

**FACTORS ASSOCIATED WITH PHYSIOLOGICAL RESPONSES  
OF MAJOR TRAUMA PATIENTS FOLLOWING  
MANAGEMENT OF LIFE THREATENING CONDITIONS**

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**FACTORS ASSOCIATED WITH PHYSIOLOGICAL RESPONSES OF MAJOR TRAUMA PATIENTS FOLLOWING MANAGEMENT OF LIFE THREATENING CONDITIONS**

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(HIGHER EDUCATION), TIPA TOSKULKAO, Ph.D. (NEUROSCIENCE),  
RAYWAT CHUNHASUWANKUL, M.D.**ABSTRACT**

This study was a descriptive research design aimed at examining the correlation between time for management of life threatening conditions, age, co-morbidities, severity of injury, management of life threatening conditions, and the physiological responses of major trauma patients following management of life threatening conditions. Eighty-three major trauma patients who received trauma resuscitation from the Outpatient Trauma Unit, Siriraj hospital participated in the study. Data were collected by record form and analyzed by descriptive statistics and Spearman Rank-Order Correlation Coefficient.

The results revealed that there were no correlations between time for management of life threatening conditions, age, co-morbidities, severity of injury, management of life threatening conditions, and the physiological responses of major trauma patients following management of life threatening conditions. Age had a positive correlation with co-morbidities ( $\rho = .322, p < .01$ ) and a negative correlation with the severity of injury ( $\rho = -.264, p < .05$ ). Moreover, the time for management of life threatening conditions had a negative correlation with the severity of injury ( $\rho = -.418, p < .01$ ) and a negative correlation with the management of life threatening conditions ( $\rho = -.315, p < .01$ ).

The study demonstrated that there were no correlations between the 5 variables and outcomes. Some of the limitations of the study should be considered before implicating the findings of this research. The possible limitations of the research could be the lack of individuals who were over forty-five years old, not enough co-morbidities, most patients were less severely injured, research instruments had low reliability value, physiological responses which measured by assess SpO<sub>2</sub>, SPB, and blood lactate level had limited interpretation because the blood lactate level changed more slowly than SpO<sub>2</sub> and SBP.

**KEY WORDS: MAJOR TRAUMA PATIENTS / LIFE THREATENING CONDITIONS /  
PHYSIOLOGICAL RESPONSES**

119 pages

ปัจจัยที่สัมพันธ์กับการตอบสนองของร่างกายผู้ป่วยอุบัติเหตุที่ได้รับบาดเจ็บรุนแรงภายหลังการจัดการภาวะคุกคามชีวิต

FACTORS ASSOCIATED WITH PHYSIOLOGICAL RESPONSES OF MAJOR TRAUMA PATIENTS FOLLOWING MANAGEMENT OF LIFE THREATENING CONDITIONS

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คณะกรรมการที่ปรึกษาวิทยานิพนธ์: กรองไฉ่ อุดมหยุด, กศ.ค., ทิพา ต่อสกุลแก้ว, ประ.ค., เรวัต ชุณหะวัณรณกุล, ว.ว. ศัลยศาสตร์

#### บทคัดย่อ

การศึกษาครั้งนี้เป็นการศึกษาเชิงบรรยายเพื่อศึกษาความสัมพันธ์ระหว่าง เวลาในการจัดการภาวะคุกคามชีวิต อายุ โรคร่วม ความรุนแรงของการบาดเจ็บ การจัดการภาวะคุกคามชีวิตกับการตอบสนองของร่างกายผู้ป่วยอุบัติเหตุ ที่ได้รับบาดเจ็บรุนแรงภายหลังการจัดการภาวะคุกคามชีวิต กลุ่มตัวอย่างที่ศึกษาในครั้งนี้คือ ผู้ป่วยที่ได้รับบาดเจ็บรุนแรงที่เข้ารับการรักษาในหน่วยตรวจโรคอุบัติเหตุ โรงพยาบาลศิริราช จำนวน 83 ราย เก็บรวบรวมข้อมูลโดยใช้แบบบันทึก วิเคราะห์ข้อมูลทั่วไปใช้สถิติเชิงบรรยาย และวิเคราะห์ความสัมพันธ์ระหว่างตัวแปรที่ศึกษาโดยใช้สัมประสิทธิ์สหสัมพันธ์สเปียร์แมน (Spearman Rank-Order Correlation Coefficient)

ผลการศึกษาพบว่า เวลาในการจัดการภาวะคุกคามชีวิต อายุ โรคร่วม ความรุนแรงของการบาดเจ็บ และการจัดการภาวะคุกคามชีวิต ไม่มีความสัมพันธ์กับการตอบสนองของร่างกายผู้ป่วยอุบัติเหตุที่ได้รับบาดเจ็บรุนแรงภายหลังการจัดการภาวะคุกคามชีวิต แต่พบว่าอายุมีความสัมพันธ์ทางบวกกับโรคร่วม ( $p = .322, p < .01$ ) และมีความสัมพันธ์ทางลบกับความรุนแรงของการบาดเจ็บ ( $p = -.264, p < .05$ ) นอกจากนี้ยังพบว่า เวลาในการจัดการภาวะคุกคามชีวิตมีความสัมพันธ์ทางลบกับความรุนแรงของการบาดเจ็บ ( $p = -.418, p < .01$ ) และยังมีความสัมพันธ์ทางลบกับการจัดการภาวะคุกคามชีวิต ( $p = -.315, p < .01$ )

จากผลการศึกษา การนำผลการวิจัยไปประยุกต์ใช้ควรพิจารณาถึงข้อจำกัดของการวิจัยที่อาจทำให้ตัวแปรที่ศึกษาไม่มีความสัมพันธ์กัน ได้แก่ ผู้ป่วยที่มีอายุมากกว่า 45 ปี มีจำนวนน้อย ส่งผลให้จำนวนโรคร่วมมีข้อมูลน้อยเช่นกัน ผู้ป่วยส่วนใหญ่มีการบาดเจ็บที่ไม่รุนแรง เครื่องมือที่ใช้ประเมินการจัดการภาวะคุกคามชีวิตมีค่าความเชื่อมั่นค่อนข้างต่ำ และการแปลผลการตอบสนองของร่างกายซึ่งประเมินจากค่าความอิ่มตัวของออกซิเจนในเลือด ความดันซิสโตลิก และระดับแลคเตทในเลือด อาจไม่เหมาะสมเนื่องจากระดับแลคเตทในเลือดมีการเปลี่ยนแปลงช้ากว่าค่าความอิ่มตัวของออกซิเจนในเลือด และความดันซิสโตลิก

## CONTENTS

	<b>Page</b>
<b>ACKNOWLEDGEMENTS</b>	<b>iii</b>
<b>ABSTRACT (ENGLISH)</b>	<b>iv</b>
<b>ABSTRACT (THAI)</b>	<b>v</b>
<b>LIST OF TABLES</b>	<b>viii</b>
<b>LIST OF FIGURES</b>	<b>ix</b>
<b>CHAPTER I INTRODUCTION</b>	<b>1</b>
Background and significance of study	1
Research question	6
Research objective	6
Research hypothesis	7
Conceptual framework	7
Scope of the study	9
Definition of terms	10
Expected outcome and benefits	11
<b>CHAPTER II LITERATURE REVIEW</b>	<b>12</b>
1. Major trauma patients	13
1.1 Characteristics of major trauma patients	13
1.2 Life threatening conditions in major trauma patients	13
2. Physiological responses of major trauma patients following management of life threatening conditions	19
3. Factors associated with physiological responses of major trauma patients following management of life threatening conditions	24
3.1 Time for management of life threatening conditions	25

**CONTENTS (cont.)**

	<b>Page</b>
3.2 Age	27
3.3 Co-morbidities	30
3.4 Severity of injury	32
3.5 Management of life threatening conditions	33
4. Conclusion	40
<b>CHAPTER III</b>	
<b>METHODOLOGY</b>	<b>42</b>
Population and sampling	42
Setting	43
Research instruments	43
Measurement of instrument qualifications	47
Protection of human subjects	48
Data collection	49
Data analysis	50
<b>CHAPTER IV</b>	
<b>RESULTS</b>	<b>51</b>
<b>CHAPTER V</b>	
<b>DISCUSSION</b>	<b>59</b>
<b>CHAPTER VI</b>	
<b>CONCLUSION</b>	<b>70</b>
<b>REFERENCES</b>	<b>73</b>
<b>APPENDICES</b>	<b>89</b>
<b>BIOGRAPHY</b>	<b>119</b>

## LIST OF TABLES

<b>Table</b>		<b>Page</b>
1	CRAMS scale	44
2	Revised Trauma Score	45
3	The demographic data of major trauma patients	52
4	Factors associated with physiological responses of major trauma patients following management of life threatening conditions	55
5	The physiological responses following management of life threatening conditions	57
6	The Spearman Rank-Order Correlation Coefficient of each variable	58

## LIST OF FIGURES

<b>Figure</b>		<b>Page</b>
1	Conceptual framework of the research study	9

## **CHAPTER I**

### **INTRODUCTION**

#### **Background and Significance of the Study**

Major trauma patients often die from severe injuries to vital organs in the circulatory, respiratory and central nervous systems (Attanawanich, 1999; Thomthitchong & Hawanont, 2001; VonRueden & Hartsock, 2002). The causes of severe injuries are transport accidents, intentional self-harm, assault, falls, electric current, heat and hot substances, fire and animate or inanimate mechanical forces (Ministry of Public Health, 2007). These injuries harm the body by destroying and diminishing the function of organs, tissues and cells, thus leading to life threatening conditions by reducing blood oxygenation and decreasing tissue perfusion which produces tissue hypoxia (Greaves, Porter, & Ryan, 2001; Jin, Shao, He, & Yao, 2006; Søreide & Steen, 2000).

Life threatening conditions in major trauma patients occur when injuries impede the flow of oxygen to vital bodily organs, such as the brain, heart, lungs and other organs which further leads to inadequate tissue perfusion. In such cases, inappropriate treatment ultimately results in catastrophic morbidity or death (Tanadsiladham, 2001) because of the failure of compensatory mechanism to deliver oxygen and blood to cells, tissues and organs. As a result all of them suffer despite the body's attempts at maintaining tissue perfusion by stimulating the neuroendocrine, immune and metabolic systems (Edwards, 2005a; Guyton & Hall, 2006). These are complex pathophysiological reactions reflective of the body's innate ability to compensate the reduction of oxygen to the tissues. The result of inadequate tissue perfusion is cell dysfunction followed by cell lysis and cell death leading to multi-organ dysfunction ultimately causing death to major trauma patients (Cottingham, 2006; Kelley, 2005; Wattanasirichaigoon, 2002).

In most cases, the death of major trauma patients with life threatening conditions are associated with blood loss and injuries of multiple organs resulting in

anatomic and physiological damage. This combination compounds the impairment of oxygen delivered to the tissues caused by obstructed airway, hypoventilation, ineffective gas exchange and loss of intravascular volume. Blunt trauma is often more life threatening than penetrating trauma because it is caused by a combination of forces resulting from multiple injuries (Unhasuta, 2006a; Weigelt & Klein, 2002). The extent of injuries from blunt trauma involves indistinct symptoms and the process of diagnosis is difficult leading to delayed treatment. Furthermore, these symptoms can even be cause of death due to progressive deterioration of patients' condition. This particular cause of death is regarded as '*preventable death*' (Greaves et al., 2001; Gruen, Jurkovich, McIntyre, Foy, & Maier, 2006; Kongsamuth, 2001; Parks, 2004; Tanadsiladham, 2001).

Preventable death in major trauma patients is usually caused by medical errors, such as the delay in diagnosis and treatment of serious injuries (Chadbunchachai, 2004; Fitzgerald et al. 2006; Suphanchaimat, Chadbunchachai, Sriwiwat, & Kullieb, 2000). The majority of these errors occur in emergency rooms; 20% have been reported during initial assessment and resuscitation with another 14% during the secondary survey and initial diagnostic tests. These errors are related to inappropriate airway and breathing management (Gruen et al., 2006) and inadequate intravenous fluid and hemorrhage controls (Fitzgerald et al. 2006; Zafarghandi, Modaghegh, & Roudsari, 2003). Incomplete initial assessment, incorrect assessment prioritization, inappropriate recognition and management of serious injury, and lengthy initial assessment and management procedures (Sakolsatayadorn, 1999) are all causes of these problems. Thus, significant medical errors occur due to failure in the treatment process (Chadbunchachai, 2004; Sakolsatayadorn, 1999).

At present, Advanced Trauma Life Support (ATLS<sup>®</sup>), which was developed by The American College of Surgeons (ACS), is a systemic approach to injuries as a standard of care aiming to identify and treat any life threatening conditions (Greaves et al., 2001; Hassan & Tesfayohannes, 2006; Kanchanarin, 2004; Sakolsatayadorn, 1999). ATLS<sup>®</sup> provides major trauma patients with rapid and prioritized assessment and management. The initial phase of ATLS<sup>®</sup> is a primary survey performed in a prescribed sequence reviewing the most life threatening conditions first, including evaluation of the airway with cervical spine stabilization,

breathing, circulation and control of bleeding, disability or neurological status and exposure (ABCDEs). The survey should be followed by a resuscitation period, during which patients are re-evaluated and monitored to assess the efficacy of resuscitation (Boswell & Scalea, 2009; Tal-Or, Tanigawa, Thierbach, Kuhnigk, & Michaelson, 2007; Unhasuta, 2006a). The primary goal of this management of life threatening conditions is the restoration of adequate tissue perfusion (Wilson, Davis, & Coimbra, 2003).

Adequate tissue perfusion reflects physiological responses of major trauma patients following management of life threatening conditions and it is also an indicator of successful management of life threatening conditions that can be evaluated by assessing hemodynamic status, tissue perfusion measurement and use of anaerobic metabolism serum markers (Rady, 2005; Wilson et al., 2003). The physiological responses following management of life threatening conditions are results of help patients get as more oxygen by clearing the airway, administration of oxygen, fluid replacement and correcting the life threatening conditions. This procedure promotes additional tissue oxygenation and perfusion. In addition, adequate airway and breathing management increase partial pressure of arterial oxygen ( $\text{PaO}_2$ ) and decrease partial pressure of arterial carbon dioxide ( $\text{PaCO}_2$ ) which also decreases stimulation of compensatory mechanism resulting in ventilation and acid-base balance returns to almost normal range (Markou., Myrianthefs & Baltopoulos, 2004). Thus, effective management of life threatening conditions to provide a patency airway and adequate ventilation must be performed rapidly and accurately. If not, deterioration of patient's condition may occur and even result in death (Greaves et al., 2001).

For the fluid replacement, adequate volume must be administrated to fill the capillaries and run through the veins to provide an adequate venous return to the heart. This promotes additional preload, stroke volume and cardiac output. Improved cardiac output increases blood pressure and mean arterial pressure (MAP), which activate negative feedback loops in the baroreceptors, stretch receptors and chemoreceptors. The negative feedback results in decreased production of catecholamines and thus produces a vasodilation promoting capillary flow (Cottingham, 2006; Guyton & Hall, 2006; LaFramboise, 2001; Watanapa & Boontaveekul, 2005). Sufficient flow of fluid in the capillaries results in profusion of

tissues and cells, therefore, increasing oxygen delivery. This is a mean of reversing the anaerobic processes whereby serum lactate levels should be decreased (Kelley, 2005; VonRueden, Bolton, & Vary, 2009). Conversely, without an adequate circulatory blood flow, the vital organs are unable to perform their functions. The physiology and biochemistry of the body are deviated progressively from the normal values, as the situations deteriorate, and a state of irreversible shock is reached followed by death (Brooke, 2005). Therefore, evaluation of physiological responses following management of life threatening conditions is an essential component in determining patient outcome.

It is found in the review of literature that several factors are associated with the physiological responses of major trauma patients following management of life threatening conditions. These factors are not only related to mechanism, but also to complicated population factors, including advanced age, decreasing physical reserves, severity of injury, pre-existing co-morbidity and insufficient ability for systemic compensation (Chang et al., 2008). For age factor, the physiology of aging limits the patients' ability to respond to the stress of injury and also their management of life threatening conditions (Boswell & Scalea, 2009). An aging patient may experience delays in the presence of deterioration or improvement of physiological changes following management of life threatening conditions resulting in delay of further interventions and increased risk of death (Yilmaz, Karcioğlu, & Sener, 2006). In a previous study, Kuhne and colleagues (2005) found that mortality in older adult patients increased beginning at age 56 years and that increase was independent of the Injury Severity Score (ISS) ( $p \leq 0.05$ ). Similarly, in a 10-year, state-wide trauma registry review, Richmond, Kauder, Strumpf and Meredith (2002) reported the risk of mortality increased by 5% for each additional year of age for those over 65 years of age. It is indicated by the aforementioned data that physiological alterations from aging processes significantly contribute to increase mortality risks following injuries sustained (Demetriades et al., 2004; Kuhne, Ruchholtz, Kaiser, & Nast-Kolb, 2005). Nevertheless, there have been no studies investigating the effects of age on physiological responses following management of life threatening conditions. Therefore, this factor has been evaluated in the present study.

For pre-existing conditions, pre-injury health status is one of the risk factors which may contribute to the patient's physiological reserve, thus influencing outcome after trauma as physiological, pre-existing medical conditions accompanied by aging (ACS, 2004; Hollis, Lecky, Yates, & Woodford, 2006; Plummer, 2009; Stephenson, 2004; Yilmaz et al. 2006). It is reported in previous studies that trauma patients with pulmonary disease or myocardial infarction had a significantly higher mortality rate than those without these conditions (Bamvita, Bergeron, Lavoie, Ratte, & Clas, 2007; Yilmaz et al., 2006). Review of the related literature indicates that the ability of the body to recover from acute trauma may be compromised by the presence of pre-existing medical conditions with impact on mortality as the patient outcome (Plummer, 2009; Stephenson, 2004). However, fewer studies to date have evaluated the relationship between co-morbidities and the physiological responses of major trauma patients following management of life-threatening conditions. Therefore, it may be assumed, that the physiological responses of major trauma patients following management of life-threatening conditions worsen as co-morbidities present.

