15	9.7	Expectation maximization
Outcome Variable			
Time from ED triage to first antibiotic	1	<1%	Case deleted

Testing of Statistical Assumptions

Outliers. The data were tested for both univariate and multivariate outliers. Univariate outliers are values pertaining to one variable that are out of range relative to the bulk of scores of the particular variable being assessed, and may distort the mean and central tendency as well as influence statistical analysis/interpretation (Munro, 2005; Tabachnick & Fidell, 2007). Given the intent to use logistic regression analysis to answer the primary research question, the data from each group (i.e. high acuity and low acuity) were assessed independently for the presence of outliers using a standardized score cut-off point of +/- 3.29 (Munro, 2005; Tabachnick & Fidell). Tables 2 (low acuity group) and 3 (high acuity group) present the standardized scores and the treatment procedures for the outlier cases in the low and high acuity groups, respectively. Among the high acuity group, two continuous variables had one data point outside the established cut-off criteria: diastolic blood pressure, and oxygen saturation (SpO2). These outliers were treated by substituting the outlier data point with the *windsorized mean*, such that the raw data point was replaced by the next to highest value in the dataset (Munro, 2005). Among the low acuity group, three variables had one data point outside the established cut-off criteria: triage time to initial physician assessment, systolic blood pressure, and diastolic blood pressure. These outliers were similarly replaced using the *windsorized mean*. The outliers for systolic and diastolic blood pressures were addressed before conversion to mean arterial pressure, which was then also assessed for outliers. None were found in either group.

Multivariate outliers. Multivariate outliers are cases among a group of variables that present an unusual blend of scores within two or more variables, and may lead to bias and statistical interpretation errors (Field, 2009; Tabachnick & Fidell, 2007). Multivariate outliers were assessed using the unstandardized residuals and with Cook's distance. None of the unstandardized residuals achieved a value greater than two, and thus, according to Cook's measure of influence, none of the predictor variables achieved values greater than one. This indicates that none of the cases are suspected of having multivariate outliers (Tabachnick & Fidell, 2007).

Multicollinearity. Multicollinearity occurs when two or more independent variables are closely related, which may cause redundant variables to be included in the logistic regression analysis and result in statistical instability (Tabachnick & Fidell, 2007). In the final model, none of the predictor variables possessed standard errors exceeding two, and the confidence intervals for each predictor variable did not have a prohibitively wide confidence index. This indicates a low index of suspicion for multicollinearity.

Normality. Continuous variables were assessed for univariate normality according to recommendations by Curran, West, and Finch (1996), who suggest that normality can be assumed when the absolute skewness is ± 2 and absolute kurtosis is ± 7. Each group (high and low acuity) was examined independently according to this criterion, and all continuous variables met the criteria proposed by Curren et al. Tables 2 and 3 present the absolute skewness and kurtosis values of all continuous variables and their associated normality assessments for the low and high acuity patients, respectively.

Sample Characteristics

Among the 154 septic patients who met the study inclusion criteria and who were retained in the dataset, 47.4 % (*n* = 73) were assigned a low acuity CTAS score (levels 3, 4 or 5) while 52.6 % (*n* = 81) were assigned a high acuity CTAS score (level 1 or level 2). Table 5 displays the characteristics of the high and low acuity groups, and the two groups combined. As depicted in the table, the mean age of the study cohort was 64.9 years (range 21 to 98) and the majority (53.9 %; *n* = 83) were male. Most of the patients presented to the ED by ambulance (77.3 %, *n* = 119), and only 37.7 % (*n* = 58) of the patients demonstrated the physiological criteria of a SIRS response (Bullard et al., 2008) at the time of ED triage. The triage nurse identified a potential focus of infection in 66.2 % (*n* = 102) of the cases, and identified almost half (48.5%, *n* = 75) of the cases as having an unwell appearance. Of the entire study cohort, 40.3% (*n* = 62) were identified as having a communication barrier. The majority 64.3 % (*n* = 99) of cases were identified as community dwelling, while the remaining cases lived in community assisted social housing (7.1%, *n* = 11) or in an assistive living environments/longer term care (28.6%; *n* = 44).

Table 2

Normality statistics for continuous variables: low acuity group

Variable	M ± SD	Skewness (+/- 2)*	Kurtosis (+/- 7)*	Normal Distribution	Outliers Z-score	Outliers Treatment
Triage to MD assessment (min)	70.9 ± 46.6	1.2	1.0	Yes	3.4	*Transformed: windsorized mean*
Patient census of the day	170.2 ± 13.7	0.3	- 0. 2	Yes	N/A	
Age	64.5 ± 18.6	- 0.5	- 0.4	Yes	N/A	
Systolic blood pressure	123 ± 27	0.5	0.6	Yes	3.5	Transformed: *windsorized mean*
Diastolic blood pressure	69 ± 14	0.0	- 0.5	Yes	3.5	Transformed: *windsorized mean*
Oxygen Saturation (SpO2)	96 ± 3	- 0.7	0.1	Yes	N/A	
Number of co-morbidities	3.3 ± 2.0	0.3	- 0.8	Yes	N/A	

Variable	M ± SD	Skewness (+/- 2)*	Kurtosis (+/- 7)*	Normal Distribution	Outliers	
					Z-score	Outliers
Number of medications	5 ± 4	0.3	- 0.9	Yes	N/A	
Mean arterial blood pressure (MAP)	87 ± 17	0.2	- 0.1	Yes	N/A	
Triage time to first antibiotics (min)	188.4 ± 95.9	0.9	1.2	Yes	N/A	

* criteria used to judge normality

Table 3

Normality statistics for continuous variables: high acuity group

Variable	M ± SD	Skewness (+/- 2*)	Kurtosis (+/- 7*)	Normal Distribution	Outliers Z-score	Outliers Treatment
Triage to MD assessment (min)	27.0 ± 21.7	1.1	1.0	Yes	N/A	
Patient census of the day	172.9 ± 14.6	0.2	0. 8	Yes	N/A	
Age	65.3 ± 17.3	- 0.4	- 0.4	Yes	N/A	
Systolic blood pressure	132 ± 32	0.6	- 0.4	Yes	N/A	
Diastolic blood pressure	66 ± 17	0.3	- 0.1	Yes	3.6	Transformed: *windorized mean*
Oxygen Saturation (SpO2)	94 ± 6	- 1.0	0.0	Yes	- 4.9	Transformed: *windorized mean*
Number of co-morbidities	3.6 ± 2.1	0.3	- 0.2	Yes	N/A	