Severity of injury is well known to be a significant factor affecting patient outcome (Greaves et al., 2001; Guzzo et al., 2005; Van Natta & Morris, 2000). Tissue injury occurs because of the body's inability to tolerate exposure to excessive acute energy, thus resulting in anatomic and physiologic damage (Bilgin, Mert, & Çamdeviren, 2005; Weigelt, Brasel, & Klein, 2009). When organs and tissues are injured, the physiological derangements occur. Thus, the physiological responses following management of life threatening conditions also depend on intensity of injuries. Moreover, the specific body areas injured also influences trauma mortality (Demetriades et al., 2004; Demetriades et al., 2005). Recent studies have shown that patients with severe thoracic injuries are more likely to die in the first six hours in the Emergency Department (Bamvita et al., 2007). Similarly, Vécsei, Arbes, Aldrian and Nau (2005) found chest trauma to be the major cause of death in major trauma patients. In addition, the findings of contemporary trauma death studies revealed that the vast majority of trauma-related deaths are secondary to severity of injury (Tein, Chu, & Brenneman, 2004). As a result, severity of injury is a significant factor that is associated with the physiological responses of major trauma patient following the management of life threatening conditions.

It is found in the review of related literature that the probability of survival of major trauma patients depends upon five factors: time for management of life threatening conditions, age, co-morbidities, severity of injury, and management of life threatening conditions. It is also found that, some researcher have focused on final outcomes, such as mortality, complications, length of stay in the intensive care unit, length of hospital stay and quality of life. In contrast, little is known about the effects of these variables on physiological responses following the management of life threatening conditions i.e. patient outcome. Even though established trauma centers have implemented the ATLS<sup>®</sup> guideline as the standard for trauma care, there is little information on the standard of time of management of life threatening conditions and performance of management of life threatening conditions in the emergency room. Therefore, the researcher is interested in examining whether these factors are associated with the outcome of management of life threatening conditions. This outcome is reflected in the physiological responses evaluated by assessing the oxygenation, perfusion and serum lactate of major trauma patients following management of life threatening conditions. The outcome of this study can be utilized to develop the provision of trauma management of life threatening conditions related to the risk factors affecting outcome. Moreover, this study can also serve as a mean of obtaining data for improving the performance of trauma care in both quality of process and outcome.

### **Research Question**

What are the factors associated with the physiological responses of major trauma patients following management of life threatening conditions?

### **Research Objective**

To examine the relation between time for management of life threatening conditions, age, co-morbidities, severity of injury, management of life threatening conditions and the physiological responses of major trauma patients following management of life threatening conditions.

## **Research Hypothesis**

The time for management of life threatening conditions, age, co-morbidities, severity of injury and management of life threatening conditions are associated with physiological responses of major trauma patients following management of life threatening conditions.

## **Conceptual Framework**

The conceptual framework of this study was adapted from the performance improvement (PI) provided by the American College of Surgeons Committee on Trauma (ACSCOT) (Committee on Trauma American College of Surgeons, 2006) to examine factors associated with physiological responses of major trauma patients following management of life threatening conditions for improvement of trauma management by reducing inappropriate variation in care, reducing complications and preventable death. The significant variables influencing patient outcome are based on the system of care, morbidity and system performance as discussed below:

1. System of care is the provision of trauma management evaluated by timeliness of care. Timeliness of care is critical in trauma care when delayed care can be as lethal as errors. When major trauma patients arrive at the hospital, they should be rapidly and appropriately assessed by a triage nurse. Life threatening conditions should also be identified and managed by the trauma team in time. Delay in triage and management of life threatening conditions increase the risk of preventable death (Simons & Kirkpatrick, 2002).

2. Morbidity refers to any deviation from normal health which may be a result of an aging or pre-existing condition. This variable is related to the patient determinant which affects physiological responses following management of life threatening conditions and comprising age, co-morbidities and severity of injury.

- 2.1 Age. The physiological effects of aging contribute to differences in the outcomes of seriously injured patients. Advanced age is associated with a progressive loss in physiological resilience and decreasing efficacy of compensatory mechanism protecting the body after injury (Pudelek, 2002). Age-related physiological changes may both contribute to the cause of trauma in some circumstances and present clinical symptoms which influence the assessment and

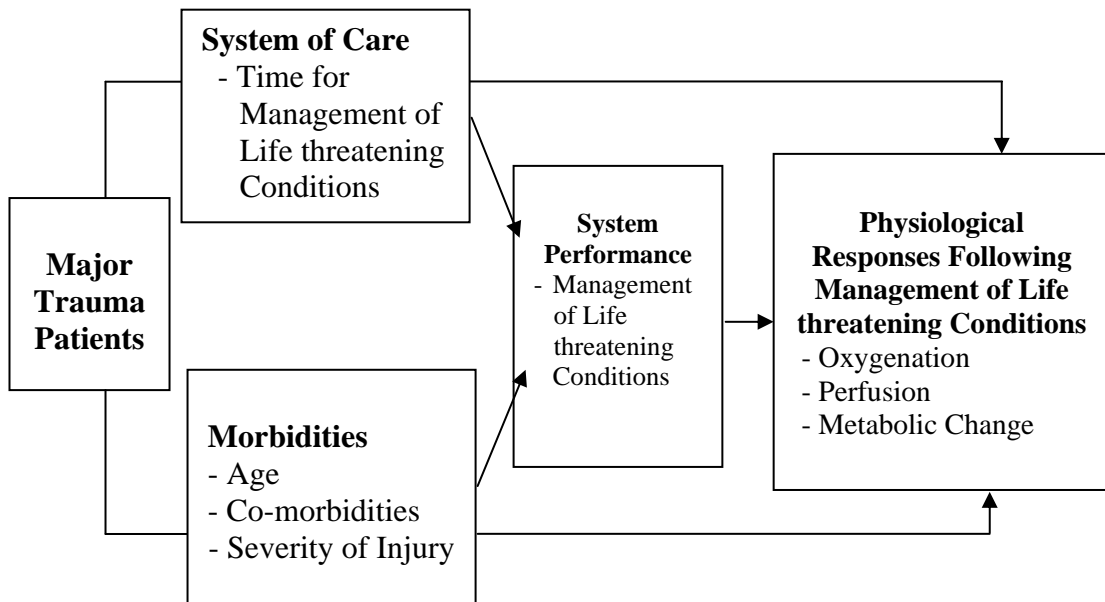
evaluation. Indeed, the outcome of physical findings at the initial assessment and following management of life threatening conditions may all be altered (Williams, Johnson, Ashley, & Wilson, 2007) and possibly lead to under resuscitation.

2.2 Co-morbidities refer to pre-existing medical conditions that may all contribute to a patient's physiological reserve, which influences trauma outcome (Pudelek, 2002). Reduced cardiac reserve from cardiovascular disease has the potential to decrease cardiac function. Both hypertensive states and medications can alter physiological compensatory mechanisms and vague signs of shock. Chronic lung disease and smoking of cigarette compromise overall respiratory function and reserve when stressed. In the resuscitative phase, decreased function of these organs can result in delayed response to injury and management of life threatening conditions. Thus, an initial assessment of the major trauma patients with co-morbidities may be more difficult and lead to under resuscitation or over resuscitation (Plummer, 2009).

2.3 Severity of injury refers to the degree of the harm in the human body evaluated by trauma scoring systems (Bilgin et al., 2005; Weigelt et al., 2009). This study applied the Revised Trauma Score (RTS) which is a physiological scoring system to measure the physical changes. The RTS combines the measurements of a patient's systolic blood pressure (SBP), respiratory rate (RR) and Glasgow Coma Scale (GCS) score. The magnitude of physiological derangement in each parameter is scored from 0-4. Thus, the RTS ranges from 0 to 12, with lower scores indicating more severe physiological derangement (Pohlman, 2007).

3. System performance is an essential component in trauma care. The major trauma patients must be treated appropriately, promptly and in accordance with appropriate priorities to identify life threatening injuries. This process constitutes the ABCDEs of trauma care to maintain adequate tissue perfusion. This mnemonic refers to: airway with cervical spine stabilization; breathing; circulation and control of bleeding; disability or neurological status; and exposure (undressing) and environment (temperature control). In parallel, the patient should be constantly monitored and re-evaluated during resuscitation. This sequential assessment is initiated by the members of the trauma team as soon as the patient arrives in emergency room. Problems in the process of care lead to physiological deterioration and increased risk of preventable death (ACS, 2004).

Five significant factors are found in the literature review. They are related to the physiological responses of major trauma patients following management of life threatening conditions. According to the system of care, delays in time to carry out procedure result in persistent hypoxia or hypoperfusion. Reduced physiological reserves due to aging and co-morbidities accompanied by physical damage from injury may reduce the ability of patients to respond to injury and the management of life threatening conditions. Thus, all factors directly affect tissue oxygenation, tissue perfusion and metabolic changes following the management of life threatening conditions. The conceptual framework of this study is demonstrated in Figure 1.



**Figure 1 Conceptual framework of the research study**

### **Scope of the Study**

This research examines the factors associated with the physiological responses of major trauma patients following management of life threatening conditions. The population of the study comprised of major trauma patients who received trauma resuscitation at the Outpatient Trauma Unit, Siriraj Hospital. Data were collected from December 2008 to April 2010.

## Definition of terms

**Major trauma patients** refer to trauma patients with severe injuries caused by external factors as identified in the V01-Y34 codes of ICD 10-TM. Patients are determined by a CRAMS scale score of 8 or less.

**Management of life threatening conditions** refer to the provision of trauma resuscitation of major trauma patients by rapid assessment and management of airway, breathing, circulation, disabilities, exposure/environment and coordination with a trauma nurse coordinator (TNC) or nurse responsible for the management of life threatening conditions. In this study, the management of life threatening conditions was evaluated by the assessment form for the management of life threatening conditions.

**Physiological responses following management of life threatening conditions** refer to the state of major trauma patients who have received management of life threatening conditions consisting of oxygenation, perfusion and metabolic changes. For this study, the patient's conditions were evaluated by assessing oxygen saturation measured by pulse oximetry (SpO<sub>2</sub>), SBP and blood lactate levels following management of life threatening conditions as interpreted in 3 categories: improved; unchanged; or worsened by a record form of outcome of the physiological responses of major trauma patients.

**Age** refers to the number of years from the patients' birth to date of data collection.

**Co-morbidities** refer to pre-existing conditions of major trauma patients that affect to physiological responses after management of life threatening conditions.

**Severity of injury** refers to the degree of injury severity calculated from the coded values of the Revised Trauma Score (RTS) comprised of 3 variables: systolic blood pressure (SBP); respiratory rate (RR); and Glasgow Coma Scale score (GCS).

**Time for management of life threatening conditions** refers to the length of time in minutes and seconds starting from the time when major trauma patients receive assessment from a triage nurse until the trauma resuscitation has been finished.

### **Expected Outcome and Benefits**

1. The findings of this study are expected to enhance understanding of the factors associated with the physiological responses of major trauma patients. This understanding is significant for trauma team in evaluating and making plans to improve the quality of trauma care.

2. It is expected that the findings of this study will be utilized as baseline data for improving the management of life threatening conditions for major trauma patients with severe injuries.

## **CHAPTER II**

### **LITERATURE REVIEW**

In this research the factors associated with physiological responses of major trauma patients following management of life threatening conditions were studied. Related literature and research papers were reviewed in terms of the following aspects:

1. Major trauma patients
  - 1.1 Characteristics of major trauma patients
  - 1.2 Life threatening conditions in major trauma patients
2. Physiological responses of major trauma patients following management of life threatening conditions
3. Factors associated with physiological responses of major trauma patients following management of life threatening conditions
  - 3.1 Time for management of life threatening conditions
  - 3.2 Age
  - 3.3 Co-morbidities
  - 3.4 Severity of injury
  - 3.5 Management of life threatening conditions
4. Conclusion

## **1. Major Trauma Patients**

### **1.1 Characteristics of Major Trauma Patients**

Major trauma patients can be defined as trauma patients with severely simultaneous injuries to different body regions or organs, which can result in systemic dysfunction potentially causing death (Holtslag, van Beeck, Lindeman, & Leenen, 2007; Hoyt, Coimbra, & Potenza, 2004). Major trauma patients are identified by CRAMS scale scores of 8 or less (Gormican, 1982 cited by Batchelor, 2000; Kosmos, 1995; Sharma, 2005). Those injuries caused by external causes identified by International Statistical Classification of Diseases and Related Health Problems (ICD 10-TM) with codes from V01-Y34 which includes transport accidents (V01-V99); falls (W00-W19); exposure to inanimate mechanical forces (W20-W49); exposure to animate mechanical forces (W50-W64); other accidental threats to breathing (W75-W84); exposure to electrical current, radiation and extreme ambient air temperature and pressure (W85-W99); exposure to smoke, fire and flames (X00-X09); contact with heat and hot substances (X10-X19); contact with venomous animals and plants (X20-X29); exposure to forces of nature (X30-X39); accidental poisoning by and exposure to noxious substances (X40-X49); overexertion, travel and privation (X50-X57); accidental exposure to other and unspecified factors (X58-X59); intentional self-harm (X60-X84); assault (X85-Y09); and events of undetermined intent (Y01-Y34) (Ministry of Public Health, 2007). These causes are harmful to the human body because of having nature of destroying and reducing functions of organs, tissues and cells leading to numerous changes in the body's internal environment (Leksakulchai, 2002). Consequently, acute physiological derangements can occur at any time following injuries and sequelae with life threatening conditions (Griggs, Morris, Runciman, Osborne, & Paix, 2005).

### **1.2 Life threatening Conditions in Major Trauma Patients**

Life threatening conditions in major trauma patients are generally caused by shortages in oxygen supply to vital organs (Brooke, 2005; Greaves et al. 2001; Rady, 2005). These conditions often occur as a result of severe injuries to the respiratory, circulatory and central nervous systems. Consequently, they are followed by hypoxemia and/or hypoperfusion (Greaves et al., 2001; VonRueden & Hartsock,

2002; Tomtitchong & Havanond, 2001). Life threatening conditions can be described as follows:

### **Hypoxemia**

Hypoxemia refers to reduction in the level of oxygen in blood potentially evaluated by arterial oxygen content ( $\text{CaO}_2$ ) (Greaves et al., 2001), partial pressure of arterial oxygen ( $\text{PaO}_2$ ) and arterial oxyhemoglobin saturation ( $\text{SaO}_2$ ) (Vichitvejpaisal, 1997; Wilson, Minokadeh, Benumof, Frass, & Barbieri, 2007). Hypoxemia is life threatening because it may compromise oxygen delivery to the periphery, resulting in tissue hypoxia. Hypoxemia may occur together with hypercapnia which means increased partial pressure of arterial carbon dioxide ( $\text{PaCO}_2$ ) caused by retention of carbon dioxide (Cranshaw & Nolan, 2006; Greaves et al., 2001; Markou et al., 2004; Porth, 2005). Major trauma patients with oxygen saturation measured by pulse oximetry ( $\text{SpO}_2$ ) at less than 95% are considered to have hypoxemia (ACS, 2004; Thavichaigarn & Kanchanarin, 2001). In general, hypoxemia is a result of the following causes:

1. Decreased oxygen delivery caused by inadequate level of oxygen in the air, airway obstruction and hypoventilation. These causes produce decreased alveolar oxygen levels resulting in decreased alveolar oxygen pressure leading to imbalanced ventilation and perfusion ratio called a ventilation/ perfusion (V/Q) mismatch where blood flow through the lungs has less oxygen while normal circulation results in decreased arterial oxygenation. Consequently, decreased  $\text{PaO}_2$  and  $\text{SaO}_2$  sequelae occur with increased  $\text{PaCO}_2$  (Brooke, 2005; Dutton, 2008; Horton, 2005; Ounnpirak, 2000; Porth, 2005; Vichitvejpaisal, 1997; Wilson et al, 2007).

- 1.1 Reduced level of oxygen in the air inspired causing low partial pressure of inspired oxygen most commonly caused by smoke inhalation with the consequences of carbon monoxide and cyanide poisoning (Brooke, 2005; Greaves et al., 2001). Carbon monoxide has an affinity for haemoglobin that is 200-250 times greater than the affinity of oxygen for haemoglobin. As a result, haemoglobin is reduced to combine with oxygen leading to reduction of tissue oxygenation (Hungspreugs & Suwanpratas, 2005)

1.2 Airway obstruction can be a primary problem or the result of another injury. The most common causes of airway obstruction are soft tissue obstruction resulting from lost muscle tone in the neck and pharynx in unconscious patients. Hematoma can cause compression of the trachea and thyroid cartilage occurring as a result of direct trauma to the head and neck. Foreign bodies or foreign materials (either intrinsic or extrinsic), such as avulsed teeth, dentures, pieces of tissue, blood clots, secretion, vomitus or any other foreign matter, may block the airway. Altered anatomy as a consequence of head and facial injuries results in displaced facial bones, such as the maxilla and mandible which may also become sources of obstruction (Cranshaw & Nolan, 2006; Greaves et al., 2001; Horton, 2005; Yamamoto, Schroeder & Beliveau, 2005). Moreover, inhaled air at high temperature, particularly associated with the inhalation of irritant gases following combustion, produces spasms in the airway and also edema of the airway wall (Brooke, 2005; Greaves et al., 2001). Airway obstruction can be partial or complete. These causes interrupt the flow of oxygen from the atmosphere to the lung alveoli with the result of reducing pulmonary ventilation leading to inadequate partial pressure of oxygen in inspired air (Brooke, 2005). These causes contribute to retention of carbon dioxide with the effect that oxygen cannot pass from the alveoli through the pulmonary capillaries, thus resulting in decreased arterial oxygenation (Horton, 2005; Pongnumkul, 2004).

1.3 Hypoventilation occurs when the volume of the air moving in and out of the lungs is significantly reduced resulting in decreased alveolar ventilation often accompanied by retention of carbon dioxide (hypercapnia). Hypoventilation is commonly caused by conditions outside the lungs, such as respiratory center depression from head injury or drugs, disorders of respiratory muscles (e.g. diaphragm or intercostal muscles) from phrenic nerve paralysis due to spinal cord injury and thoracic cage disorders from chest wall injury (Greaves et al., 2001; Porth, 2005). A loss of mechanical function of the chest wall inhibits the normal movement of the thorax or interrupts the formation of negative pressure within the thorax and leads to hypoventilation. The loss of negative intrapleural pressure results in the partial or total collapse of the lung on the affected side with a resulting accumulation of air or blood in the pleural space. These conditions are found in

patients with pneumothorax, open pneumothorax, hemothorax and flail chest. Furthermore, the increased intrathoracic pressure can also cause mediastinum to shift to opposite side due to tension pneumothorax and massive hemothorax. The consequences of this compression are failure to ventilate and reduced venous return which can lead to decreased cardiac output. As a result, the mismatching of ventilation and perfusion occur and contribute significantly to hypoxemia (ACS, 2004; Attanawanich, 1999; Brooke, 2005; Guyton & Hall, 2006; Yamamoto et al., 2005).