Variable	M ± SD	Skewness (+/- 2*)	Kurtosis (+/- 7*)	Normal Distribution	Outliers Z-score	Outliers Treatment
Number of medications	6 ± 3	0.3	- 0.2	Yes	N/A	
Mean arterial blood pressure (MAP)	81 ± 20	0.3	- 0.5	Yes	N/A	
Triage time to first antibiotic (min)	124.7 ± 84.3	0.9	0.4	Yes	N/A	

* criteria used to judge normality

Preliminary Univariate Analysis

Prior to evaluating the data using binary logistic regression modeling, univariate analyses were conducted to determine potential predictors of acuity assignment. Univariate associations that achieved a significance level of $p \leq 0.25$ were included in the regression analysis, as per recommendations by Hosmer and Lemeshow (2000). As shown in Tables 4 and 5, three continuous and seven categorical variables met the criterion for inclusion.

Table 4

Student's t-test comparisons of potential predictor continuous variables by acuity level

Variable	$M \pm SD$	t	p
Age		.260	.511
Low acuity	64.5 ± 18.6		
High acuity	65.3 ± 17.3		
Patient daily census		1.79	.836
Low acuity	170.2 ± 13.7		
High acuity	172.9 ± 14.6		
Number of medications		.403	.051*
Low acuity	5.9 ± 4.3		
High acuity	6.1 ± 3.7		
Number of co-morbidities		.942	.348
Low acuity	3.3 ± 2.0		
High acuity	3.6 ± 2.1		
Oxygen Saturation (SpO2)		- 3.14	<.001*
Low acuity	96 ± 3		
High acuity	93 ± 6		
Mean Arterial Blood Pressure		1.79	.075*
Low acuity	87 ± 16		
High acuity	81 ± 20		

For all variables, N for low acuity cases = 73; N for high acuity = 81
* Indicates $p \leq .25$ and inclusion in multivariate analysis

Table 5

Chi-square comparison of acuity level with potential predictor variables

Variable	Total Sample	Acuity Level		χ^2	*p*
		High	Low		
	(*n* = 154)	(*n* = 81)	(*n* = 73)		
	N	*n* (%)	*n* (%)		
Gender				2.27	0.15*
Male	83	39 (46.9%)	44 (53.1%)		
Female	71	42 (59.2%)	29 (40.8 %)		
Mode of arrival to ED				0.25	1.00
Self	35	18 (52.4%)	17 (48.6%)		
Ambulance	119	63 (52.9%)	56 (47.1%)		
Temperature SIRS				0.02	1.00**
Not in SIRS range	60	32 (53.3%)	28 (46.7)		
In SIRS range	94	49 (52.1%)	45 (47.9%)		

Variable	N	High n (%)	Low n (%)	χ^2	*p*
Heart rate SIRS				1.72	0.24*
Not is SIRS range	35	15 (42.9%)	20 (57.1%)		
In SIRS range	119	66 (55.5%)	53 (44.5%)		
Respiratory SIRS				1.91	0.19*
Not in SIRS range	67	31 (46.3%)	36 (53.7%)		
In SIRS range	87	50 (57.5%)	37 (42.5%)		
SIRS (composite) at triage				1.35	0.32
Yes	58	34 (58.6%)	24 (41.4%)		
No	96	47 (48.9%)	49 (51.1%)		
Focus of infection identified				0.21	0.73
Yes	102	55 (53.9%)	47 (46.1%)		
No	52	26 (50.0%)	26 (50.0%)		
Unwell Appearance				9.51	< 0.01*
Yes	75	49 (65.3%)	26 (34.7%)		
Not noted	79	32 (40.5%)	47 (59.5%)		

Variable	N	High n (%)	Low n (%)	χ^2	*p*
Acute confusion				2.96	0.10*
Yes	30	20 (66.7%)	10 (33.3%)		
No	124	61 (49.2)	63 (50.8%)		
Language barrier/chronic confusion				8.13	0.01*
Yes	32	24 (75.0%)	8 (25.0%)		
No	122	57 (46.7%)	65 (53.3%)		
Place of residence				5.15	0.08*
Community	99	50 (50.5 %)	49 (49.5%)		
Assistive living	44	28 (63.6%)	16 (36.4%)		
Community/social	11	3 (27.3%)	8 (72.7%)		

*Indicates $p \leq .25$ and inclusion in multivariate analysis
** Indicates variable included into the model based on clinical/theoretical rationale (Bullard et al. 2008)

Research Questions Results

Research Question 1: *What are the specific patient and contextual factors that contribute to the assignment of high acuity (CTAS Level 1 or 2) or low acuity (CTAS level ≥ 3) triage scores for ED patients with a most responsible medical diagnosis of sepsis?*

Binary logistic regression analysis using a forward stepwise approach was conducted to determine the independent predictors of ED triage acuity assignment among patients admitted through the ED with a diagnosis of sepsis. The 10 variables with $p \leq 0.25$ in the univariate analyses (Tables 4 and 5) were included in the analysis. Although temperature did not meet this criterion, it was decided to include this variable in the logistic regression analysis due to its clinical importance with respect to the SIRS criteria and in recognition of its important role in triage acuity assignment.

The results displayed in Table 6 show that those with a language barrier/chronic cognitive impairment (*OR* 5.7; 95% *CI* 2.15, 15.01), acute confusion (*OR* 3.4; 95% *CI* 1.3, 8.2) and an unwell appearance (*OR* 3.4; 95% *CI* 1.7, 7.0) were more likely to be assigned high acuity CTAS scores. The results also suggest that patients with lower mean arterial blood pressure at ED triage (*OR* .98; 95% *CI* .96, 1.00) were more likely to be assigned a higher acuity CTAS score. More precisely, for each 1 mm Hg reduction in mean arterial pressure, the odds of getting a high acuity CTAS score increased by 2%. Overall, the four predictor variables explained between 6% (Cox & Snell R square) and 24% (Negelkerke R square) of the total variance of acuity assignment of septic patients in this sample.