2. Impaired diffusion is described as a condition in which gas exchange between the alveoli and the red blood cells is reduced because of an increase in the distance of diffusion or a decrease in the permeability of the alveolar capillary membrane to movement of gases. Impaired diffusion most commonly occurs in trauma patients due to injury to the lung parenchyma which causes reduction in the permeability of the alveolar capillary membrane. These changes produce increased pulmonary vascular resistance, decreased pulmonary vascular flow and reduced lung compliance resulting in interstitial fluid accumulation and decreased alveolar membrane diffusion (Attanawanich, 1999; Pongnumkul, 2002; Porth, 2005). Moreover, impaired diffusion is also caused by reduced red blood cells from hemorrhage. Thus, blood and hemoglobin in the pulmonary circulation cannot be saturated with oxygen. As a result, blood leaving the lungs has low oxygen saturation potentially resulting in reduced oxygen delivery to the tissues (Sharpe & Steyn, 2005; Wilson et al, 2007).

3. Impaired circulatory function due to injuries can reduce pulmonary circulation and result in decreased blood flow to the gas exchange portion of the lungs. Alveolar dead space occurs and produces mismatching of ventilation and perfusion. Eventually, ineffective gas exchange occurs with reduced blood flow in systemic circulation carrying oxygen to the tissues and cells, thus leading to diminished cellular respiration further resulting in tissue hypoxia (Guyton & Hall, 2006; Hungspreugs, & Suwanpratas, 2005; Porth, 2005; Wilson et al, 2007). The most common cause of hypoxemia due to impaired circulatory function are loss of blood volume in the circulatory system; reduced cardiac pumping ability from direct injury to the heart and great vessels; and circulatory obstruction from tension pneumothorax or cardiac tamponade (Brooke, 2005; Greaves et al., 2001; Yamamoto et al., 2005).

In conclusion, hypoxemia and hypercapnea contributing to respiratory failure are conditions in which the lungs fail to adequately oxygenate the blood to prevent carbon dioxide retention. Hypoxemia and hypercapnea are the results of such conditions as impaired ventilation, compromised matching of ventilation and perfusion, or disrupted blood flow in the lungs. The consequence of hypoxemia is hypoxia which means reduction in oxygen supply to the tissues (Brooke, 2005; Porth, 2005). The effects of hypoxia are decreased mental proficiency and performance of discrete motor movements (Guyton & Hall, 2006).

### **Hypoperfusion**

Hypoperfusion or inadequate tissue perfusion is defined as circulatory shock which means generalized inadequate blood flow through the body to the extent that the body tissues are damaged due to insufficient flow, especially in terms of oxygen and other nutrients delivered to the tissues and cells. Shock usually results from inadequate cardiac output caused by reduced blood volume, obstruction to the blood flow from the heart, diminished cardiac pumping ability and decreased vascular tone. These causes produce decreased venous return, decreased cardiac output, reduced tissue perfusion and impaired cellular metabolism resulting in an accumulation of metabolic waste (Edward, 2005b; Guyton & Hall, 2006; Porth, 2005; VonRueden et al., 2009; Wattanasirichaigoon, 2002). Each cause of hypoperfusion is described as follows:

1. Reduced blood volume is a significant cause of shock called hypovolemic shock. In trauma patients, the most common cause of hypovolemic shock is acute hemorrhage. A massive blood loss can result from abdominal trauma, thoracic trauma, pelvic fracture and long-bone fracture with arterial trauma (Greaves et al., 2001; Kneale, 2003). Hypovolemic shock may also be the result of plasma loss from burn. Plasma is lost through the denuded skin areas so the plasma volume becomes markedly reduced. Consequently, it contributes greatly to increase blood viscosity as a result of increased red blood cell concentration in the remaining blood and this exacerbates the sluggishness of blood flow (Guyton & Hall, 2006; Unhasuta, 2007; Von Rueden et al., 2009). These volume losses reduce both preload and stroke volume

and cause reduced cardiac output resulting in impaired perfusion to the tissues and cells (Cottingham, 2006; Kelley, 2005; Kneale, 2003; Porth, 2005).

2. Obstruction to blood flow from the heart may be caused by the accumulation of air and blood in the pleural space, but does not release, thus causing an increase of intrathoracic pressure and compression of major great vessels, lungs, heart and trachea. The results of this compression are failure to ventilate which causes diminished arterial oxygenation with decreased cardiac output, perfusion and, eventually, venous return resulting in decreased blood flow to the central circulation (Porth, 2005; Unhasuta, 2007; Yamamoto et al., 2005). Moreover, blood clots or bubbles of gas from pulmonary embolisms can obstruct pulmonary vessels and result in elevated right heart pressure and impaired venous return (Attanawanich, 1999; Edward, 2005b; Porth, 2005).

3. Reduced cardiac pumping ability may be caused by directly traumatizing the heart muscle or, by restricting heart function by compressing with accumulated blood and blood clots in the pericardial space, elevating intrapericardial pressure and impairing ventricular fillings to result in ineffective pumping to the circulatory system. As a result, stroke volume and cardiac output are reduced (Brooke, 2005; Greaves et al., 2001; Kelley, 2005; Unhasuta, 2007). Furthermore, coronary blood flow is reduced during a period of increased myocardial oxygen demand resulting in myocardial dysfunction and failure (Kelley, 2005).

4. Decreased vascular tone is possibly the result of a severe brain stem injury at the level of the medulla and injury to the spinal cord above the level of T1 results in loss of sympathetic control of blood vessels. These causes contribute to peripheral vasodilatation, decreased systemic vascular resistance and enhanced vagal reflexes causing severe bradycardia. In the presence of a normal or low intravascular volume, this expanded vascular capacity causes severe hypotension, inadequate cardiac output, reduced tissue perfusion and impaired cellular metabolism (Edwards, 2005b; Greaves et al., 2001; Kelley, 2005; Porth, 2005; Unhasuta, 2007; Von Rueden et al., 2009).

If cardiac output continues to decrease, blood pressure and tissue perfusion is also decreased. Consequently, tissue hypoxia occurs as a result of hypoperfusion. Hypoxia causes alteration of cellular metabolism, cellular membrane disruption and

coagulation defects. These conditions indicate the failure of compensatory mechanism to maintain adequate tissue perfusion. Furthermore, severe cellular and organ dysfunction develops and rapidly leads to death (Edward, 2005b; Von Rueden et al., 2009)

In summary, life threatening conditions in major trauma patients in the emergency phase are the result of complex pathophysiological reactions, some directly as a result of the event itself and others as part of a compensatory response (Cottingham, 2006; Greaves et al., 2001; Matthews & Bentley, 2005). The main features of pathophysiological disturbances triggered by hypoxemia and hypoperfusion, such as shock, result in decreased oxygenation, inadequate tissue perfusion, tissue hypoxia and eventually death (Brooke, 2005; Dutton, 2008; Edwards, 2005a; Wattanasirichaigoon, 2002).

## **2. Physiological Responses of Major Trauma Patients Following Management of Life threatening Conditions**

When the human body sustains injuries, local and systemic responses are stimulated to control the internal environment for maintenance of constant conditions in the body. The pattern of response depends upon whether the injury is mainly hemorrhage, lack of oxygen, tissue damage or pain. Physiological changes occur through its compensatory mechanism to protect the body from damage of cells, tissues and organs (Cottingham, 2006; Dutton, 2008). The initial physiological responses are neuroendocrine responses, metabolic responses and immune responses. The neuroendocrine responses are seen immediately after injuries and continue throughout the treatment during and after management of life threatening conditions until the body returns to normal condition. Hemodynamic alterations, changes in oxygen supply occur with demands and metabolic disturbances (Edwards, 2005a). Therefore, physiological changes following management of life threatening conditions are reflected in the response of the body to the management of life threatening conditions caused by hypoxemia and inadequate tissue perfusion. These responses are described as follows:

## **2.1 Physiological Responses of Major Trauma Patients toward Hypoxemia Following Management of life threatening conditions**

Major trauma patients who sustain airway obstruction and hypoventilation can develop hypoxemia and coexisted hypercapnea. Impaired gas exchange may also develop. If not managed properly, these conditions hold the potential for developing hypoxia. Clinically, different organs have different sensitivities to hypoxia, the heart and brain being the most sensitive (Greaves et al., 2001; Hungspreugs & Suwanpratas, 2005). With complete airway obstruction, patients become unconscious within two minutes as the PaO<sub>2</sub> drops to approximately 30 mmHg (SaO<sub>2</sub>< 50%). Apnea follows in 2-6 minutes. When PaO<sub>2</sub> is approximately 15-25 mmHg and cardiac arrest is likely to occur within 5-10 minutes (Horton, 2005).

Under conditions of hypoxemia and hypercapnea, inadequate alveolar ventilation and carbon dioxide retention can cause respiratory acidosis. The body responses to decreased PaO<sub>2</sub>, increased PaCO<sub>2</sub> and acidosis by stimulated central chemoreceptors at the medulla and peripheral chemoreceptors at carotid and aortic bodies resulting in increased ventilation. Alveolar hypoxia also stimulates pulmonary vasoconstriction resulting in increased pulmonary arterial pressure and improves the matching of ventilation and blood flow. Additionally, hypoxia provokes release of erythropoietin from the kidneys to increase production of red blood cells resulting in increased red blood cell concentration and the oxygen-carrying capacity of the blood. This compensatory mechanism usually takes place within minutes to maintain PaO<sub>2</sub> and PaCO<sub>2</sub> and produce enough oxygen for cells to function properly (Brooke, 2005; Markou et al., 2004; Porth, 2005). Thus, effective management of life threatening conditions to provide a patency airway and adequate ventilation must be performed quickly and accurately. If not, deterioration in the condition of patient may occur and result in death (Greaves et al., 2001).

Following management of life threatening conditions, the physiological responses are results of help patients get more oxygen by clearing the airway, administration of oxygen and correcting the life threatening conditions. These promote additional tissue oxygenation. In addition, adequate airway and breathing management increase PaO<sub>2</sub> and decrease PaCO<sub>2</sub> which also decreases stimulation of compensatory mechanism resulting in ventilation and acid-base balance returns to a nearly normal

range (Markou et al., 2004). These responses can be determined by assessment of clinical manifestations such as respiratory rate (normal range 10-29 times per minute) (Richards & Mayberry, 2004; Tal-Or et al., 2007), decreased respiratory effort, return to normal neurological status; and diagnostic measures of oxygen levels, such as arterial oxygen saturation by pulse oximetry which should be  $\geq 95\%$  (ACS, 2004; Thavichaigarn & Kanchanarin, 2001). If the patient receives inappropriate or delayed treatment, hypoxia develops and may cause unconscious, decreased respiratory rate, hypotension, bradycardia, decreased cardiac output and ultimate cardiac arrest (Horton, 2005; Hungspreugs & Suwanpratas, 2005). Thus, evaluation and monitoring of tissue oxygenation during and after management of life threatening conditions are important stages of effective management in major trauma patients and also reflect the efficacy of trauma care in emergency room (Hulme, 2006).

## **2.2 Physiological Responses of Major Trauma Patients Towards Hypoperfusion Following Management of Life threatening Conditions**

In major trauma patients, hypoperfusion is caused, at least in part, by depletion of circulating volume, obstruction to blood flow from the heart, ineffective cardiac pumping ability and reduction of vascular tone, as mentioned above. Hypoperfusion mostly results from acute blood loss. Significant blood loss reduces circulatory volume due to internal or external hemorrhage causing hypovolemic shock. Hypovolemia can cause both hypoxemia and inadequate tissue perfusion because it is a result of loss of both circulating plasma and red blood cells. Clinically, adequate blood flow to the tissues and cells requires 3 major components, adequate cardiac pumping, effective vascular tone and sufficient blood volume. When one component is impaired, blood flow to the tissues is threatened or compromised (Brooke, 2005; LaFramboise, 2001; Smeltzer & Bare, 2004; Wattanasirichaigoon, 2002). Compensatory mechanism is stimulated to restore blood flow and tissue perfusion. Initial response is triggered by peripheral hypoperfusion causing vasoconstriction to increase preload and cardiac output. Decreased intravascular volume stimulates atrial stretch reflex, while decreasing arterial blood pressure stimulating the baroreceptors in the aortic arch and carotid sinus causing pressure response to trigger the sympathetic nervous system (Cottingham, 2006; Dutton, 2008; Kelley, 2005; LaFramboise, 2001).

The sympathetic stimulation affects the functions of the endocrine glands, peripheral nerve endings and adrenal medulla to release catecholamine, such as epinephrine and norepinephrine, resulting in increased vascular tone, heart rate, cardiac contractility and vasoconstriction in order to increase venous return and, thus, preload. The responses are efforts to provide blood flow to major organs, especially, the brain, heart and lung first. Additionally, decreases in blood pH and rises in carbon dioxide concentrations activate chemoreceptors in the kidneys, simultaneously, decreased renal blood flow activates renin-angiotensin aldosterone cascade to release aldosterone generating the re-absorption of sodium and, thus, catecholamine. In the meantime, the increased serum osmolarity stimulates osmoreceptors in the hypothalamus to release antidiuretic hormone (ADH) by the posterior pituitary gland. ADH causes the kidneys to further retain water in an effort to raise blood volume and blood pressure. Moreover, decreased capillary hydrostatic pressure also causes shifts of fluids from intracellular and interstitial space to capillaries to increase intravascular volume to maintain sufficient tissue perfusion and cellular metabolism (Cottingham, 2006; Edwards, 2005a; Kelley, 2005; Wattanasirichaigoon, 2002; Smeltzer & Bare, 2004).

Hypoperfusion depletes oxygen delivery to the cells, thus resulting in impaired cellular metabolism. At the cellular level, reduction of oxygen first affects the mitochondria using the anaerobic metabolism to produce adenosine triphosphate (ATP), which is essential for creating energy in cells. The anaerobic metabolism gradually produces lactic acid. The accumulation of lactic acid eventually results in a metabolic acidosis perpetuating cellular dysfunction and potentially leading to tissue damage (Bolton, 2007; Cottingham, 2006; Kneale, 2003; Smeltzer & Bare, 2004). This metabolic disturbance can cause progressive vasodilatation, loss of response to fluids and catecholamine, capillary leak, diffused coagulopathy and cardiac dysfunction (Dutton, 2008; Edwards, 2005b; Kelley, 2005).

It can be noted that the primary function of compensatory mechanism is to deliver oxygen to tissues and remove waste products. Any derangement of this process in major trauma patients due to reduced oxygen supply from both respiratory and circulatory failure leads to life threatening conditions, such as shock. In such situations, unresolved shock can result in death. Effective management of life

threatening conditions must be aimed at preventing further injuries and restoring adequate tissue oxygenation and perfusion, including bleeding control and fluid versus blood replacement (Brooke, 2005).

In replacing fluids, adequate volume must be administered to fill the capillaries and run through the veins to provide an adequate venous return to the heart. This promotes additional preload, stroke volume and cardiac output. Improved cardiac output increases blood pressure and mean arterial pressure (MAP), which activate negative feedback loops in the baroreceptors, stretch receptors and chemoreceptors. The negative feedback results in decreased production of catecholamines and thus produces a vasodilation promoting capillary flow. Due to decreased blood catecholamine, cardiac contractility and peripheral vascular resistance are decreased with the effects of decreased heart rate, pulse rate, diastolic blood pressure and thereby widening the pulse pressure (Cottingham, 2006; Guyton & Hall, 2006; LaFramboise, 2001; Watanapa & Boontaveekul, 2005). Sufficient cerebral and renal blood flow also result in improved mental status and increased urine output (ACS, 2004; Cottingham, 2006; Smeltzer & Bare, 2004). Additionally, adequate flow of fluid in the capillaries results in profuse tissues and cells, therefore, increasing oxygen delivery. This is a mean of reversing the anaerobic processes whereby serum lactate levels should be decreased (Kelley, 2005; Von Rueden et al., 2009). Conversely, without an adequate circulatory blood flow, the vital organs are unable to perform their functions. The physiology and biochemistry of the body are deviated progressively from the normal values, as the situations deteriorate, and a state of irreversible shock is reached this is followed by death (Brooke, 2005).

According to physiological responses following management of life threatening conditions mentioned above, evaluating the hemodynamic status is most basic approach to assess adequacy of resuscitation. Traditionally, successful management of life threatening conditions should see patients with SBP  $\geq$  90 mmHg, MAP  $\geq$  70 mmHg, heart rate  $\leq$  100 beats per minute, SpO<sub>2</sub>  $\geq$  95% (ACS, 2004; Cocchi, Kimlin, Walsh, & Donnio, 2007; Cottingham, 2006). However, it has been documented that up to 85% of severely injured patients have evidence of ongoing tissue hypoxia despite normalization of vital signs, suggestive of occult oxygen debt (defined as the cumulative deficit in cellular oxygen consumption) and the presence of

compensated shock (Prittie, 2006). It is reported in previous studies that serum marker of metabolism such as lactate levels is sensitive physiological parameters, which give crucial information about the actual tissue perfusion in trauma patients (Cottingham, 2006; Englehart, & Schreiber, 2006; Napolitano, 2005; Tisherman et al., 2004; Wilson et al., 2003). The recent study by Aslar, Kuzu, Elhan, Tanik, & Hengirmen (2004) demonstrated that serum lactate levels are the most important determinants of clinical outcome in critical injured patients. Therefore, serum lactate levels may provide valuable information regarding global perfusion and oxygenation in major trauma patients.