The sensitivity and specificity of the model were 73% and 58% respectively, while the overall precision of the final model was 65.6%. Further, the positive and negative predictive values were identical at 65.5%, indicating reasonable predictive function of the model. Hosmer and Lemeshow goodness of fit statistic was not significant (p = .590), indicating that the model had a good fit with the data.

Table 6

Summary of final logistic regression results

Variable	*B*	*SE*	*OR*	95% *CI* Range	*p*
Language barrier/chronic cognitive impairment	1.74	0.46	6.6	2.15 – 15.01	< .001
Acute confusion	1.18	0.47	3.5	1.28 - 8.18	0.01
Unwell appearance	1.23	0.37	3.9	1.81 - 7.03	0.001
Mean arterial blood pressure	- 0.02	0.01	0.98	0.96 – 1.00	0.049

B = unstandardized coefficient; *SE* = standard error; *OR* = odds ratio; *p* = probability of accepting the null hypothesis at an alpha of 0.05.

Table 7

Classification table: final step of the analysis

		Predicted CTAS Level		Percentage Correct
		Low acuity	High acuity	
Observed CTAS Level	Low acuity	42	31	57.5
	High acuity	22	59	72.8
Overall Precision				65.6

Research Question #2: *Among emergency department patients with a most responsible medical diagnosis of sepsis how do those with high versus low triage acuity scores differ with respect to 28-day in-hospital mortality?*

Kaplan-Meier time-to-event analysis was conducted to examine the 28-day mortality among those who received high versus low acuity CTAS scores. The median time to event (i.e., in-hospital 28-day mortality) was incalculable because neither group reached a point during the 28 day follow-up period at which at least 50% of the cases had died. The results (Figure 3) indicate however, that those who were assigned a higher acuity triage score had a lower mean survival time as compared to those who were assigned low acuity scores (24.5 days [*SE* = 1.4] versus *M* = 26.5 [*SE* = 1.0] respectively; Log rank = 6.56; $p = 0.01$). Unadjusted cox regression (Figure 4) analysis was conducted to assess the hazard ratio of mortality among both groups. The results of this analysis indicate that the hazard of 28-day in-hospital mortality was 3.4 times greater (95% *CI* 1.3, 9.3; $p = 0.02$) among those with high acuity triage scores.

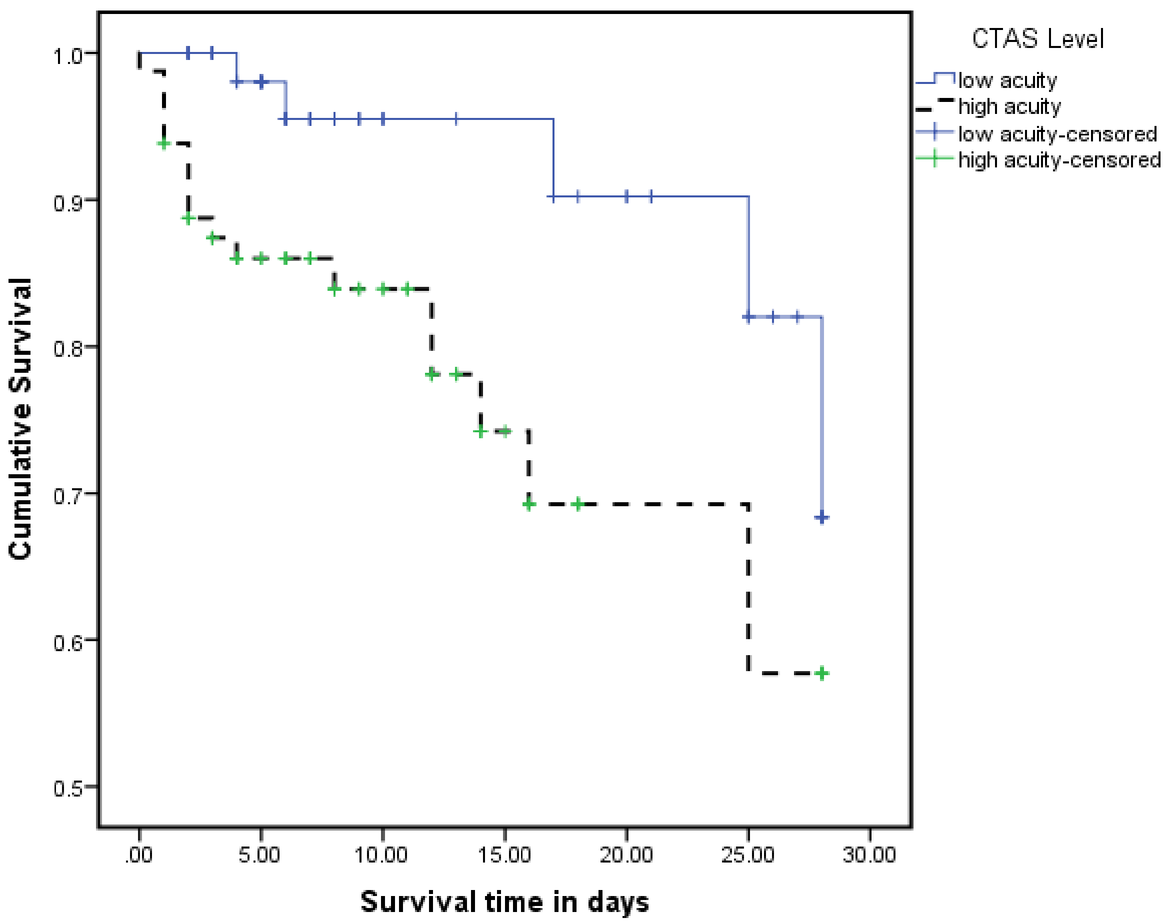

Figure 3. Kaplan-Meier curves comparing survival between the high and low acuity groups

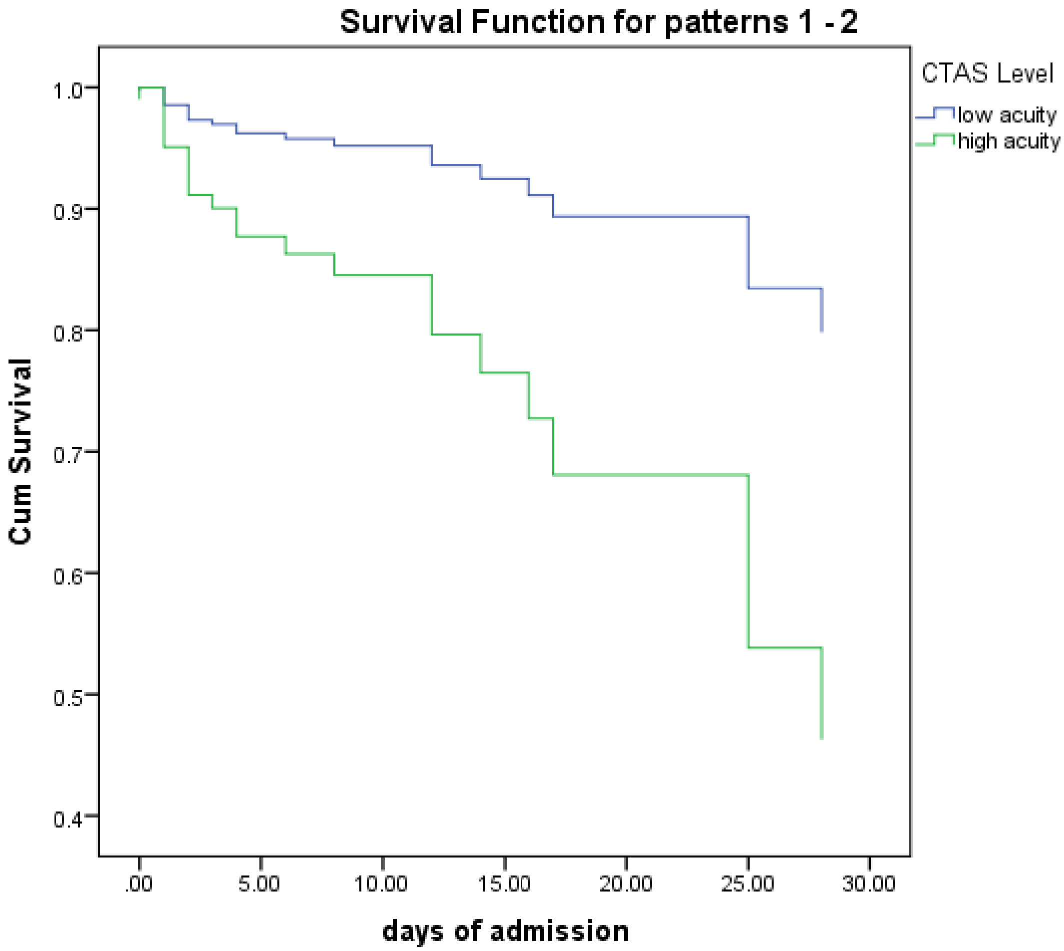

Figure 4. Cox Regression curve depicting the survival curves for the high and low acuity groups

Research Question #3: *Among emergency department patients with a most responsible medical diagnosis of sepsis, what is the difference in time to first antibiotic administration between those who received high versus low triage acuity scores?*

Student's t-test analysis was conducted to answer this question. The results displayed in Table 7 show that those who were assigned a high acuity triage score (CTAS 1 or 2) had a lower mean time to first antibiotic administration by the ED nurse than the low acuity group.

Table 8

Mean time to first antibiotic administration by acuity level: student's *t*-test comparisons

Variable	*M* ± *SD* *(minutes)*	*t*	*p*
Acuity Level		4.39	< 0.001
High acuity	125 ± 84		
Low acuity	188 ± 96		

significance = $p \leq .05$

Chapter 5

Discussion

Predictors of Acuity Assignment

Patient factors. Consistent with the CTAS guidelines (Bullard, et al., 2008), the study findings suggest that patient appearance (i.e., unwell looking) was a significant predictor of acuity assignment, such that those who were identified by the ED triage nurse as having an unwell appearance (or equivalent) were more likely to be assigned a high acuity triage score. This finding is consistent with those of two studies that concluded that visual cues (Salk et al., 1998) and clinical presentation (which likely encompassed appearance) (Garbez et al., 2011) play an important role in the ED triage process. This finding is also congruent with the results of three qualitative studies (Arslanian-Engoren, 2009; Cone & Murray, 2002; Edwards, 2007) that suggested that visual cues/general appearance is a central component in ED nurses' triage decisions.

Whether operationalized as individual variables or as a composite, the study findings demonstrate that none of the SIRS-related vital signs (i.e., heart rate > 90; respiratory rate > 20, and temperature < 36.0 or > 38.0) were predictors of acuity assignment. This finding is consistent with previous literature that investigated the role of patient vital signs on triage acuity assignment. Cooper and colleagues (2002) demonstrated that a very large proportion of triage decisions (92.1 %) were not influenced by ED triage nurses' knowledge of vital signs. In fact, knowledge of vital signs resulted in changes (mostly up-grades) in assigned acuity level in only 7.9% of cases. Gerdtz and Bucknall (2001) also concluded that ED triage nurses frequently base their acuity decisions on markers other than vital signs. Conversely, Garbez et al., (2011) found that patient vital signs were a significant factor that influenced triage acuity assignment, particularly when differentiating between high (level 2) versus low acuity (level 3) patients.