In conclusion, the physiological responses of major trauma patients are results of compensatory mechanism initiated by tissue and organ damage leading to hypoxemia and hypoperfusion. Restoration of tissue perfusion must be performed by correcting life threatening situations and providing systemic tissue oxygenation and perfusion. Evaluation of tissue oxygenation and perfusion can be determined by assessment of peripheral organ perfusion including hemodynamic status, tissue perfusion measurement and use of anaerobic metabolism serum markers. These strategies should be implemented continually during and after management of life threatening conditions. Improvement and deterioration of physiological derangements are reflected in the efficacy of management of life threatening conditions and also quality of trauma care (Cottingham, 2006; Rady, 2005; Wilson et al., 2003). Finally, fewer studies to date have evaluated whether the physiological responses of major trauma patients following management of life threatening conditions as a patient outcome. Therefore, the present study evaluated this outcome.

### **3. Factors Associated with Physiological Responses of Major Trauma Patients Following Management of Life threatening Conditions**

According to the review of literature and the conceptual framework of this study, patient outcome of trauma care depend upon several factors. These involve host factors, such as age and co-morbidities; mechanisms of injury causing injury severity; timeliness of care as system factors; and trauma management as system performance (Committee on Trauma American College of Surgeons, 2006; Søreide, & Steen, 2000, Van Natta & Morris, 2000). In the emergency phase, the primary goal of patient

outcome is improvement in physiological status following management of life threatening conditions. Thus, all 5 factors, including time for management of life threatening conditions, age, co-morbidities, severity of injury and management of life threatening conditions, could be considered in relation to physiological responses following management of life threatening conditions which can be explained as follows:

### **3.1 Time for Management of Life threatening Conditions**

Depend on the cause of life threatening conditions as mentioned above, these conditions require immediate treatment. A rapid initial assessment should be performed upon arrival at the emergency room (Greaves et al., 2001; Kelley, 2005). Assessment is based on a series of ATLS<sup>®</sup> guidelines. This process involves many steps that must be done simultaneously and quickly to correct life threatening problems. This management of life threatening conditions should be completed in the first three to five minutes from arrival at emergency room (Sakolsatayadorn, 1999; Tal-Or et al., 2007; Unhasuta, 2006a). However, when multiple life threatening injuries are encountered, the management of life threatening conditions takes longer time to complete (Tal-Or et al. 2007). Because time is of the essence, the management of life threatening conditions is significant to patient outcome. Serious injuries would take a lethal course if left untreated within the first minutes to few hours following trauma (ACS, 2004; Driscoll, & Vincent, 1992; Lowe, Pope, & Hedges, 1990; Stahel, Heyde, & Ertel, 2005). Physiologically, more than 5 to 8 minutes of total circulation arrest can cause at least some degree of permanent brain damage (Guyton & Hall, 2006). Therefore, it is significant to pay attention to immediate assessment and appropriate management of hypoxemia and hypoperfusion in major trauma patients in the emergency room.

In the emergency room, organizational processes to correct life threatening conditions include patient triage, initial assessment, life-saving interventions, monitoring, re-evaluation and documentation (ACS, 2004; Selfridge-Thomas, 2005). The primary purpose of triage is the timely evaluation and treatment of the injured patient. Triage is accomplished by assigning each patient a category reflecting the urgency with which care is required. When the time from triage to treatment is shorter,

triage accuracy is important but not critical. On the other hand, long waits for treatment allow for no error in triage decision making as patients may die (McMahon, 2003). Thus, time-management of life threatening conditions involves triage time and resuscitation time.

An early study by Lowe et al. (1990) reported the mean time of trauma resuscitation from initial assessment of airway, breathing and circulation to back examination as 10 minutes. This study, however, did not evaluate the time-management and patient outcome. Later, Driscoll and Vincent (1992) studied resuscitation times in four units of Level I trauma centers; two of the centers were in North America and the other two were in South Africa. The results demonstrated that Unit A completed life-saving procedures in an average time of 5 minutes, while Units B, C and D took 7, 20 and 47 minutes, respectively, in order to follow the same procedures. They also reported that times for management of life-saving procedures had a significant correlation with changes in SBP and RTS during the patient's stay in the resuscitation room. This finding indicates that speed of resuscitation had a definite bearing on the patient's subsequent physiological condition. Moreover, when predictability was analyzed with patient survival as the outcome, the time for life-saving procedures remained predictive of patient survival ( $p < .005$ ) (Driscoll & Vincent, 1992).

In 2001, Lossius and colleagues reported that the median time from admission to first x-ray was 5 minutes in major injured patients when the trauma team was activated. And time intervals from injury to definite care of 60 min or more were significantly associated with death within 30 days after injury. Another study by Van Olden and colleagues (2003a) reported that the median time of resuscitation in severely injured patients who were treated by mobile medical teams was 41.30 minutes. Similarly, Van Olden and colleagues (2003b) demonstrated the median time of resuscitation in severely injured patients at 49 minutes. These two studies did not examine the effects of time of resuscitation on the patient outcome.

A recent study by Spanjersberg, Bergs, Mushkudiani, Klimek and Schipper (2009) revealed that the median time of primary surveys in severely trauma patients was 10.0 minutes. When compared to mortality and expected number of deaths by using TRISS methodology, it was found that 16 and 18 patients died. This

finding indicated that the mortality was not high. It should be noted, however, that differences in findings might be caused by types of patients or trauma team structures. Another related study also supported that time for management of life threatening conditions affected patient outcome. This study examined causes of preventable deaths in the emergency phase of trauma care. Most results demonstrated that delays in treatment, such as delays in securing the airway, delay in hemorrhage control and fluid replacement, are errors resulting in death (Gruen et al., 2006; Ivatury et al., 2008; Saltzherr et al., 2010; Teixeira et al., 2007; Zafarghandi et al., 2003).

When airway is compromise and hemorrhage is not corrected, the result is delayed interventions. The body still prolongs hypoxemia and hypoperfusion, patient's conditions worsen and the patients are unable to respond to management of life threatening conditions. In this situation, SpO<sub>2</sub> is lower than 95 %, SPB drops lower than 90 mmHg and blood lactate level elevates over initial values. Later, organ and tissue dysfunction occurs and the patient eventually dies (Tanadsiladham, 2001). In patients with tension pneumothorax and cardiac tamponade, delays in chest tube replacement or decompression results in progressive conditions and rapid death (Attanawanich, 1999). However, rapid interventions to correct life threatening conditions and provide adequate oxygenation and perfusion by maintaining patency airway, hemorrhage control and fluid transfusion, can help patient conditions improve (ACS, 2004; Greaves et al., 2001; Cottingham, 2006). For this reason, time for management of life threatening conditions is considered an influential factor toward physiological responses following management of life threatening conditions. Moreover, it also reflects the efficacy of emergency room management and quality of trauma care.

### **3.2 Age**

Age is a significant factor that may contribute to poorer outcome. Advanced age is associated with a progressive loss in physiological resilience, decreasing the efficacy of compensatory mechanism that protect the body after injuries (Chang et al. 2008; Kauder, Schwab, & Shapiro, 2004; Williams et al., 2007). The physiology of aging limits the patient's ability to respond to the stress of injury and also their management of life threatening conditions. This is perhaps the most

important factor in the cardiovascular system (Boswell & Scalea, 2009). Age-related changes of the cardiovascular system include an increased amount of collagen, causing a stiffened left ventricle and increased rigidity of the cardiac valves. Stress response and catecholamine release are not altered, but sensitivity to catecholamines is decreased. Elasticity of the arterial walls is declined, thus causing an increase in pulmonary and peripheral vascular resistance. The overall cardiovascular changes are manifested through diminished cardiac reserve which becomes apparent through cardiac dysfunction with potential for decreasing cardiac output. These changes may result in a delay in the activation of responses and diminished magnitude of compensatory mechanism. The significant signs of early shock may initially be subtle (Atwell, 2002; Kauder et al., 2004; Stephenson, 2004). Thus, accurate assessment and initial management are not easy to achieve in elderly trauma patients (Chang et al. 2008)

The pulmonary system also undergoes physiological changes. The pulmonary arteries thicken, thus increasing pulmonary vascular resistance. The lung parenchyma and chest wall become stiff, leading to reduced pulmonary compliance. Alveolar ducts enlarge; and alveoli become flatter and shallower, thus decreasing the lungs' vital capacity. These changes cause ventilation perfusion mismatch resulting in ineffective gas exchange (Atwell, 2002; Plummer, 2009; Williams et al., 2007; Stephenson, 2004). Hypoxia may develop easily after serious injuries and slowly return to normal after initial management (Thavichaigarn & Kancharin, 2001).

Brain weight is decreased with progressive loss of neurons, thus resulting in cerebral atrophy (Atwell, 2002; Plummer, 2009; Williams et al., 2007; Stephenson, 2004). Due to the increased space created around the brain, the amount of blood can be accumulated before any neurological symptoms become apparent. The effects of age on renal function results in diminished blood flow and glomerular filtration rate (GFR) reduced bladder capacity and decreased diluting ability. Decreases in the production of renin and angiotensin are also seen (ACS, 2004; Plummer, 2009; Stephenson, 2004). The loss of tissue turgor and the arteriosclerosis affecting virtually aging patients may limit tamponade and increase blood loss into muscle compartments (Boswell & Scalea, 2009). As a result, the physiological effects of

aging contribute to differences in outcomes between younger and older injured patients (Jacoby, Ackerson and Richmond, 2006).

Potential problems with airway management should be anticipated while patients undergo management of life threatening conditions. Missing teeth or removed dentures can make bag-mask ventilation difficult. Endotracheal intubation also may be difficult to accomplish because of deformity or rigidity of the cervical spine (Plummer, 2009). The lack of cardiovascular reserve limits the heart's ability to rapidly accept fluid volume delivered during interventions (Boswell & Scalea, 2009). An aging patient may experience delay in the presence of deterioration or improvement of physiological changes resulting in delay of further interventions and increased risk of death. As a result of some physiological and pathological changes, elderly trauma patients are more likely to have higher mortality rates than younger trauma patients with similar injuries (Yilmaz et al., 2006). Thus, in the initial assessment and management trauma team should consider physiological changes due to aging processes throughout, during and after management of life threatening conditions (ACS, 2004; Chang et al. 2008).

In to related study, Jacoby et al. (2006) analyzed published research pertaining to the in-hospital outcomes of serious injuries among older adults. The results showed that the older adults in these studies had higher mortality rates than younger adults with comparable severity of injury. Hannan, Waller, Farrel and Rosati (2004) examined the characteristics and outcomes of geriatric trauma patients in New York State (n = 76,466), reporting that in-hospital mortality rose substantially with increasing age, from 5.1% for the patients younger than 40 years to 5.9%, 9.4%, 12.3% and 15.8% for the patients in the groups represented, respectively, at the ages of 40 to 64, 65 to 74, 75 to 84 and 85 years or older. Related to a 13-39 year old reference group, the odds of mortality increased to 2.67, 8.41, 17.40 and 34.98 for age groups 40-64, 65-74, 75-84 and 85 years of age or older, respectively. Similarly, Kulshrestha, Munshi, & Wait (2004) found that mortality increased by 4% (95% CI, 2-5%) for each 1-year increase in age. Guzzo et al. (2005) conducted a study on the predictable ability of variables in 15,534 trauma patients, finding that age was associated with mortality (ROC 0.61). In contrast, there were three studies reviewed that reported conflicting age-mortality relationships with no significant differences in

in-hospital death rates between older and younger injured patients (Gallagher et al. 2003; Nagy et al., 2000; Roth et al. 2001). However, this difference was not statistically significant.

It is indicated in the aforementioned data that physiological alterations from aging processes significantly contribute to increase mortality risks following injuries sustained (Demetriades et al., 2004; Kuhne et al. 2005). Nevertheless, there have been no studies investigating the effects of age on physiological responses following management of life threatening conditions. Therefore, these factors have been evaluated in present study.

### **3.3 Co-morbidities**

Pre-injury health status is one of the risk factors which may contribute to the patient's physiological reserve, thus influencing outcome after trauma as physiological, pre-existing medical conditions accompanied by aging (ACS, 2004; Hollis et al., 2006; Plummer, 2009; Stephenson, 2004; Yilmaz et al. 2006). The prevalence of the pre-existing medical conditions in trauma patients has been reported 23.2% (n = 405) (Bergeron et al., 2003), 23% (n = 14,965) (Hollis et al., 2006) and 26% (n = 6,839), as expected, the elderly presented a higher proportion of co-morbidity (Bamvita et al., 2007). For distribution of pre-existing medical conditions, Nagy et al. (2000) concluded that the most common pre-existing conditions were cardiac disease, hypertension and chronic pulmonary diseases. Another study by Bochicchio et al. (2005) reported the most common co-morbidity as the risk factor of tobacco use (24%), followed by hypertension (17%) and coronary artery disease (9%) (n = 1,172). Later, Hollis et al. (2006) proposed cardiovascular disease as the major pre-existing medical condition, followed by respiratory disease (19%) and noted that only 0.2% of the patients had more than one category (n = 14,965).

Previous studies have reported the different effects of pre-existing medical conditions on mortality. Brennan et al. (2002) concluded that chronic liver disease and ischemic heart disease were associated with mortality. Grossman et al. (2002) analyzed outcomes of the study of 33,781 injured patients and found that liver disease, renal disease and cancer were the pre-existing conditions statistically associated with trauma deaths in older patients. Yilmaz et al. (2006) demonstrated that patients with

pulmonary disease or myocardial infarction had a significantly higher mortality rate than those without. Another study by Bamvita et al. (2007) found that acute blunt trauma patients who died had pre-existing medical conditions (60.7%). Interestingly, the majority of these deaths occurred in the intensive care unit (45.8%) or ward (46.4%) and there were few deaths in the emergency room (7.3%). On the contrary, the research findings by Gallagher et al. (2003) demonstrated that cardiac morbidity affects a significant number of older injured patients, but the occurrence of a cardiac event did not portend early mortality. Bochicchio et al. (2005) examined the risk factors and their impact on outcome, but found no statistically significant risk factors on mortality. Moreover, Hollis et al. (2006) reported that the presence of pre-existing medical conditions was not associated with increased mortality in the most severely injured patients.

As mentioned in above data, pre-existing heart disease seems to have greater effect on patient mortality. Myocardial infarction (MI), cardiomyopathy from lifelong hypertension and valvular disease are causes of cardiac dysfunction, resulting in limited reserves available to respond to the stress of injury. Cardiovascular medications to control hypertension may result in impaired ability to respond to hypovolemia. Secondary to MI, Cardiogenic shock has a high risk of death. Injured patients with coronary artery disease can develop cardiogenic shock from an acute coronary thrombosis and MI. Thus, patients with underlying cardiac disease cannot easily increase cardiac output in response to stress to avoid their problems during management of life threatening conditions (Mullins, 2000; Stephenson, 2004). As a result, delayed physiological responses following management of life threatening conditions are seen and may have increased morbidity and mortality.

From the reviewed data, it is found that the ability of the body to recover from acute trauma may be compromised by the presence of pre-existing conditions with impact on mortality as the patient outcome. However, fewer studies to date have evaluated whether the relationships between co-morbidities and the physiological responses of major trauma patients following management of life threatening conditions. Therefore, it may be assumed that the physiological responses of major trauma patients following management of life threatening conditions worsen as co-morbidities present.

### 3.4 Severity of Injury

Severity of injury is well known to be a significant factor affecting patient outcome (Greaves et al., 2001; Guzzo et al., 2005; Van Natta & Morris, 2000). Severity of injury refers to the degree of the harm in the human body and can be determined by a trauma scoring system. The injury occurs because of the body's inability to tolerate exposure to excessive acute energy, thus resulting in anatomic and physiologic damage (Bilgin et al., 2005; Weigelt et al., 2009). Thus, the methods of trauma scoring are based on physiological impairment, anatomic injury sites or several combinations thereof. There are, however, certain limitations in accuracy on any trauma scoring method, despite the use of mathematical models (Levin, Bachtis, Acosta, & Jacoby, 2007; Van Natta & Morris, 2000). The researcher in present study used the RTS, which is a physiological scoring system to determine severity of injury in major trauma patients upon arrival at the emergency room because physiological scores can measure physiological changes presenting in real time during assessment and are much easier to calculate, while anatomic scores require accurate diagnoses which cannot rapidly identify and have limitations in that the one-dimensional representation of the trauma patient's wide variety of multiple injuries (Kanchanarin, 2001; Levin et al., 2007).

The RTS describes an acute dynamic physiological reserve in response to injury representative of vital organ functions comprised of SBP, RR and GCS (Champion et al. 1989; Levin et al., 2007; Van Natta & Morris, 2000). These parameters are coded from 0 to 4 based on the magnitude of physiological derangement. The RTS is calculated by adding the coded values for each of these three physiological parameters. The sum of three coded values ranges from 0-12. Lower values correspond to higher injury severity, thus indicating more physiological impairment (Chawda, Hildebrand, Pape, & Giannoudis, 2004; Gabbe, Cameron, & Finch, 2003; Talbert, 2009). The accuracy and sensitivity of the RTS has been identified as an instrument for predicting the likelihood of serious injury and mortality (Gabbe et al., 2003; Jennings, 2004; Jin et al., 2006; Moore et al., 2006).

Previous studies have shown that severity of injury influences mortality in severely injured patients. Guzzo et al. (2005) studied 15,534 trauma patients and found a mean RTS of  $8 \pm 1$  which was associated with mortality (ROC 0.88, 95% CI; 0.86-

0.91). Freixinet et al. (2008) studied 1,772 chest trauma patients, reporting that patients who had lower RTS scores had higher mortality rates. Brennan et al. (2002) also documented that 76.8 % of the patients who had below normal RTS scores died and that lower RTS values were an independent predictor of mortality. Gabbe et al. (2003) reviewed articles focusing on the use of the RTS in adult trauma populations. This study reported the RTS to be a good predictor of mortality. Kuhls, Malone, McCarter, & Napolitano (2002) reported that the RTS provides a moderate predictor of mortality (AUC = 0.84, 95%CI; 0.818–0.870). Another study by Smith et al. (2007) determined early indicators of mortality and causes of death in hemodynamically unstable patients with pelvic ring injuries. The results indicated that the ISS ( $t = -5.62$ ,  $P < 0.001$ ) and RTS ( $t = 6.10$ ,  $P < 0.001$ ) were statistically significant independent predictors of mortality. In addition, the findings in contemporary trauma death studies have revealed that the vast majority of trauma deaths are secondary to the severity of injury (Tein, Chu, & Brenneman, 2004). These results confirm that severe physiological derangements increase the risk of death.

As indicated in the aforementioned studies, severity of injury also influences the patient's response for management of life threatening conditions. However, previous studies have focused on severity of injury and in-hospital mortality. There has been no study to investigate the effects of severity of injury on physiological responses following management of life threatening conditions. Therefore in this study, the researcher evaluated these factors.

### **3.5 Management of Life threatening Conditions**

According to the life threatening conditions mentioned above, the conditions are results of various causes from severe injuries to the vital organs. The injury patterns for each patient vary greatly in terms of harm to the body. Clinically, patients should be assessed and treatment priorities established based on their injuries, vital signs and injury mechanisms. Referring to the ATLS<sup>®</sup> guidelines, treatment priorities are based on the likelihood of a patient to die within a short time from a life threatening injury according to the "A-B-C-D-E" mnemonic. Using this algorithm, the overall logical sequential treatment priorities must be established for patient assessment. During management of life threatening conditions, causes of hypoxemia

and hypoperfusion are identified and managed simultaneously with a frequent reassessment of the patient's physiological status and response to resuscitative measures (ACS, 2004; Boswell & Scalea, 2009; Hassan & Tesfayohannes, 2006; Kanchanarin, 2004; Kelley, 2005; Stahel et al. 2005; Tal-Or et al., 2009; Unhasuta, 2006a). The evaluation and detection of physiological changes is vital, so early therapeutic interventions may occur (Edwards, 2005b; Greaves et al., 2001) and it may also reflect the outcome. Thus, each step of management of life threatening conditions should be aimed at restoring functions of vital organs to be determined by physiological responses following management of life threatening conditions (Wilson et al., 2003). The effects of each process are described below:

### 1. Airway Management

The first priority of management of life threatening conditions is airway management. Immediate airway assessment should detect lethal causes of hypoxemia as previously mentioned. Airway obstruction is the most common problem in major trauma patients. An obstructed airway must be corrected immediately, because hypoxia can cause severe hypoxic brain damage and cardiac arrest within minutes. Likewise, a clear airway does not ensure adequate ventilation, so any cause of hypoxemia should be corrected. Moreover, the important component of initial airway management is cervical spine protection because cervical spine injuries may be exaggerated by airway management. In any patient at risk, the cervical spine must be stabilized simultaneously with appropriate immobilization devices (ACS, 2004; Greaves et al., 2001).

Assessment of airway patency and spontaneous breathing is the first important step. This can be done by looking, listening and feeling for reduced or absent air flow. If the patient has an appropriate verbal response to questioning, this indicates a patent airway. However, ability to phonate does not indicate that the airway is secure. Supplemental oxygen via oxygen mask with a reservoir bag at 10-12 liters/minute should be administered to all trauma patients. If apnea occurs, a manual airway maneuver should be performed. (Tal-Or et al., 2007).

In case of upper airway obstructions, the airway can be cleared by removing and suctioning any obstructive objects such as blood and foreign bodies and positioning by chin lift and jaw thrust and/or inserting a pharyngeal or

nasopharyngeal airway. In addition, supplemental oxygen via oxygen mask with a reservoir bag at 10-12 liters/minute should be provided as soon as possible. Endotracheal intubation should be used in cases of airway obstruction not relieved by simple maneuvers; airway loss from laryngeal fracture; hematoma from facial injury; and protection of blood or gastric content aspiration. If the patient continues to have insufficient oxygenation or failure to use basic airway adjuncts, a surgical airway which is cricothyroidotomy must be done (ACS, 2004; Cranshaw & Nolan, 2006; Greaves et al., 2001; Hassan & Tesfayohannes, 2006; Kongsamuth, 2001; Unhasuta, 2006a).

If the patient receives correct, complete and rapid airway interventions following airway management, PaO<sub>2</sub>, SaO<sub>2</sub> should be increased, determined by SpO<sub>2</sub> ≥ 95 % (ACS, 2004; Greaves et al., 2001; Tal-Or et al., 2007). In contrast, prolonged hypoxemia from any airway problems can cause rapid death. This death is preventable death mostly resulting from inappropriate airway management (Esposito, Sanddal, Reynolds, & Sanddal, 2003; Gruen et al., 2006; Ivatury et al., 2008; Sugrue et al., 2008; Teixeira et al., 2007). Therefore, airway management is essential intervention with critical effects on physiological responses following management of life threatening conditions to increase the chance of survival.

## 2. Breathing Management

The second step of management of life threatening conditions is breathing assessment and maintenance. The patient's chest should be exposed adequately to assess chest wall excursion. Basic physical examination techniques should be applied to assess breathing condition. Inspection should be done to find abnormal signs of breathing, distended neck veins and any marks or wounds. Palpation may detect subcutaneous emphysema, tracheal deviation and any injuries to the chest wall. Percussion may demonstrate the presence of air and blood in the chest. Auscultation should be performed to assess gas flow in the lungs. Breathing assessment must involve breathing pattern, respiratory rate, effort, chest movement, symmetry of breathing, abnormal breathing sounds and oxygen saturation measured by a pulse oxymeter (normal SpO<sub>2</sub> ≥ 95%) (ACS, 2004; Greaves et al., 2001; Tal-Or et al., 2007).

The process of breathing management emphasizes the importance of immediate identification and treatment of life threatening injuries related to the process of breathing as well as maintenance of ventilation throughout the management of life threatening conditions. An immediate life threatening thoracic injury which must be treated rapidly at this time is tension pneumothorax, open pneumothorax, massive hemothorax and flail chest. Tension pneumothorax requires immediate decompression and is initially managed by rapidly inserting a large-caliber needle into the second intercostal space in the midclavicle line of the injured thorax. Definite treatment usually requires only chest tube insertion into the fifth intercostal space just anterior to the midaxillary line. Open pneumothorax or sucking chest wounds require prompt closure of the defect with a sterile occlusive dressing large enough to cover the wound's edge and taped securely on 3 sides. After that, a chest tube should be placed remote from the wound as soon as possible. Massive hemothorax is initially managed by simultaneous fluid resuscitation and decompression of the chest cavity. Flail chest is usually accompanied by pulmonary contusions which affect impairment of ventilation and oxygenation. Initial therapy includes adequate ventilation, administration of humidified oxygen and fluid resuscitation. If patients have inadequate ventilation, they should be treated by intubation and supported by mechanical ventilators along with intravenous analgesia (ACS, 2004; Attanawanich, 1999; Greaves et al., 2001; Tal-Or et al., 2007; Tanadsiladham, 2001).

Moreover, every major trauma patient should receive supplemental oxygen. If not intubated an oxygen mask with a reservoir bag of 10-12 liters/minute should be provided to achieve optimal oxygenation. In cases of inadequate ventilation and oxygenation, effective ventilation can be achieved by bag-valve-face mask techniques with O<sub>2</sub> 10-15 liters/min. before intubation. The patient must be ventilated periodically during prolonged intubation. During intubation, the cervical spine should be kept in the neutral position. If the cervical collar is taken off, manual axial inline traction should be done. With intubation of the trachea accomplished, assisted ventilation should be followed by using positive pressure breathing techniques. Oxygen saturation should be monitored by a pulse oxymeter and

not lower than 95% (ACS, 2004; Richards & Mayberry, 2004; Tal-Or et al., 2007; Wilson et al, 2007).

Therefore, if the patient receives effective breathing interventions after breathing management, respiratory rate and effort should return to normal, PaO<sub>2</sub>, SaO<sub>2</sub> should also be increased, determined by SpO<sub>2</sub> ≥ 95 % (ACS, 2004; Tal-Or et al., 2007; Wilson et al, 2007). In contrast, deterioration may be caused by inappropriate management and/or potential life threatening presence. Errors or delayed chest tube insertion would impede gas transport and then more aggressively reduced gas exchange results in severe hypoxia and death (Sugrue et al., 2008; Tanadsiladham, 2001). Therefore, breathing management is also a significant treatment towards the outcome of physiological responses following management of life threatening conditions and mortality.

### 3. Circulatory Management

Evaluation of circulation involves assessment of circulatory perfusion and volume status; control of hemorrhage; restoration of intravascular volume if depleted; and frequency re-evaluation. Therefore, rapid and accurate assessment of hemodynamic status, including heart rate, respiratory rate, level of consciousness, capillary refill and character of pulse, such as quality, rate and regularity, is essential and should be accomplished within few seconds. The presence of pallor, diaphoresis, or decreased level of consciousness suggests the presence of hypovolemic shock. A rapid and shallow pulse is also a sign of hypovolemia, but there may be other causes as well. Moreover, lowered blood pressure upon arrival is the most important sign of hypovolemia and requires efforts aimed at hemorrhage control. Consequently, bleeding sources should be identified and managed rapidly at the same time (ACS, 2004; Hassan & Tesfayohannes, 2006; Richards & Mayberry, 2004; Rossaint et al., 2006; Tal-Or et al., 2007; Thavichaigarn & Kanchanarin, 2001).

Rapid control of hemorrhage from external causes can be performed by direct manual pressure on the wound, ligation and application of a tourniquet. Long bones should be splinted and external fixation considered in certain pelvic fractures. Fluid resuscitation should be rapidly administered via two large-bore intravenous catheters in areas not distal to vascular or bony damage. The most desirable sites for peripheral intravenous lines are in the upper extremities. Ringer's

lactate solution is preferred as an initial crystalloid solution. All intravenous solutions should be warmed by storage in a warm environment. For life threatening blood loss, O-negative and/or unmatched type specific blood are also considered necessary. Other peripheral lines, venous cut-down and central venous catheters should be utilized if necessary. If blood loss continues, it should be controlled by operative intervention. In case where cardiac tamponade is strongly suspected in the patient's diagnosis, a subxyphoid pericardiocentesis may help to temporarily normalize hemodynamic status, after which thoracotomy or pericardiotomy surgery should be prompted (ACS, 2004; Hassan & Tesfayohannes, 2006; Richards & Mayberry, 2004; Rossaint et al., 2006; Tal-Or et al., 2007).

Following circulatory management, appropriate fluid replacement can restore intravascular volume and preload, then ventricular filling and cardiac output improves as a result of adequate tissue perfusion. If the patient is responding to circulatory management efforts, the heart rate should tend toward baseline, increase in SBP > 90 mmHg, normal mean arterial pressure (70-100 mmHg), widened pulse pressure (normal 40-60 mmHg), increased urine output > 1.0 ml/kg/hr, improved mental status, SpO<sub>2</sub> ≥ 95 % and decreased serum lactate level (Cottingham, 2006; Dutton & Howard, 2007). In contrast, errors during this process may result in death from compensated circulatory deterioration (Tal-Or et al., 2007). These errors are caused by inaccurate and incomplete assessment leading to inappropriate hemorrhage control and/or fluid replacement (Esposito et al., 2003; Gruen et al., 2006; Ivatury et al., 2008; Sugrue et al., 2008; Teixeira et al., 2007). Inadequate resuscitation or ongoing blood loss result in and cause persistent acidosis. Accumulation of lactic acid and other metabolites are increased risks for mortality (Cottingham, 2006; Dutton & Howard, 2007). These results indicate that effective circulatory management affects physiological responses following management of life threatening conditions as an outcome.

#### 4. Disability (Neurologic Evaluation)

A rapid neurological evaluation is performed immediately after identified life threatening conditions related to airway, breathing and circulation. This process establishes the patient's level of consciousness, papillary size and reaction, lateralizing signs and spinal cord injury level. A decreased level of consciousness may

indicate decreased cerebral oxygenation that should initially be attributed to hypoxia, hypovolemia, cerebral injury or hypoglycemia. However, the effects of drugs, alcohol, hypothermia and metabolic causes should be considered (ACS, 2004; Tal-Or et al., 2007). Additionally, unconscious patients who have  $GCS \leq 8$  usually appear to have irregular breathing with decreased  $SaO_2$  ( $SpO_2 < 95\%$ ) and increased  $PaCO_2$ . These patients must receive effective airway and breathing management to provide tissue perfusion which contributes to improved physiological responses following management (Hassan & Tesfayohannes, 2006; Kongsamuth, 2001; Parks, 2004; Richards & Mayberry, 2004; Unhasuta, 2006a).

#### 5. Exposure/ Environment Control

The physical examination in this process is aimed at investigating hidden life threatening injuries to help the patient receive correct and appropriate treatment and also find possible evidence of injured lesions by the log-rolled technique. The patient should be completely undressed before being surveyed from head to toe, front and back, including axillae and perineum. Hypothermia must be prevented by assessing body temperature and using warm blankets to cover the patient during and after the investigations. Moreover, intravenous fluids should also be warmed ( $39^\circ C$ ) to prevent hypothermia. All findings of these examinations must be documented in the patient's chart (ACS, 2004; Kongsamuth, 2001; Richards & Mayberry, 2004; Tal-Or et al., 2007).

#### 6. Monitoring and Re-evaluation

The trauma patient must be frequently reassessed for airway, breathing and circulation to assure that new findings are not omitted with constant monitoring of physiological changes to discover deterioration from previous findings. Changes or deteriorations in patient status must be identified early so immediate interventions can be initiated as necessary. Hemodynamic stats, such as blood pressure, respiratory rate, heart rate, pulse rate, ECG, MAP, pulse pressure, oxygen saturation; urine output; level of consciousness, GCS, pupil size and reaction to light; and serum lactate level should be monitored every 5 minutes (ACS, 2004; Cottingham, 2006; Hassan & Tesfayohannes, 2006). Additionally, well-documented information aids in determining whether subsequent findings are new injuries or changes from an evolving injury process (ACS, 2004; Hassan & Tesfayohannes, 2006). Furthermore,

protection of the patient's confidential information is required and information should be given by physicians or responsible nurses (Kneale, 2003; Unhasuta, 2006b).

As mentioned above, major trauma patients with life threatening conditions are at risk of death from the scene until departure from the emergency room, especially, in the initial phase of care known as the golden hour following injury. Medical errors often occur during this phase as a result of delay and failure in the treatment process (Chadbunchachai, 2004; Sakolsatayadorn, 1999). Accurate and appropriate management of life threatening conditions should aim at maintaining life and preventing further complications. However, management of life threatening conditions alone does not ensure patient survival unless definite treatment for the primary cause of the respiratory and/or circulatory failure is administered (Rady, 2005). Furthermore, physiological responses during and after the management of life threatening conditions should be mentioned to reassess and indicate early outcomes.

#### **4. Conclusion**

Major trauma patients encounter life threatening conditions caused by hypoxemia and hypoperfusion leading to inadequate tissue perfusion and organ dysfunction resulting in death. These conditions require rapid and accurate management to identify and correct life threatening conditions. The goal of management of life threatening conditions is hemodynamic status, tissue oxygenation and metabolic derangement returned to normal range. However, physiological responses to management of life threatening conditions are associated with many factors comprised of the following: 1) time for management of life threatening conditions consisting of triage time and resuscitation time. Shorter times for management of life threatening conditions would secure the patient's life from life threatening conditions; 2) the advanced age of the patient and diminished organ functions from decreased physiological resilience; 3) co-morbidities contributing to the creation of pathophysiological lesions of such organs resulting in impaired compensatory mechanisms; 4) severity of injury and disability of compensatory mechanisms, thus preventing the body from maintaining homeostasis and 5) proper management by accurate, prioritized and complete assessment and interventions improve patient conditions following management of life threatening conditions.

These factors must be considered during and after management of life threatening conditions. In addition, physiological responses following management of life threatening conditions should be evaluated frequently and constantly until the patient has left the emergency room. If the patient's condition worsens, trauma team members responsible for the provision of care should re-assess and find the causes of any problems and then perform appropriate life-saving interventions. As a result, preventable death due to management of life threatening conditions can be prevented.

There have not been any previous studies on factors associated with the physiological responses of major trauma patients following management of life threatening conditions. This study aimed to examine the factors associated with the physiological responses following management of life threatening conditions and also reflecting the efficacy of trauma care. The findings of this study could be used as essential information for improving outcomes for major trauma patients.

## **CHAPTER III**

### **METHODOLOGY**

This study was based on a descriptive research design aimed at examining the factors associated with the physiological responses of major trauma patients following management of life threatening conditions.

#### **Population and Sampling**

The population for this study was comprised of major trauma patients with severe injuries caused by external causes as identified by International Statistical Classification of Diseases and Related Health Problems (ICD 10-TM) coded V01-Y34 who received trauma resuscitation from the Outpatient Trauma Unit, Siriraj Hospital. The researcher observed the provision of management for life threatening conditions beginning with the triage until the trauma resuscitation was finished and evaluated the physiological responses of major trauma patients following the management of life threatening conditions.

The samples for this study were selected by the purposive criteria method based on the following criteria:

##### **Inclusion Criteria**

1. Age over 13 years
2. CRAMS score equal to or less than 8

##### **Exclusion Criteria**

1. Pregnancy
2. Victims of mass casualty
3. Transfers from other hospitals
4. Death before hospital arrival
5. Death during management of life threatening conditions

The sample size in this study was calculated based on Power Analysis (Polit & Beck, 2008). Given a conventional level of power of test 0.80, the alpha level of significance for two-tailed hypothesis test 0.05 and a medium effect size of 0.30, a sample size of 88 was necessary. Eighty eight participants were approached to participate in this study. However, five participants refused to be research samples. Therefore, the samples in this study were 83 major trauma patients.

## Setting

This study examined the management of life threatening conditions of major trauma patients, arrived at the Outpatient Trauma Unit, Siriraj Hospital as an excellent Level I trauma center providing trauma care for all possible needs of trauma patients 24 hours a day by specially trained trauma team with traumatologists, neurologists, orthopedists, anesthesiologists and trauma nurses. The statistical record of Siriraj Hospital shows the average emergency care of injured patients as 2,000 persons per month. There were 147 major trauma patients requiring hospitalization per month in 2007 (Trauma Association of Thailand, 2007) and 561 patients requiring resuscitation for an average of 47 patients per month in the same year (Statistics of Siriraj's Outpatient Trauma Unit, 2007). Every major trauma patient receiving management of life threatening conditions comprising triage, assessment and management from the trauma team which generally has a patient- trauma surgeon-trauma nurse ratio of approximately 1 : 1 : 2 – 1 : 2 : 3.