The finding that SIRS-related vital signs did not appear to play a significant role in triage acuity assignment is somewhat difficult to explain in light of the increased emphasis that the most recent CTAS update (Bullard et al., 2008) has placed on vital signs as a tool that can be used in the early recognition of adult patients with potential sepsis. Perhaps triage nurses in the sample were unaware of the clinical importance of the SIRS criteria in distinguishing patients' acuity levels. It is also possible that nurses relied more on other markers as the basis for acuity assignment (i.e., unwell appearance, communication barriers, or low blood pressure).

The findings suggested that mean arterial blood pressure was the only vital sign that was an independent predictor of triage acuity. Specifically, those with lower mean arterial blood pressures were more likely to be assigned higher acuity triage scores. Although blood pressure is not one of the SIRS criteria, it is not surprising that it was predictive of higher acuity assignment because ordinarily, those with lower than normal blood pressure for any given clinical situation should be assigned a higher acuity level by the triage nurse (Bullard et al., 2008).

CTAS guidelines stipulate that the presence of a suspected infectious process is one criterion to consider in the determination that a patient may have sepsis. In this study, focus of infection was not a predictor of acuity assignment in either the univariate or multivariate analyses. Due to the absence of other research examining the relationship between a suspected focus of infection and ED triage acuity assignment, it is not possible to explain this finding within the context of existing literature. However, possible explanations for this finding could be that the triage nurses did not adequately probe for a source of infection during the triage encounters, and/or that the source was occult in nature (i.e. osteomyelitis or endocarditis), and therefore difficult to identify during a short clinical interview.

Consistent with other findings suggesting that communication barriers complicate clinical history taking and impact clinical decision making in general (Bard et al., 2004; Hampers & McNulty, 2002), the results of this study provide evidence that communication barriers (i.e., acute confusion and language barrier/chronic confusion) impact ED triage acuity assignment among patients with sepsis. Specifically, the findings suggest that patients who presented with acute confusion were 3.5 times more likely to receive a higher acuity triage classification than those presenting without acute confusion. This finding cannot be compared with previous research, as it is believed that this study is the first to specifically address the relationship between acute confusion and CTAS classification among patients with sepsis. However, it is congruent with current CTAS guidelines, which suggest that any patient presenting to the ED with acute confusion, and a suspected infectious process should be triaged as high acuity (i.e. CTAS 2 or 1) (Bullard et al., 2008). Intuitively, this finding is also congruent with generic clinical practice. If a patient demonstrates acute confusion, their reliability as a historian is questionable. Hence, it is not surprising that triage nurses might choose to err on the side of safety (i.e., assign a higher acuity triage score), likely because of their inability to elicit sufficient clinical history to make an informed triage decision under pressured circumstances.

The findings also suggest that individuals with sepsis who presented to the ED with a communication barrier that was due to chronic confusion or a language barrier were also more likely to be assigned high acuity CTAS scores. Although no studies were found that described the relationship between chronic confusion or language barrier on triage acuity assignment, the current finding is consistent other research pertaining to clinical decision making in relation to language barriers. Hampers and McNulty (2002) found that language barriers in the ED were associated with a higher incidence of diagnostic investigations and admissions, likely due to a need for additional sources of information to fill in the gaps in information. Bard et al., (2004) reported that language and communication barriers may lead to potentially preventable intubations among trauma patients, likely because of uncertainty of clinical information during a time requiring rapid assessment and management, which is similar to ED triage. As discussed in the previous text regarding acute confusion, the inability to elicit pertinent clinical information at the time of triage may explain the higher acuity triage classification, as it impairs the triage nurses' ability make an informed triage decision.

Patient gender was not a significant factor in triage acuity assignment. This result is reassuring because ideally, one's gender should not influence medical priority, regardless of presenting complaint. Although other studies (Arslanian-Engoren, 2001; Atzema et al., 2010) have reported that gender does influence ED triage acuity assignment, both of these studies sampled cardiac patients, a population in which women are more likely to present with atypical symptoms of heart attack (Dey et al., 2009; Milner, Vaccarino, Arnold, Funk, & Goldberg, 2004). Sepsis symptomatology is more gender neutral, suggesting that gender should not play a role in triage classification, as was the case in this study.

The study findings suggest that age, number of medications, and number of co-morbidities were not significant factors in triage acuity assignment. Although it was anticipated that older patients, and those with a higher number of co-morbidities and prescription medications would be assigned a higher acuity triage score because of their complexity and vulnerability, this was not the case. Despite the absence of research examining how these factors relate to triage acuity assignment among potentially septic patients in particular, the findings are consistent with the tendency of ED triage nurses to under-triage geriatric patients (Grossmann et al., 2012; Platts-Mills et al., 2010) in general.

Contextual factors. Not surprisingly, the findings suggest that daily ED census was not a significant predictor of acuity assignment among patients with sepsis. Similar results were reported by Chen et al. (2010), and Richardson (1998), who also measured ED busyness using daily ED volumes. Although these studies used a heterogeneous sample as opposed to a homogeneous sample of septic patients, it is encouraging that daily ED volumes were not related to triage acuity assignment. The research findings conflict with a report to the Ontario Hospital Association (Slone et al. 2005), which suggested that transient crowding in the ED triage area may influence acuity assignment, such that ED triage nurses may under-triage patients when the triage environment is busy or overcrowded.

Given the retrospective design of this study, daily ED census was used as a proxy measure for overall ED *busyness,* as it was hoped that a higher daily ED census (i.e., crowding) would represent overall busyness within the ED, including the busyness of the ED triage nurse. Unfortunately, this static proxy measure of busyness was unable to capture the moment-to-moment changes that are characteristic of EDs. Hence, the absence of a relationship between ED busyness and triage classification in this and other studies using similar measures of busyness, may not accurately represent the true nature of the relationship. Thus, further study is needed in this area.

Although it is known that clinical severity is a predictor of ambulance use (Rucker et al., 1997; Ruger, Richter, & Lewis, 2006), the results of this study suggest that mode of arrival to the ED (i.e., ambulance versus self-presentation) was not a significant factor in triage acuity assignment. This finding was somewhat surprising and is inconsistent with that of other research (Atzema et al., 2010) demonstrating that arrival to the ED by ambulance was associated with higher priority CTAS scores among patients with symptoms of AMI. The difference in findings between these two studies may be related to the difference in populations that were studied. For example, patients with chest pain who present to the ED via ambulance would ordinarily have a pre-hospital 12-lead ECG. This would likely inform the triage acuity assignment, especially if ischemic changes were evident. Lastly, in a qualitative study, Chung (2005) reported that arrival to the ED by ambulance may be associated with higher acuity triage category assignment because it allows for clinical history taking and physiological assessment prior to arrival to the ED.