## Research Instruments

The instrument for data collection was divided into the following three parts:

**1. Major Trauma Patient Demographic Data Records:** The recorded data comprised gender, age, date and time of injury, time on arrival, triage time, triage outcome, cause of injury, type of injury, co-morbidities, pre-hospital care, site of injury, life threatening conditions and CRAMS scale score.

CRAMS scale was used to identify major trauma patients by assessing circulation, respiration, abdomen/thorax, motor and speech. Each parameter had a 0 -2 score. The total scores ranged from 0 -10 where a score of 8 or less was considered

major trauma (Gormican, 1982 cited by Batchelor, 2000; Kosmos, 1995; Sharma, 2005) as shown in Table 1.

**Table 1** - CRAMS scale

Components	Score		
	2	1	0
C - Circulation	Normal Capillary Refill and SBP $\geq 100$	Delayed Capillary Refill Or SBP $\geq 85 < 100$	No Capillary Refill Or SBP $< 85$
R - Respiration	Normal	Abnormal (Labored or Shallow)	Absent
A – Abdomen /Thorax	Abdomen and Thorax Not Tender	Abdomen Or Thorax Tender	Rigid Abdomen or Flail Chest or Penetrating Injuries
M - Motor	Normal	Response Only to Pain (Not Decerebrate)	No Response (Decerebrate)
S – Speech	Normal	Confused	Unintelligible Words

Adapted from Bachelor (2000): Adult Pre-Hospital Scoring System - A Critical Review (*Trauma*, 2, 255)

**2. Records of factors associated with the physiological responses of major trauma patients with life threatening conditions** were as follows:

2.1 Records of time for management of life threatening conditions consisted of:

2.1.1 Triage time was measured in seconds starting from the time when the major trauma patient received assessment from a triage nurse until he was transferred to the emergency room.

2.1.2 Resuscitation time was measured in minutes and seconds starting from the arrival of major trauma patient in the emergency room and received initial assessment and management of airway, breathing, circulation, disabilities,

exposure/environment and coordination with the trauma nurse coordinator (TNC) or a nurse responsible for the management of life threatening conditions until the management of life threatening conditions was finished.

2.1.3 The time for management of life threatening conditions was measured in minutes and seconds of the sum of the triage and resuscitation times.

2.2 Record of severity of injury. This record was adapted from the Revised Trauma Score (RTS), which was developed by Champion and colleagues (1989) to measure trauma severity. The RTS is a physiological score comprising 3 variables: systolic blood pressure (SBP); respiratory rate (RR); and Glasgow Coma Scale score (GCS). For the GCS, points were given for eye opening (E, scored 1–4), best verbal response (V, scored 1-5) and best motor response (M, scored 1–6). Thus, the total GCS score ranged from 3 to 15. The RTS was calculated from the coded value of each variable (scored 0 – 4). The total score of severity of injury ranged between 0-12 (Table 2).

**Table 2** Revised Trauma Score

<b>Glasgow Coma Scale Score (GCS)</b>	<b>Systolic Blood Pressure (SBP)</b>	<b>Respiratory Rate (RR)</b>	<b>RTS Coded Value</b>
13-15	> 89	10-29	4
9-12	76-89	> 29	3
6-8	50-75	6-9	2
4-5	1-49	1-5	1
3	0	0	0

Adapted from Champion et al. (1989): A revision of the trauma score (*The Journal of Trauma*, 29(5), 624)

2.3 The assessment form for management of life threatening conditions. This instrument was used to evaluate initial assessment and management of airway, breathing, circulation, disabilities, exposure/environment and coordinate with the TNC or nurse responsible for management of life threatening conditions. The researcher modified from The Resuscitation Management Self Evaluation Assessment Form

which was developed by Unhasuta and the Trauma Nurse Network of Thailand (2008) for assessment of resuscitation management of life threatening conditions in 221 injured-patients in emergency rooms at 12 hospitals. This checklist Form consists of 12 items. The reliability value was 0.92 (Unhasuta and Trauma Nurse Network of Thailand, 2008). The researcher modified each item to assess major trauma patients receiving management of life threatening conditions and added 2 more items for coverage and completion. Thus, this instrument contained 14 items and each item was based on 3-level scales scored and interpreted as follows:

- |                       |   |   |
|-----------------------|---|---|
| Received              | = | The patient received correct and complete procedures for management of life threatening conditions (score = 1). |
| Received Incompletely | = | The patient received correct but incomplete management of life threatening conditions (score = 0).              |
| Not received          | = | The patient did not receive any procedure of management of life threatening conditions (score = 0).             |

The total scores ranged from 0 to 14 where a high score reflected the complete procedures patient received for management of life threatening conditions and a low score reflected the incomplete procedures patient received for management of life threatening conditions.

### **3. Record form for the physiological responses of major trauma patients receiving management of life threatening conditions:**

3.1 The record form for the physiological responses of major trauma patients receiving management of life threatening conditions is a record documenting the patient's responses to management of life threatening conditions e.g. tissue oxygenation, tissue perfusion every 5 minutes starting from initial assessment and management until the management of life threatening conditions was finished and documenting metabolic changes following management of life threatening conditions. They are as follows:

3.1.1 Assessment of tissue oxygenation, which included oxygen saturation measured by pulse oximetry (SpO<sub>2</sub>) and respiration rate (RR)

3.1.2 Assessment of tissue perfusion, which included systolic blood pressure (SBP), heart rate (HR), pulse rate (PR), mean arterial pressure (MAP), capillary refill, level of consciousness (LOC), urine output and bowel sounds

3.1.3 Assessment of metabolic changes which included blood lactate level.

3.2 Record form for the outcomes of the physiological responses of major trauma patient following management of life threatening conditions. The outcome was evaluated by assessing SBP, SpO<sub>2</sub> and blood lactate level following management of life threatening conditions in 3 categories as follows:

3.2.1 Improved physiological responses mean major trauma patients have SBP  $\geq 90$  mmHg, SpO<sub>2</sub>  $\geq 95$  % and blood lactate level  $\leq 2$  mmol/L following management of life threatening conditions.

3.2.2 Unchanged physiological responses mean major trauma patients have SBP, SpO<sub>2</sub> following management of life threatening conditions at the same level before receiving management of life threatening conditions and blood lactate level  $\sim 2$  mmol/L following management of life threatening conditions.

3.2.3 Worsened physiological responses means major trauma patients have SBP  $< 90$  mmHg, SpO<sub>2</sub>  $< 95$  % and blood lactate level  $> 2$  mmol/L following management of life threatening conditions.

## **Measurement of Instrument Qualifications**

### **Validity Measurement**

The researcher examined the validity of the instrument, comprising the major trauma patients' demographic data records, the records concerning factors associated with the physiological responses of major trauma patients consisting of the record for the time of management of life threatening conditions, the record of severity of injury, the assessment form for management of life threatening conditions and the record form of the physiological responses of major trauma patients receiving management of life threatening conditions by a panel of 5 experts. This panel was composed of one trauma surgeon, one anesthesiologist, one trauma nurse coordinator

and two nurses with expertise in the management of life threatening conditions (Appendix A). Content validity was examined and comments on content, accuracy and coverage of the instrument were made among the members of the panel. The instrument was then modified and amended in terms of language and content accuracy according to suggestion of the experts.

### **Reliability Measurement**

After receiving approval from the panel of experts, the assessment form for the management of life threatening conditions was tried out for reliability with 15 patients who met the inclusion criteria. The researcher used the instrument to assess the provision of management for life threatening conditions and documented data. The obtained data were then calculated for reliability, using Cronbach's alpha Coefficient. The reliability value of the assessment form for the management of life threatening conditions was 0.72, when applied with 83 patients; the reliability value was found to be 0.523.

### **Protection of Human Subjects**

In this study, the researcher was well aware of and concerned about the values, rights and autonomy of the research participants according to the ethical principles of human research and potential impact on the samples, because the samples were major trauma patients with severe injuries requiring immediate management of life threatening conditions upon arrival at the hospital. The researcher was obligated to observe and document data before explaining the details of the study and asking for the participation in the study. When the management of life threatening conditions had been completed and the patient or their relatives had received medical information from TNC or the nurse responsible for management of life threatening conditions, the researcher explained the objectives, expected benefits, inclusion and exclusion criteria of sample selection and data collection before requesting the patient's participation in the study. The patients and their relatives were free to participate or refuse participation in the study. The patients were assured their refusal to be research participants or withdrawal from the study would have no effects on the provision of treatment and trauma care. If the patients or their relatives refused to participate or when a patient's data did not meet the inclusion criteria, the data was excluded and

destroyed without delay. All obtained data was be kept confidential and employed for this research only. The findings of this study were reported only as the overall conclusions of the study.

## **Data collection**

In this study, the researcher collected data in following steps:

1. The researcher sent an introduction letter issued by the Dean of the Faculty of Graduate Studies, Mahidol University, to the Dean of the Faculty of Medicine, Siriraj Hospital, and the Standard Institutional Review Board (SIRB) and requested permission to conduct data collection.

2. The research proposal was submitted to the SIRB, the Faculty of Medicine, Siriraj Hospital, Mahidol University, requesting permission for the data collection in the Outpatient Trauma Unit. The researcher collected the data on the physiological responses of major trauma patients with life threatening conditions every day from 1.00 p.m. to 4.00 p.m., 6.00 p.m. to 9.00 p.m. and 11.00 p.m. to 5.00 a.m. of the next day from 12 December 2008 to 23 April 2010.

3. After the research proposal had been granted, the researcher met the Head of the Nursing Department of Siriraj Hospital, the Head of the Operative Nursing Division, and the Head Nurse and trauma nurses of the Outpatient Trauma Unit to explain the objectives of the research and the procedure to perform the data collection.

4. The researcher performed the data collection for each patient as described below:

- 4.1 When the patients arrived at the hospital, the researcher observed them and documented data on gender, age, date and time of injury, time of arrival, triage time, triage outcome, cause of injury, type of injury, co-morbidities, pre-hospital care, site of injury, life threatening conditions, CRAMS scale score and starting time for management of life threatening conditions.

- 4.2 During the management of life threatening conditions, the researcher recorded the starting time for management of life threatening conditions, assessed severity of injury, and assessed the management of life threatening conditions.

4.3 When the management of life threatening conditions was finished and the patient or their relatives had received information from the TNC or the nurse responsible for management of life threatening conditions, the researcher introduced herself to patients or their relatives, explained the research objectives, expected benefits, sample selection and data collection before requesting their participation in the research. In cases with conscious patients capable of signing informed consent forms, the researcher asked the patients for permission. On the other hand, the researcher asked the patients' relatives as the legal representative of the patients for permission when the patients were unconscious. Once the human rights protection of the patients had been assured, the researcher asked them to sign the informed consent form. In cases where the patients or their relatives refused to participate in the study, the patients' data was excluded and immediately destroyed.

5. After completion of the data collection from 83 participants, the researcher checked the accuracy of the data. The collected data were analyzed by using the Statistical Package for Social Science (SPSS), version 16.

## **Data Analysis**

The data were analyzed as detailed below:

1. Frequency and percentage were used for the analysis of data related to gender, age, triage outcome, cause of injury, type of injury, co-morbidities, pre-hospital care, site of injury, life threatening conditions, time for management of life threatening conditions, severity of injury, management of life threatening conditions and physiological responses of major trauma patients following management of life threatening conditions.

2. The mean and standard deviation of patients' age, management of life threatening conditions and time for management of life threatening conditions were calculated.

3. The relationships between the time for management of life threatening conditions, age, co-morbidities, severity of injury, management of life threatening conditions and physiological responses following management of life threatening conditions were analyzed using Spearman Rank-Order Correlation Coefficient at the statistically significant level 0.05.

## **CHAPTER IV**

### **RESULTS**

The purpose of this study was to examine the factors associated with the physiological responses of major trauma patients following management of life threatening conditions. Eighty eight patients were approached to participate in this study. Five patients declined to be research samples. Therefore, the sample in this study was composed 83 major trauma patients who received trauma resuscitation at the Outpatient Trauma Unit, Siriraj Hospital. Data collection was conducted from December 2008 to April 2010. The results are presented in 4 parts as follows:

1. The demographic data of the major trauma patients
2. The factors associated with the physiological responses of major trauma patients following management of life threatening conditions
3. Physiological responses of major trauma patients following management of life threatening conditions
4. The relationships between the time for management of life threatening conditions, age, co-morbidities, severity of injury, life threatening management and physiological responses of major trauma patients following the management of life threatening conditions

## 1. Demographic Data of Major Trauma Patients

A total of 83 major trauma patients participated in the study. It was found that the majority of these patients were males (92.8%). Most patients were transferred from scene to hospital within 30 minutes (77.1%). The triage outcome was incomplete as 21.7% of the patients were undertriage. The major cause of injury was found to be assault (44.6%), followed by transport accidents (42.2%). The patients were injured by blunt mechanisms (57.8%) and penetrating mechanisms (39.8%). Approximately, 61.45% of the major trauma patients had received pre-hospital care. Most of them had had patient assessments and spinal board splinting. The head was the main site of injury (47%), followed by both chest and abdomen (33.7%). About 66.3% (55 patients) had life threatening conditions. Seven patients had more than one life threatening conditions. The most common life threatening conditions were airway obstruction (28.92%), followed by hemorrhage (21.7%), and dyspnea (16.9%). Most of the patients had CRAMS scale scores of 8 (40%), followed by 7 (36.1%), and 6 (16.9%). Above findings are displayed in Table 3.

**Table 3** Demographic Data of Major Trauma Patients (n = 83)

Characteristics	Number	Percentage
<b>Gender</b>		
Males	77	92.8
Females	6	7.2
<b>Transfer Times</b>		
≤ 30 min	64	77.1
> 30 min	19	22.9
<b>Cause of Injury</b>		
Transport Accidents	35	42.2
Assault	37	44.6
Falls	7	8.4
Exposure to Inanimate Mechanical Forces	2	2.4
Intentional Self-harm	1	1.2
Unidentified Causes	1	1.2

**Table 3** Demographic Data of Major Trauma Patients (n = 83) (Continued)

<b>Characteristics</b>	<b>Number</b>	<b>Percentage</b>
<b>Type of injury</b>		
Blunt injury	48	57.8
Penetrating injury	33	39.8
Blunt and penetrating injury	2	2.4
<b>Site of Injury (One patient had more than one site of injury)</b>		
Head	39	47.0
Neck	11	13.3
Chest	28	33.7
Abdomen and Back	28	33.7
Pelvis	5	6.0
Upper extremities	18	21.7
Lower extremities	13	15.7
<b>Life threatening conditions (One patient had more than one life threatening condition)</b>		
None	28	33.7
Airway Obstruction	25	30.1
Dyspnea	14	16.9
Hemorrhage	18	21.7
Tension Pneumothorax	2	2.4
Spinal injury	1	1.2
<b>CRAMS Scale Score</b>		
8	34	41.0
7	30	36.1
6	14	16.9
5	3	3.6
4	2	2.4

## **2. Factors associated with physiological responses of major trauma patients following management of life threatening conditions**

### **2.1 Time for management life threatening conditions**

The findings revealed that the majority of times for management of life threatening conditions ranged from 10.01 to 20.00 minutes (56.6%), followed by 20.01-30.00 minutes (21.7%), 5.01-10.00 minutes (16.9%), and more than 30 minutes (4.8%) (Mean = 16.97, S.D. = 9.03). For each period of time for management of life threatening conditions, most of the triage periods were between 0.30-1.00 minutes (79.5%); resuscitation period was 10.01-20.00 minutes (49.4%), followed by 5.01-10.00 minutes (22.9%), and, 20.01-30.00 minutes (19.3%). The above findings are displayed in Table 4 and Appendix E.

### **2.2 Patient's age**

It was revealed by findings that most of the major trauma patients were aged between 26-35 years (30.1%), followed by 13-25 years (27.7%), and 36-45 years (24.1%). Notably, eighty-two percent of the patients were 13-45 years of age. The patients were aged between 14-81 years with a mean age of 34.75 years (S.D. = 14.164). The findings are displayed in Table 4.

### **2.3 Co-morbidities**

It was also revealed by the findings that most major trauma patients (77.1%) had no pre-existing medical conditions. Thus, only 19 patients (22.9%) had pre-existing health problems. The most common co-morbidities were hypertension (8.4%) and respiratory disease (6%). These findings are presented in Table 4.

### **2.4 Severity of injury**

The findings revealed that the majority of the patients were initial RTS score 12 (32.5%), followed by RTS 11 (30.1%), and RTS 10 (22.9%). The findings are displayed in Table 4.

### **2.5 Management of life threatening conditions**

The findings revealed that the mean score for management of life threatening conditions was 10.12 (S.D. = 1.533). The most frequently encountered score for management of life threatening conditions was 11 (25.3%), followed by scores of 12 (20.5%), and scores of 10 (18.1%). Patients' conditions were identified within 2 minutes and rapid management was performed together with physicians and

nearly completed (98.8%). Only 4 major trauma patients received complete documentation (4.8%), and 6 patients (7.2%), were kept warm and had environment control. The findings are displayed in Table 4 and Appendix E.

**Table 4** Factors associated with physiological responses of major trauma patients following management of life threatening conditions (n = 83)

Characteristics	Number	Percentage
<b>Time for management of life threatening conditions (minutes)</b>		
5.01 – 10.00	14	16.9
10.01 – 20.00	47	56.6
20.01 – 30.00	18	21.7
> 30.00	4	4.8
(Mean = 16.97, S.D. = 9.03, Min =5.28, Max =54.18)		
<b>Age (years)</b>		
13 – 25	23	27.7
26 – 35	25	30.1
36 – 45	20	24.1
46 – 55	8	9.6
56 – 65	4	4.8
> 65	3	3.6
Mean = 34.75, S.D. = 14.164		
Range = 67 (Min = 14, Max = 81)		

**Table 4** Factors associated with physiological responses of major trauma patients following management of life threatening conditions (n = 83) (Continued)

<b>Factors</b>	<b>Number</b>	<b>Percentage</b>
<b>Co-morbidities</b> (One patient had more than one co-morbidity)		
None	64	77.1
Hypertension	7	8.4
Respiratory Disease	5	6.0
Heart Disease	3	3.6
Diabetes Mellitus	3	3.6
Liver Disease	2	2.4
Hyperthyroidism	1	1.2
AIDS	1	1.2
<b>Severity of Injury</b>		
RTS 12	27	32.5
RTS 11	25	30.1
RTS 10	19	22.9
RTS 9	2	2.4
RTS 8	8	9.6
RTS 7	1	1.2
RTS 6	1	1.2
<b>Management of life threatening conditions</b> (score)		
6	1	1.2
7	2	2.4
8	12	14.5
9	14	16.9
10	15	18.1
11	21	25.3
12	17	20.5
13	1	1.2
(Mean = 10.12, S.D. = 1.533)		

### **3. Physiological responses of major trauma patients following management of life threatening conditions**

The findings revealed that most patients improved physiological responses following management of life threatening conditions (44.6%). Twenty four patients had deteriorating conditions (28.9%), and twenty two patients remained unchanged (26.5%). This is displayed in Table 5.