Outcomes Associated with Acuity Assignment

Septic patients who were assigned high acuity CTAS scores (i.e., CTAS 1 or 2) were at a higher risk of mortality than their lower acuity (≥ CTAS 3) counterparts. Specifically, the results indicate that the risk of 28-day in-hospital mortality was 3.4 times greater among those who were assigned high acuity CTAS scores. In general, this finding is comparable to other research (Dong et al., 2007; Wuerz, 2001) which suggests that patients who were assigned a high acuity CTAS score were the most sick and were therefore more likely to die than those assigned a lower score. Hence, the finding of the current study is somewhat reassuring, and suggests that the ED triage nurses were generally able to identify the sickest patients. This finding should be interpreted with caution, as the analysis did not adjust for potential confounding variables.

Patients with sepsis who were assigned a high acuity CTAS score received their first antibiotic sooner than their lower acuity counterparts. This finding is not surprising given that high acuity patients generally have a shorter time to initial physician assessment (as was found in this study), and may be prescribed empirical antibiotic coverage based on this initial assessment. In light of current evidence (Dellinger et al., 2004; Francis, Rick, Williamson & Peterson, 2010; Green et al., 2008) that identifies timely antibiotic administration as a cornerstone of optimal ED sepsis management, these results are reassuring, as they imply that that the sickest patients (i.e., those with higher CTAS scores) are those who receive antibiotics earlier.

Although the findings of the study demonstrate that high acuity patients received earlier antibiotic administration overall, the average time from triage to first antibiotic administration in the high (M = 125 minutes) and low (M = 188 minutes) acuity groups was concerning. Although benchmarks for the administration of first antibiotic among septic patients could not be found, key recommendations from international (Dellinger et al., 2008) and Canadian (Green et al. (2008) guidelines suggest that antibiotics should be administered within the first 60 minutes of identification of sepsis. Given that every hour of delay in antibiotic administration increases the rate of mortality (Gaieski et al., 2010; Kumar et al., 2006), further research on this issue is warranted.

Implications and Recommendations

ED nurses in the research setting tended to assign high acuity triage scores to patients with sepsis who had communication barriers and/or who appeared to be unwell, while vital signs played a limited role the determination of acuity. The following text provides a discussion of the implications of the research findings in the areas of clinical practice, education, theory, and future research.

Practice and Education

ED triage decision making is a complex process that is interconnected with critical thinking and clinical experience (Gerdtz & Bucknall, 2001; Smith & Cone, 2010), the use of patient visual cues (Edwards, 2007), and intuition (Cioffi, 1998; Petal, Gutnik, Karlin & Pusci, 2008). In this study, ED triage nurses assigned a high acuity triage score during times of uncertainty, specifically when encountering communication barriers. This is congruent with general ED nurse triage pearls suggesting that "when in doubt, triage up." It is recommended that ED clinical educators, triage peer mentors, and ED physicians encourage triage nurses to assign the highest and most reasonable CTAS score to a patient when there is uncertainty about the reliability of the clinical history that is provided. This practice will only improve patient safety and the delivery of quality care. Future research on this subject matter should consider a prospective methodological design to further evaluate this particular phenomenon.

The use of visual cues, specifically an unwell appearance, was a significant predictor of high acuity assignment. Although this study was not able to determine if nursing factors such as experience or expertise influenced the interpretation of an unwell appearance, other research has determined that visual cues (Edwards, 2007), and intuition (Cioffi, 1998; Petal, Gutnik, Karlin & Pusci, 2008) inform triage decision making (i.e., acuity assignment). Hence, much like with communication barriers and uncertainty, it is imperative that ED educators and seasoned ED triage nurses encourage triage nurses to consider the patients' general appearance when assigning an acuity score, as this will likely elevate overall triage nurse decision making accuracy and confidence, especially among patients with sepsis. Unfortunately, these aspects of triage decision making are not well identified within CTAS guidelines, and research on this topic is limited. Hence, future nursing research on ED triage decision making should prospectively evaluate the relationship between the triage nurses' interpretation of visual cues (i.e., appraisal of an unwell appearance) and acuity assignment.

Whether operationalized as individual variables or as a composite, SIRS-related vital signs did not play a significant role in acuity assignment. Although this study did not examine triage nurses' knowledge of the indicators of a SIRS response nor its clinical implications in regards to sepsis, it is likely that triage nurses many not have been aware of the indicators of a SIRS response, as there was limited emphasis placed on the importance of timely recognition of sepsis during the study interval. In light of this finding, improved education on how to identify potentially septic patients during orientation of ED triage nurses and/or during formal in-service education, may facilitate more appropriate use of SIRS related vital signs during patient triage. In addition, placement of physical resources (e.g., posters) at triage stations may cue triage nurses to screen for the components of a positive SIRS response in relation to suspected sepsis. An additional strategy could include periodic triage audits by ED clinical educators or nurse champions, who could follow-up with individual nurses who may not have accurately triaged septic patients due to failure to incorporate or interpret SIRS related vital signs as a potential indicator of sepsis.

An additional strategy with potential to facilitate early identification of septic patients could be to educate pre-hospital care provides (i.e., paramedics) about the indicators of a SIRS response and its relevance to sepsis. While research (Seymour et al., 2012; Wang, Weaver, Shapiro, and Yealy, 2010) has shown that some advanced level paramedics have a general awareness about the relationship between a positive SIRS response and sepsis, there may be opportunities to develop and increase knowledge capacity among all paramedic staff. Hence, it is recommended that paramedics receive education about the clinical significance of a SIRS response in relation to sepsis. Paramedics often report clinical findings during telephone communication with ED triage nurses, or during their formal clinical hand-over. If paramedics routinely screened pre-hospital vital signs for a SIRS response, and reported a positive finding to triage nurses, it may help with the early identification of potentially septic patients, and subsequent triage score assignment (i.e., high acuity).