**Table 5** The physiological responses of major trauma following management of life threatening conditions (n = 83)

<b>Factors</b>	<b>Number</b>	<b>Percentage</b>
<b>Physiological responses</b>		
Worsened	24	28.9
Unchanged	22	26.5
Improved	37	44.6

### **4. The relationships between the time for management of life threatening conditions, age, co-morbidities, severity of injury, management of life threatening conditions, and physiological responses of major trauma patients following management of life threatening conditions**

The relationships between the time for management of life threatening conditions, age, co-morbidities, severity of injury, management of life threatening conditions and the physiological responses of major trauma patients following management of life threatening conditions were analyzed by Spearman Rank-Order Correlation Coefficient. The result indicated that there were no relationship between time for management of life threatening conditions, age, co-morbidities, severity of injury, management of life threatening conditions and the physiological responses of major trauma patients following management of life threatening conditions.

Furthermore, the findings revealed that age had a positive, significantly correlation with co-morbidities ( $\rho = .322$ ,  $p < .01$ ) and a negative, significantly

correlation with severity of injury ( $\rho = -.264$ ,  $p < .05$ ). Additionally, time for management of life threatening conditions had a negative correlation with severity of injury ( $\rho = -.418$ ,  $p < .01$ ). Finally, time for management of life threatening conditions had a negative correlation with the management of life threatening conditions ( $\rho = -.315$ ,  $p < .01$ ), as shown in Table 6.

**Table 6** The Spearman Rank-Order Correlation Coefficient of each variable

<b>Factors</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>
1. Time for management of life threatening conditions	1.000					
2. Age	.157	1.000				
3. Co-morbidities	.084	.322**	1.000			
4. Severity of injury	-.418**	-.264*	-.087	1.000		
5. Management for life threatening conditions	-.315**	-.103	-.131	.107	1.000	
6. Physiological Responses following management for life threatening conditions	-.122	-.183	.188	.191	.057	1.000

\*  $p < .05$ , \*\*  $p < .01$

## **CHAPTER V**

### **DISCUSSION**

This research was aimed at examining the factors associated with physiological responses of major trauma patients following management of life threatening conditions. The findings of this study are discussed in terms of the following issues: 1) Characteristics of major trauma patients; 2) Correlation of factors associated with the physiological responses of major trauma patients following management of life threatening conditions.

#### **1. Characteristics of Major Trauma Patients**

Research findings indicated that the majority of the major trauma patients were males (92.8%). The patients were aged between 14 - 81 years with a mean age of 34.75 years. The largest age group was 13-45 years of age (82%). These findings were congruent with the findings of previous studies, in which it was found that the majority of major trauma patients were men (76%) with a median age of 38 years (range: 1-86; interquartile range: 23-55 years) (Lossius et al., 2001). These findings were also similar to a study by Spanjersberg et al. (2009) who found that 73% of trauma patients were men with a mean age of 33 years (S.D. 19). Jin et al. (2006) also found the majority of multiple trauma patients to be males (74.3%) with a mean age of 41.7 years. Moreover, Paladino, Sinert, Wallace anderson, Yadav and Zehtabchi (2008) reported major trauma patients in their study sample as having a mean age of 38.3 years with 83.1% of patients being males. In Thailand, the study by Saisud (2004) showed that the majority of trauma patients were male (80%) and aged between 16 – 77 years with a mean of age of 33.42 years. These results reinforce the natural trend of trauma patients as continuing to exist in men and younger populations (Potenza & Nolan, 2007).

It was found in the present research that about 57.8% of the patients suffered from blunt trauma. It's similar to a study by Demetriades et al. (2004) who

found patients injured by blunt trauma (65%) and penetrating trauma (35%). Another study by Saisud (2004) studied trauma patients who had received pre-hospital care and also reported that 93% of trauma patients had suffered blunt trauma. A recent study in Hong Kong by Leung and colleagues (2010) also found that the majority of patients suffered from blunt trauma (n=1218 or 83.9%), while penetrating injuries occurred in 129 (8.9%) patients. From the present study, it can be concluded that transport accidents and fall were the main causes of blunt trauma (50.6%). Not surprisingly, the most common site of injury encountered in this study was the head (47%), followed by chest, abdomen and back (33.7%). These findings concurred with previous studies (Bernhard et al., 2007; Jin et al. 2006; Leung et al., 2010; Saisud, 2004). Thus, airway obstruction was responsible for the majority of life threatening conditions (30.1%), followed by hemorrhage (21.7%) and dyspnea from respiratory distress (16.9%). This can be explained in light of the fact that head trauma patients usually have an obstructed airway caused by relaxation of the tongue and oropharynx during unconsciousness (Cranshaw, & Nolan, 2006). By CRAMS scale scores, most of the patients were scored at 8 (41.0%) and 7 (36.1%).

This study also found that assault was the main cause of injury (44.6%), followed by transport accidents (42.2%) and falls (8.4%). Another study by Saisud, examined in the Thai social context and reported traffic accidents as the most common cause of injury (75%), followed by assault (14%). Another study by Freixinet et al. (2008) showed that the significant causes of injury were road traffic accidents (43.5%) and home and leisure accidents (36.1%). Other causes were physical aggression (10.2%) and work related accidents (5.7%). Thus, it is worthy to note that assault significantly increased in this study. This could be added that violence is the current problem in society. Furthermore, alcohol use is thought to be a significant contributor to the high incidences of violence (WHO, 2002).

## **2. Correlation of factors associated with physiological responses of major trauma patients following management of life threatening conditions**

According to the research findings, there was no any statistical significance between the independent variables i.e. time for management of life threatening conditions; age; co-morbidities; severity of injury; management of life threatening conditions and dependent variables i.e. the physiological responses of major trauma patients following management of life threatening conditions. The discussions of the findings are described below:

### **2.1 The relationships between the time for management of life threatening conditions, age, co-morbidities, severity of injury, management of life threatening conditions, and the physiological responses of major trauma patients following management of life threatening conditions**

#### **Time for Management of Life threatening Conditions**

According to the research findings it can be said that time for management of life threatening conditions was not statistically significant from the physiological responses of major trauma patients following management of life threatening conditions. Thus, it can be construed that the findings of the research did not support research hypothesis. The possible explanations might be found in following factors: 1) patient characteristics; 2) trauma team performance; 3) transfer time and prehospital care; and 4) outcome measurement. Patient characteristics might affect resuscitation times, with the more severely injured patients taking longer time to resuscitate. In aspect of trauma team performance, the patients who received airway and breathing intervention took longer time to complete procedure i.e. intubation. For the third factor, the patients who received prehospital care, primary assessment and management were performed from scene. Additionally, if the patients received rapid transfer, severe physiological compromises may not occur. Finally, blood lactate levels change more slowly than SpO<sub>2</sub>, and SBP. Therefore, interpretation of outcome may not accurately enough in this study.

The findings also demonstrated that the mean time for management of life-threatening conditions was 16.97 minutes. The examination of the related literature for management of life threatening conditions demonstrated that the median time of the primary survey in severely traumatized patients was 10.0 minutes (Spanjersberg et al., 2009). Another study by Lossius and colleagues (2001) reported that the median time from admission to first x-ray was 5 minutes in severely injured patients once the trauma team was activated. Hilbert et al. (2007) reported an average length of stay in the trauma room of 38 min. In a study by Van Olden and colleagues (2003a), the median time of resuscitation in severely injured patients treated by mobile medical teams was 41.30 minutes. Moreover, the study of Van Olden and colleagues (2003b) demonstrated the median time of resuscitation in severely injured patients as 49 minutes. These findings revealed that the time for management of life threatening conditions varied in each study.

The first hour after injury is the golden hour of trauma resuscitation that affects the outcome. Clinically, the shorter times for management of life threatening conditions affects patient survival and prolonged times are associated with negative outcomes (Bernhard et al., 2007; Van Olden et al., 2003a; Van Olden et al., 2003b). The related literature supported that time interval from injury to definite care of 60 minutes or more was significantly associated with death within 30 days following injury (Lossius et al., 2001). In contrast, Spanjersberg and colleagues (2009), Van Olden and colleagues (2003a) concluded that shorter resuscitation times do not necessarily mean improved resuscitations. Differences in results can also be described by dissimilarities in the study design, patient population and structure of resuscitation.

### **Age**

This study found no statistical significance between age and the physiological responses of major trauma patients following management of life threatening conditions. Thus, the research hypothesis was not supported by the outcome. Upon consideration of the majority of the patients, 82 % of them were aged between 13-45 years. Only 3.6% of them were aged > 65 years. The fewer participants in the age group at > 65 years may be a reason that can be explained. In young

patients, physiological derangement from injury and resuscitation may be hidden by compensatory mechanisms.

The researcher did not find any study related to the correlation between these factors as previous studies focused on age as a risk factor for mortality (Bergeron et al., 2003; Demetriades et al., 2004; Giannoudis, Harwood, Court-Brown, & Pape, 2009; Harris et al., 2003; Kuhne et al. 2005, Ottochian et al., 2009). Harris and colleagues (2003) found that the risk of mortality for patients suffering head injuries increased as early as 30 years of age, with the greatest increase occurring after age 60 ( $p < .001$ ). This finding was similar to a study by Demetriades et al. (2004) who found that the highest number of trauma-related mortalities occurred in the age group of 21 to 40 years for both penetrating and blunt trauma, which i.e. this risk decreased after the age of 40 years. The study of Bergeron and colleagues (2003) found that early deaths ( $\leq 72$  hours) occurred almost exclusively in patients younger than 65 (0.9% vs. 6.5%;  $p = 0.02$ ). However, overall mortality was significantly higher in the elderly patients.

In another retrospective study by Kuhne et al. (2005) it was demonstrated that mortality in severely injured elderly trauma patients increased beginning at the age of 56 years and that increase was independent of the injury severity (ISS). A recent study by Ottochian and colleagues (2009) showed that the mortality of penetrating trauma patients was higher for each group and significantly increased after age 65. Additionally, Giannoudis and colleagues (2009) discovered that mortality rates in older patients were more than twice those seen in the adult population (19% in the under 40's to almost 50% in patients over 75). Moreover, present study found that four patients who had improved physiological response following management of life threatening conditions were aged  $< 35$  years. Thus, increasing age is a risk factor for morbidity and mortality that should be considered when evaluating trauma patients at all phases of trauma care.

### **Co-morbidities**

Research found no any statistically significant relationships between co-morbidities and the physiological responses of major trauma patients following management of life threatening conditions. Thus, in this factor also the research

hypothesis was not supported by the findings. It was found that, the majority of the patients had no pre-existing medical conditions (77.1%). It was indicated that most patients were healthy person. Thus, physiological compromises from injury and resuscitation were effective protection from compensatory mechanisms. This fact can be supported by various research findings.

In the review of related literature, the researcher did not find studies associated with co-morbidities and the physiological responses following management of life threatening conditions. Previous studies documented pre-existing medical conditions associated with significantly increased mortality rates following trauma (Hollis et al., 2006; Grossman et al., 2002; Sarkar, 2009; Wutzler et al., 2008). Grossman and colleagues (2002) discovered that the pre-existing medical conditions associated with the odds ratio for mortality was hepatic diseases (odds ratio 5.1; 95% CI, 3.1-8.2), followed by renal diseases, cancer and congestive heart failure. Wutzler et al. (2008) reported that six conditions could be identified as associated with substantially impaired outcomes if present in injured patients. These were pre-existing Stage IV peripheral arterial occlusive disease, heart disease, hepatitis/liver cirrhosis, carcinoma, coagulation disorder and obesity.

Another study, however, reported that pre-existing medical conditions were not risk factors for mortality (Bochicchio et al., 2005; Richmond et al., 2002). These reports confirm previous studies which demonstrated that the presence of one or more pre-existing medical condition was not associated with an increased relative risk (RR) of death (RR, 0.80 and 95% confidence interval [CI], 0.71–0.90; RR, 1.09 and 95% CI, 0.95–1.24, respectively) (McGwin, MacLennan, Fife, Davis, & Rue, 2004). The aforementioned data is noteworthy because physiological changes from aging and pre-existing medical conditions are subtle and may inhibit accurate assessment (Stevenson, 2004). Therefore, age and co-morbidities are recommended for consideration when evaluating trauma patients (ACS, 2004).

### **Severity of Injury**

According to the research findings, there was no statistical significance between severity of injury and the physiological responses of major trauma patients following management of life threatening conditions. Thus, in this context as well, the

research hypothesis was not supported by the findings. One reasonable explanation might be the fact that the RTS is based on physiological data that rapidly and constantly changes following injury, so physiological derangements may be hidden by compensatory mechanisms resulting in high scores despite severe injury. The physiological effects of injury may be quite different among individuals (Chawda et al., 2004; Jin et al., 2006; Oyetunji et al., 2010). For another reason, RTS is not specific enough to accurately determine the level of severity of injury (Jin et al., 2006; Talbert, 2009). However, previous studies have indicated the RTS score as a good predictor of mortality (Brennan et al., 2002; Gabbe et al., 2003; Guzzo et al. 2005; Jennings, 2004; Jin et al., 2006; Kuhls et al. 2002).

In current study, the majority of the patients were initial RTS score 12 (32.5%), followed by RTS score 11 (30.1%). It should be noted that initial RTS scores in this group were high. These findings suggest that injuries sustained lesser impact on cardiac, respiratory or neurological status. It was indicated that severity of injury was not high. The possible explanations may be: 1) most of patients were transferred within 30 minutes (77.1%) from the scene, thus, physiological derangement remained in the compensation stage; 2) The head injured patients who were accompanied by hemorrhage in the thoracic or abdominal cavities might be hidden by acute intracranial hypertension; 3) The more seriously injured patients who died in the emergency room were excluded; 4) this study involved a small group of patients.

In the literature review the researcher did not find studies indicating a correlation between severity of injury and the physiological responses of major trauma patients following management of life threatening conditions. Previous studies have focused on severity of injury and mortality. Brennan and colleagues (2002) performed a prospective study to investigate the risk of mortality in 8,654 trauma patients. This study found that 85.5% of trauma patients had RTS scores of 12 and the RTS was an independent predictor of mortality (OR 0.46; 95%CI: 0.41-0.51). One previous study in China by Jin et al. (2006) found that 9.6% of the patients had scores of RTS <6, 19.3 %; RTS 6-7, 52.8%; RTS 8-10 and 18.3% had scores of RTS 11-12. However, they also found that 26 of the 261 patients who had scores of RTS 11 to 12 had more severe injuries than fatal trauma.

There was another study by Freixinet and colleagues (2008) who studied 1,772 patients, suffering from chest trauma. This study reported that mortality was increased as RTS values indicated greater cardiac, respiratory, or neurological involvement and increases in direct proportion to the number of rib fractures present. Oyetunji et al. (2010) studied different measures of physiological injury assessment in their ability to predict mortality in trauma patients. The result of this study confirmed the previous studies indicating that RTS was highly predictive of mortality with an AUROC of 0.85 (n = 1,484,648). Neumann, Brasil, & Albers (2009) identified predictors of mortality in patients with traumatic spinal cord injury (n = 84). The results showed that absent neurologic function, high injury severity scores, low RTS, GCS < 9, shock at admission vasopressor use, mechanical ventilation, acute renal insufficiency were closely associated with mortality. On the other hand, the main independent predictors for mortality were GCS scores of < 9 and vasopressor use. In conclusion, these results reinforce that severity of injury was a major risk for mortality in trauma patients.

### **Management of Life threatening Conditions**

Research findings suggested that there was no any statistical significance between management of life threatening conditions and the physiological responses of major trauma patients following management of life threatening conditions. Therefore it can be concluded that research hypothesis of the present research was not supported by the findings. In this study, the majority of management of life threatening conditions scores were 11 (25.3%), followed by scores of 12 (20.5%) and scores of 10 (18.1%). Furthermore, the mean score of management of life threatening conditions was 10.12 (S.D. = 1.533). Above data indicated that the patients received incomplete or did not receive management of life threatening conditions that should affect the outcome. One reasonable explanation might be the reason that the reliability value of the assessment form for the management of life threatening conditions was 0.72, when applied with 83 patients the reliability value was found as 0.523. For another reason, the errors may not immediately affect to the physiological responses following management of life threatening conditions but generate deterioration and not be able to

respond to further management (Greaves et al., 2001; Richards & Mayberry, 2004; van Olden et al., 2003a).

When each item was considered, the patients received identification of their conditions within two minutes 98.8%, c-spine protection 65.1%, assessment of airway and breathing 95.2%, evaluation of patency and adequacy of ventilation 97.6%, oxygen therapy 73.5%, assessment of circulation and shock 97.6%, fluid management 32.5%, assessment of level of conscious 98.8%, complete removal of clothing to investigate hidden life threatening injuries 97.6% and the performance of rapid management together with trauma surgeons 98.8% (Appendix E), It was noticeable that seven of these managements were performed for more than 90% of the patients, except for c-spine protection, oxygen therapy and fluid management because more than one fourth of the patients who sustained only penetrating injuries were fully consciousness and without c-spine tenderness. For oxygen therapy and fluid management, most patients also received 100% oxygen via mask with reservoir bag 10-12 LPM and warmed intravenous fluid transfusion but longer than 4 minutes. These findings indicated that there were other reasons besides management of life threatening conditions that were responsible for physiological responses following management of life threatening conditions in major trauma patients i.e. rate and amount of intravenous fluid.