Finally, the finding that a large proportion of patients with sepsis received lower acuity triage scores (47.4%; n = 73) might be related to a problem with the CTAS guidelines. Although the CTAS guidelines emphasize the importance of early identification of potentially septic patients (Bullard et al, 2008) the criteria for high acuity assignment (i.e., CTAS level 2 or level 1) may be too restrictive, such that it guides nurses to classify some septic patients as low acuity. Given that all patients in the sample were eventually diagnosed with sepsis, it would have been preferable that all had received a high acuity CTAS score. Yet, only 38% (n = 58) actually met the CTAS criteria for a positive SIRS response (i.e., heart rate > 90; respiratory rate > 20, and temperature < 36.0 or > 38.0). In recent years, several institutions have developed their own screening tools, informed by recommendations put forth by the International Surviving Sepsis Campaign (Dellinger et al., 2008). The aim of this campaign is to reduce mortality from sepsis by improving its recognition, diagnosis, and management. Several such tools (Francis, Rick, Williamson & Peterson, 2010; Shapiro et al, 2006; Sweet et al., 2010) utilize only two SIRS criteria (as opposed to three criteria proposed by CTAS guidelines) plus a focus of infection as the basis for identification of potential sepsis at triage, and thus for assigning high acuity scores. Triage sepsis screening tools that use two SIRS criteria to evaluate for sepsis are more consistent with established definition of the SIRS criteria (Bone et al., 1997; Levy et al., 2003; Kanji, Devlin, Piekos, & Racine, 2001). Use of such tools should increase the likelihood that patients with potential sepsis would be appropriately triaged as high acuity.

Given the current evidence (Gaieski et al., 2010; Kumar et al., 2006), the results of this study indicate that there is a need to improve the overall time to receipt of first antibiotic administration. It is recommended that ED nurses and physicians share this burden of care. Although the prescription of antibiotics is a physician responsibility, ED nurses should collaborate with physician colleagues and discuss their clinical suspicions of sepsis, and the necessity of early empirical antibiotic coverage. Such dialogue may facilitate earlier prescription and administration of antibiotics, which would improve the provision of care for septic patients. Equally important is the dialogue between the triage nurse and the primary ED nurse during the transfer of care. Triage nurses who have a high index of suspicion of sepsis should report this to the receiving nurse. This flow of information will likely be transmitted to the ED physician, and serve as a cue for timely prescription and administration of antibiotics. Delays in antibiotic administration also places additional merit in adopting an ED specific sepsis protocol, as research (Francis et al., 2010; Tipler et al., 2012) has found that sepsis protocols improve time to administration of first antibiotic. Hence, organizations should consider adopting such a protocol to improve the overall internal efficiency of how emergency department care staff identify and manage septic patients, including during the initial ED triage encounter. Such process improvements will likely enhance time to delivery of first antibiotic and increase the overall value of healthcare services delivered in the ED.

Theory and Research

Although the conceptual model used in this study has intuitive appeal from a clinical perspective, the study findings provide only partial support for this model. That is, only three patient factors were predictive of high acuity assignment in patients with sepsis, while none of the environmental factors examined were related to acuity assignment. Since nursing factors were not examined, conclusions cannot be drawn about how they impact triage acuity assignment. Ideally, only patient factors should influence triage acuity assignment. The findings that the SIRS related vital signs and other salient patient related variables were not predictive of acuity assignment does not necessarily point to a problem with the conceptual model, but may instead reflect a problem with nursing practice that needs to be addressed from a practice/educational perspective. Absence of support for a relationship between environmental factors (i.e., busyness) and triage assignment might be a reflection of reality, and thus, an indicator that the conceptual model may not accurately reflective the reality of a dynamic emergency department. Or, this may also be an issue with the retrospective design of this study, which made it impossible to get an accurate representation of the environmental factors that were at play during the specific triage encounters that were examined in the study. Further testing of this model using a stronger (i.e., prospective) research design is needed to provide additional insight into the utility of this conceptual model, and to further substantiate the factors involved in triage decisions.

It is believed that this is the first study to investigate the factors related to triage nurse acuity assignment among patients with sepsis. Although the findings of this study are important, and have significant implications for ED nursing practice, it is recommended that this study be replicated in other sites (i.e., rural, community, and large academic EDs) for verification of its findings, and to facilitate generalization. Future research on triage nurse decision making should consider the effect of triage nurse factors on acuity assignment using a prospective design. Including nurse related variables such as level of ED experience, level of education, years of triage experience, and knowledge of the indicators if SIRS and sepsis will likely provide additional insight into the factors that are involved in the complex process of triage decision making. Use of a prospective design would also allow the inclusion of real-time markers of ED busyness (i.e., interruptions, wait times, bed shortages, or patient surges/congestion at the triage station) as well as qualitative examination of nurse triage decision making (i.e., fatigue, peer pressure, or general stress level), which could provide a richer understanding nurses' thought processes during individual triage encounters.

Preliminary work (Francis, Rick, Williamson & Peterson, 2010; Sweet et al., 2010) has demonstrated the effectiveness of ED sepsis protocols on time to first antibiotic administration. With the growing emphasis of sepsis protocols in Canadian EDs, it is recommended that future studies examine the impact of these tools on nursing practice, specifically on triage nurses' recognition of septic patients and the accuracy of acuity assignment. Measuring triage nurse awareness and use of SIRS related vital signs during acuity assignment before and after a sepsis education intervention would be one strategy to determine the effectiveness of an ED sepsis protocol in regards to nursing care.

Limitations

While the findings of this study contribute new knowledge regarding triage acuity assignment among patients with sepsis, this study is not without limitations. The study did not account for the effect of triage nurse factors on acuity assignment. Collecting data on triage nurse variables (i.e., level of experience, level of education, and triage expertise), and matching the triage nurse with the index patient would have provided a richer description of the factors that influence triage acuity assignment among patients with sepsis, and may further support the use of the conceptual model in this study. Although the original intent was to include triage nurse factors in this study, one of the REBs that reviewed this study raised concern that the primary investigator was a colleague of the ED nurses who would be surveyed, and would have access to nurses personal information. Hence, it was decided not to evaluate the effect of nursing factors on triage acuity assignment.

Although it appears that there were minimal missing data, the inherent difficulties associated with retrospective data collection must be acknowledged. For example, there is a possibility that documentation in the triage records and nursing progress notes may have been inconsistent (i.e., omitting reference to general appearance, or a focus of infection). The design of this study also precluded qualitative examination of the acuity assignment decision making processes. Perhaps future research using a mixed-methods design could provide further insight into triage acuity assignment among septic patients using the same factors of influence (i.e., nurse, patient, and contextual).

It is possible that daily ED census may not have been the most appropriate measure of ED busyness, given the dynamic nature of an ED. Or possibly, the *a priori* threshold of 170 patients per day may not be appropriate cut-off point for defining ED busyness. Additionally, this was an exploratory study that had sufficient power for the variables that were significant. However, it is possible that some of the non-significant findings could have been the result of lack of power. Unfortunately, it is very difficult to ascertain the power for each of the study predictors given the exploratory nature of the study and the lack of literature concerning the true effect size of many of these potential predictors. For this reason, it is recommended that future research on this topic use a larger sample size. Lastly, this was a single centre study. Although the study setting was at large academic teaching centre with high patient volumes, the results may not be generalizable and must be interpreted accordingly.

Conclusions

It is believed that this is the first study to evaluate the predictors of triage acuity assignment among patients with sepsis. The results of this exploratory study indicate that patient factors, specifically, communication barriers, acute confusion, an unwell appearance, and hypotension were independent predictors of high acuity assignment among septic patients. Surprisingly, the physiological indicators that should be used in the identification of sepsis (i.e. SIRS response) did not appear to have a role in triage acuity assignment. Research findings also suggest that septic patients who were assigned high acuity CTAS scores tended to have shorter times to first antibiotic administration, and a higher 28-day in-hospital mortality. Although these preliminary findings have merit, and may be useful to triage nurses and clinical educators who educate ED triage nurses about the principles of ED triage among patients with suspected sepsis, further prospective exploration is necessary to verify the findings of this study.

Appendix A

Sepsis Cases: LHSC Health Records April 1, 2009 to March 31, 2010

UH & VH cases

CTAS Score

Visit Disposition	1 - Resuscitation	2 - Emergent	3 - Urgent	4 - Less Urgent	Total
Admitted as inpatient	8	90	91	6	195
Admitted to SCU	7	31	11	3	52
Total	15	121	102	9	247

VH Site Only

CTAS Score

Visit Disposition	1 - Resuscitation	2 - Emergent	3 - Urgent	4 - Less Urgent	Total
Admitted as inpatient	6	44	48	3	101
Admitted to SCU	4	20	10	2	36
Total	10	64	58	5	137

Data Source: Cases taken from the National Ambulatory Care Reporting System (NACRS) Database that were submitted to the Canadian Institute of Health Information (CIHI) from submitted periods April 2009 to March 2010.

Appendix B

The Canadian Triage and Acuity Scale*

Triage Category: CTAS score	Definition	Ideal wait time to be seen/reassessed (minutes)	Clinical example
1	Resuscitation	Immediate/ongoing	Threat to life or limb i.e. cardiac arrest, major trauma, presenting fetal parts
2	Emergent	15 minutes	Conditions that potentially threat life or limb i.e. sepsis, chest pain with cardiac features, clear plan of suicide
3	Urgent	30 minutes	Conditions that may progress to serious problem i.e. acute central pain 4-7/10, mild respiratory distress, uncontrolled bloody diarrhea
4	Less urgent	60 minutes	Conditions that need intervention within one or two hours i.e. tight cast, laceration, upper extremity injury
5	Non-urgent	120 minutes	Conditions that may be part of a chronic problem i.e. medication request, minor bite, simple laceration

**Adapted from: Updated Participants Manual. Canadian Association of Emergency Physicians (2009).*

Appendix C

Data Collection Record: Contextual and Patient Factors

Patient Code: ________________
Patient category: CTAS 1 or 2 ______ CTAS 3, 4 or 5 _________
Contextual Factors

1. Time of ED triage:
2. Date of ED triage:
3. Day of the week: Mon Tue Wed Thr Fri Sat Sun
4. Mode of arrival to ED: self police ambulance other
5. Time from triage to physician first assessment:
6. Patient census for the day:
7. Number of admissions in the ED for the shift (0700) and (1900):

Patient Factors:
Age:________ Gender: M_____ F_____

1. Recorded triage vital signs obtained by: ED triage Ambulance
2. Vital signs

   BP________ Not obtained _________

   Temp________ Not obtained _________

   HR________ Not obtained _________

   RR________ Not obtained _________

   SpO2 ________ Not obtained _________

3. Presence of a SIRS response per triage indicators: Yes_____ No______
4. Nurse triage note includes evidence of a focus of infection Yes ______ No_______

If yes, specific symptom→

<u>Actual Source of infection (per medical diagnosis):</u> pulmonary genitourinary gastro-intestinal wound/dermatological, Haematological (i.e. neutropenia) musculoskeletal other (i.e. recent post-op) unknown

5. Identified appearance of patient by triage nurse as unwell → Yes _____ Not noted______

   <u>If yes, specific documented appearance:</u>

6. Number of patient comorbidities identified at triage: ___________

7. Number of prescribed medications identified at triage: __________

8. Place of residence: Community dwelling Assistive Living Incarcerated

9. Presence of a communication barrier: Yes_____ Not noted ______

   If yes, specific barrier document: confusion language barrier historian status

Patient Outcome:

1. 28-day in-hospital mortality: Yes No Date of death

2. If yes, death occurred ______________ days after admission

3. If not, patient discharged ___________ days after admission

Process of Care:

1. Date and Time of first antibiotic administration: _______________

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