In the review of related literature, the researcher did not find any study which examined the relationship between these factors. Previous studies have focused on management of life threatening conditions and mortality. Gruen and colleagues (2006) documented errors during initial assessment and resuscitation that contributed to death, including airway management and hemorrhage control. Airway errors involved unsuccessful attempts at endotracheal intubation, failure to adequately gain or regain control using simple maneuvers and failure to adequately protect the airway from aspiration. Other errors were delayed control of intrathoracic hemorrhage, which was most often delay in the diagnosis of massive hemothorax with inadequate evacuation of blood from the chest, or inadequate recognition of the volume that had already been evacuated.

A previous study in Tehran by Zafarhandi et al. (2003) found inappropriate care to be the cause of preventable death due to error in airway

management in 16 patients, ventilation support in 4 patients, chest tube insertion in 4 patients, delayed fluid transfusion in 9 patients and neck fixation in 4 patients. Sugrue et al. (2008) determined life threatening clinical errors in 17,157 trauma patients, finding a total of 1063 errors with 40.0% occurring in the area of resuscitation. These errors were related to assessment failure (25.8%), including inadequate haemorrhage control (23.5%), poor management (10.4%), inadequate airway management (7.3%), poor control of breathing problems (5%) and diagnostic errors (4.3%). For the effects of the errors, 20.2% were deemed to have no effect on outcome. A recent study by Saltzherr et al. (2010) reported that 31 errors occurred in the potentially preventable death group and 23 errors in the non-preventable death group in 62 patients. Most errors included delay in treatment and errors in management. Overall, 38 errors occurred in the trauma resuscitation room. Thus, these results indicated that errors in management of life threatening conditions contributed to preventable death which reflects the quality of trauma care in the emergency room.

## **2.2 The relationships between the time for management of life threatening conditions and severity of injury**

The findings revealed that time for management of life threatening conditions had negative correlation with severity of injury ( $\rho = -.418$ ,  $p < .01$ ). This finding indicated that trauma patients who sustained severe injuries received management of life threatening conditions more rapidly than those who had less severe injuries. It can be explained that the patients who had less severe injuries were not fully conscious. They were incorporate with life saving interventions which took longer to correct life threatening conditions.

Conversely, a recent study in Greece by Theodorou et al. (2009) examined stratified ISS and duration in the emergency room, finding that patients who had an ISS of 1–9 had a mean duration in the emergency room (MDER) of 1 hour and 26 minutes, while patients with an ISS of 10–15 had an MDER of 1 hour and 31 minutes, patients with an ISS of 16–24 had a MDER of 1 hours and 50 minutes and patients with an ISS >25 had a MDER of 1 hour and 36 minutes. Theodorou and colleagues demonstrated that severely injured patients took longer time to complete interventions in emergency room. However, it is essential for patients with life threatening

conditions that the time for management of life threatening conditions should be kept as short as possible (Spanjersberg et al., 2009; Theodorou et al., 2009; van Olden et al., 2003a; van Olden et al., 2003b).

### **2.3 The relationships between age and co-morbidities**

The findings revealed that age was positively associated with co-morbidities ( $\rho = .322$ ,  $p < .01$ ). These findings are supported by the previous studies in which pre-existing medical conditions were more frequently encountered factors in older age groups (Bergeron et al., 2003; McGwin et al., 2004; Perdue, Watts, Kaufmann, & Trask, 1998; Wutzler et al., 2008). The prevalence of the pre-existing medical conditions in trauma patients was reported as 23.2% ( $n = 405$ ) (Bergeron et al., 2003), 23% ( $n = 14,965$ ) (Hollis et al., 2006) and 26% ( $n = 6,839$ ), as expected, the elderly presented a higher proportion of co-morbidity (Bamvita et al., 2007).

### **2.4 The relationships between age and severity of injury**

The findings revealed that age was negatively associated with severity of injury ( $\rho = -.264$ ,  $p < .05$ ). It was indicated that the young patients had more suffered from severe injuries than older patients. These findings concurred with previous study which found the patients aged  $< 65$  were more severely injured than elderly patients ( $\geq 65$  years) as shown by their lower GCS scores ( $p = .00003$ ) and lower mean RTS (7.1 vs. 7.6, respectively;  $p < .0001$ ) and higher ISS ( $p = .031$ ) distributions (Bergeron et al., 2003). The other studies by Richmond and colleagues (2002) demonstrated that injury severity was found to decrease as age increased (65–75, ISS = 12.2; 75–84, ISS = 11.9;  $\geq 85$ , ISS = 10.3;  $p < .0001$ ). However, one study has reported that there were no significant differences in the median ISS between age groups (Giannoudis et al., 2009; Kuhne et al. 2005).

These findings suggested that young trauma patients have several characteristics of normal development, such as lack of intellectual ability and experience to adequately assess the consequences of high-risk activities, which predispose them to serious injury. The other risk of serious injuries in younger age groups was refusal or negligence to wear helmets. Lastly, substance abuse and alcohol use are also leading contributors to severity of injury (Loisell, 2003).

## **CHAPTER VI**

### **CONCLUSION**

This research was a descriptive study design aimed at examining the factors associated with physiological responses of major trauma patients following management of life threatening conditions. This study was based on the concept of performance improvement (PI) in trauma care provided by the American College of Surgeons Committee on Trauma (ACSCOT). Present research was approved by the Siriraj Institutional Review Board, Mahidol University and conducted in the Outpatient Trauma Unit at Siriraj Hospital. Data collection was performed from December 2008 to April 2010. The participants comprised 83 patients who were identified as major trauma patients by CRAMS scale scores of 8 or less. Of these, 66.3% (55 patients) had life threatening conditions. The research instrumentation included three parts: 1) The major trauma patients' demographic data records; 2) Records of factors associated with the physiological responses of major trauma patients with life threatening conditions and 3) Record forms of the physiological responses of major trauma patients while receiving management of life threatening conditions. The reliability value of the assessment form for management of life threatening conditions measured by Cronbach's alpha Coefficient was 0.72, when applied with 83 patients; the reliability value was found to be 0.523.

The data were analyzed with the computer program, Statistical Package for the Social Science (SPSS 16.0). Statistical analysis was performed using descriptive statistics, including frequency, percentage, range, mean and standard deviation; and correlation between management of life threatening conditions time, age, co-morbidities, severity of injury, management of life threatening conditions, and physiological responses of major trauma patient following management of life threatening conditions by the Spearman Rank-Order Correlation Coefficient. The research findings are summarized as follows:

1. The majority of the patients were males (92.8%) aged between 14 – 81 years with a mean age of 34.75 years. The major cause of injury was assault (44.6%), followed by transport accidents (42.2%). The patients were injured by blunt mechanisms (57.8%) and penetrating mechanisms (39.8%). The most major trauma patients (77.1%) had no pre-existing medical conditions. The head was the main site of injury (47%), followed by both chest and abdomen (33.7%). Fifty-five patients (66.3%) had life threatening conditions. Seven patients had more than one life threatening condition. The most common life threatening conditions were airway obstruction (30.1%), followed by hemorrhage (21.7%) and dyspnea (16.9%). Most patients had CRAMS scale scores of 8 (40%), followed by 7 (36.1%) and 6 (16.9%).

2. The results of the factors associated with physiological responses following management of life threatening conditions are summarized as follows: the majority of time for managing life threatening conditions 10.01 – 20.00 minutes (56.6%) and a mean of time for managing life threatening conditions was 16.97 minutes; the mean age was 34.75 years and the majority of ages were from 13 to 45 years (82%); pre-existing conditions were found in 19 patients (22.9%); the majority of the patients were initial RTS score 12 (32.5%); and the mean score of management of life threatening conditions was 10.12. The overall outcome of major trauma patients improved physiological responses following management of life threatening conditions (44.6%).

3. For the correlation analysis, there was no statistical significance among the 5 variables and the physiological responses following management of life threatening conditions. The findings revealed that time for management of life threatening conditions had a negative correlation with severity of injury ( $\rho = -.418, p < .01$ ) and a negative correlation with the management of life threatening conditions ( $\rho = -.315, p < .01$ ). Moreover, age had a positively associated with co-morbidities ( $\rho = .322, p < .01$ ) and a negatively associated with severity of injury ( $\rho = -.264, p < .05$ ).

## **Implications and Recommendations**

### **Implications and Application of Research Findings**

1. According to the research findings, we should notice some limitations when implicating the findings of the study. First, even small groups of aged > 45 years can cause positive skewness distribution and too little amount of co-morbidities. Second, most patients had less severity of injury. CRAMS scale score may not be accurate enough to screen major trauma patients. Third, research instrument which assess management of life threatening conditions was low reliability value, thus, data were not reliable. Forth, physiological responses as outcome measured by assess 3 variables: SpO<sub>2</sub>, SBP, and blood lactate level were limited interpretation because blood lactate level change more slowly than SpO<sub>2</sub> and SBP. Data analysis may be used for each variable for the sole purpose of analysis.

2. This can probably be suggested that physiological responses should be continued to be monitored in ICU or ward.

### **Recommendations for Further Study**

1. Further study should be conducted on the evaluation of specific risk factors affecting trauma patients following management of life threatening conditions.

2. Clinical practice guidelines must be developed for optimal care of major trauma patients and the guidelines should include evaluating the effectiveness of these protocols.

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## **APPENDICES**

## **APPENDIX A**

### **LIST OF EXPERTS**

The validity of research instrument was assessed by five consulting experts:

1. Assist. Prof. Dr. Wanvimon Sangchote, M.D.  
Department of Anesthesiology  
Faculty of Medicine Ramathibodi Hospital, Mahidol University
2. Assoc. Prof. Dr. Pornprom Muangman, M.D.  
Division of trauma surgery  
Department of surgery  
Faculty of Medicine Siriraj Hospital, Mahidol University
3. Pol. Col. Ubol Choomjinda, M.Ed.  
Police General Hospital
4. Miss Raewadee Luepongluckkana  
Head Nurse of Emergency Medicine  
Bangkok Metropolitan Administration Medical College & Vajira Hospital
5. Mr. Verachat Churit  
Head Nurse of Emergency unit  
Maharajnakornchiangmai Hospital

## APPENDIX B

### ETHICAL CLEARANCE

2 PRANNOK Rd. BANGKOKNOI  
BANGKOK 10700



MAHIDOL UNIVERSITY  
Since 1888  
Siriraj Ethics Committee

Tel. (662) 4196405-6  
FAX (662) 4196405

#### Certificate of Approval

COA no. Si 666/2008

**Protocol Title :** Factors associated with physiologic response of major trauma patient after life threatening management.

**SIEC number :** 627/2551(EC1)

**Principal Investigator/Affiliation:** Miss. Sirirat Netnimitphol  
Faculty of Nursing, Mahidol University

**Research site :** Faculty of Medicine Siriraj Hospital

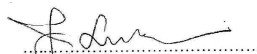
**Approval includes :**

1. EC Submission Form
2. Proposal
3. Informed Consent Form
4. Informed Consent Form (for child)
5. Case Record Form


**Approval date :** December 2, 2008

**Expired date :** December 1, 2009

This is to certify that Siriraj Ethics Committee is in full Compliance with International Guidelines For Human Research Protection such as the Declaration of Helsinki, the Belmont Report, CIOMS Guidelines and the International Conference on Harmonization in Good Clinical Practice (ICH-GCP).

  
.....  
Prof. Jariya Lertakyamanee, M.D.  
Chairperson

December 9, 2008  
date

  
.....  
(Clin. Prof. Teerawat Kulthanan, M.D.)  
Dean of Faculty of Medicine Siriraj Hospital

December 12, 2008  
date

2 ถนนพรานนก บางกอกน้อย  
กรุงเทพฯ 10700



โทร (662) 4196405-6  
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คณะกรรมการจริยธรรมการวิจัยในคน คณะแพทยศาสตร์ศิริราชพยาบาล

เอกสารรับรองโครงการวิจัย

หมายเลข SI 666/2008

ชื่อโครงการภาษาไทย : ปัจจัยที่สัมพันธ์เกี่ยวกับการตอบสนองของร่างกายผู้ป่วยอุบัติเหตุที่ได้รับบาดเจ็บรุนแรงภายหลังการ  
จัดการภาวะฉุกเฉินชีวิต

รหัสโครงการ : 627/2551(EC1)

หัวหน้าโครงการ / หน่วยงานที่สังกัด : น.ส.ศิริรัตน์ เนตรนิมิตรผล  
คณะพยาบาลศาสตร์ มหาวิทยาลัยมหิดล

สถานที่ทำวิจัย : คณะแพทยศาสตร์ศิริราชพยาบาล

เอกสารที่รับรอง :

1. แบบเสนอโครงการวิจัยเพื่อขอรับการพิจารณาจากคณะกรรมการจริยธรรมการวิจัยในคน
2. โครงร่างการวิจัย
3. หนังสือแสดงเจตนายินยอมเข้าร่วมการวิจัย
4. หนังสือแสดงเจตนายินยอมเข้าร่วมการวิจัย (สำหรับเด็ก)
5. แบบบันทึกข้อมูล

วันที่รับรอง : 2 ธันวาคม 2551

วันหมดอายุ : 1 ธันวาคม 2552

คณะกรรมการจริยธรรมการวิจัยในคน คณะแพทยศาสตร์ศิริราชพยาบาล มหาวิทยาลัยมหิดล ดำเนินการให้การรับรอง  
โครงการวิจัยตามแนวทางหลักจริยธรรมการวิจัยในคนที่เป็นสากล ได้แก่ Declaration of Helsinki, the Belmont Report, CIOMS Guidelines  
และ the International Conference on Harmonization in Good Clinical Practice (ICH-GCP).

ลงนาม .....  
(ศาสตราจารย์แพทย์หญิงจรรยา เลิศอรรมขมณี)  
ประธานคณะกรรมการจริยธรรมการวิจัยในคน

9 ธันวาคม 2551  
วันที่

ลงนาม .....  
(ศาสตราจารย์คลินิกนายแพทย์ธีรวัฒน์ กุลทนันทน์)  
คณบดี คณะแพทยศาสตร์ศิริราชพยาบาล

12 ธันวาคม 2551  
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2 PRANNOK Rd. BANGKOKNOI  
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MAHIDOL UNIVERSITY  
*Since 1988*

**Siriraj Institutional Review Board**

**Certificate of Approval (Renewal)**

COA no.Si 666/2008

**Protocol Title** : Factors associated with physiologic response of major trauma patient after life threatening management.

**Protocol number** : 627/2551(EC1)

**Principal Investigator/Affiliation**: Miss. Sirirat Netnimitphol  
Faculty of Nursing, Mahidol University

**Research site** : Faculty of Medicine Siriraj Hospital

**Approval includes :**

1. SIRB Submission Form Amendment 1 Dated 30 July 2009
2. Proposal
3. Informed Consent Form
4. Informed Consent Form (for child 13-14 years old)
5. Informed Consent Form (for parent of child 13-14 years old)
6. Informed Consent Form (for parent of child 15-18 years old)
7. Case Record Form

**A Renewal date (1<sup>st</sup>)** : December 2, 2009

**Expired date** : December 1, 2010

This is to certify that Siriraj Institutional Review Board is in full Compliance with International Guidelines For Human Research Protection such as the Declaration of Helsinki, the Belmont Report, CIOMS Guidelines and the International Conference on Harmonization in Good Clinical Practice (ICH-GCP).

(Prof. Jariya Lertakyamane, M.D.)

Chairperson

January 5, 2010

date

(Clin. Prof. Teerawat Kulthanan, M.D.)

Dean of Faculty of Medicine Siriraj Hospital

January 6, 2009

date

2 ถนนพหลโยธิน บางกอกน้อย  
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คณะกรรมการจริยธรรมการวิจัยในคน คณะแพทยศาสตร์ศิริราชพยาบาล

เอกสารรับรองโครงการวิจัย (ต่ออายุ)

หมายเลข *Si* 666/2008

ชื่อโครงการภาษาไทย : ไปถึงที่สัมพันธ์ซึ่งกันเกี่ยวกับการตอบสนองของร่างกายผู้ป่วยอุบัติเหตุที่ได้รับบาดเจ็บรุนแรงภายหลังการจัดการภาวะคุกคามชีวิต

รหัสโครงการ : 627/2551(EC1)

หัวหน้าโครงการ / หน่วยงานที่สังกัด : น.ส.ศิริรัตน์ เนตรนิมิตรผล  
คณะพยาบาลศาสตร์ มหาวิทยาลัยมหิดล

สถานที่ทำวิจัย : คณะแพทยศาสตร์ศิริราชพยาบาล

เอกสารที่รับรอง :

1. แบบเสนอโครงการวิจัยเพื่อขอรับการพิจารณาจากคณะกรรมการจริยธรรมการวิจัยในคน ฉบับแก้ไขครั้งที่ 1 วันที่ 30 กรกฎาคม 2552
2. โครงร่างการวิจัย
3. หนังสือแสดงเจตนายินยอมเข้าร่วมการวิจัย
4. หนังสือแสดงเจตนายินยอมเข้าร่วมการวิจัย (สำหรับเด็กอายุ 13-14 ปี)
5. หนังสือแสดงเจตนายินยอมเข้าร่วมการวิจัย (สำหรับผู้แทนโดยชอบธรรมของเด็กอายุ 13-14 ปี)
6. หนังสือแสดงเจตนายินยอมเข้าร่วมการวิจัย (สำหรับเด็กอายุ 15-18 ปี)
7. แบบบันทึกข้อมูล

วันที่ต่ออายุ (1) : 2 ธันวาคม 2552

วันหมดอายุ : 1 ธันวาคม 2553

คณะกรรมการจริยธรรมการวิจัยในคน คณะแพทยศาสตร์ศิริราชพยาบาล มหาวิทยาลัยมหิดล ดำเนินการให้การรับรองโครงการวิจัยตามแนวทางหลักจริยธรรมการวิจัยในคนที่เป็นสากล ได้แก่ Declaration of Helsinki, the Belmont Report, CIOMS Guidelines และ the International Conference on Harmonization in Good Clinical Practice (ICH-GCP).

ลงนาม ..... *Dr. In* ..... 5 มกราคม 2553  
(ศาสตราจารย์แพทย์หญิงจรรยา เลิศอรรมณี) วันที่  
ประธานคณะกรรมการจริยธรรมการวิจัยในคน

ลงนาม ..... *Dr.* ..... 6 มกราคม 2553  
(ศาสตราจารย์คลินิกนายแพทย์ธีรวัฒน์ กุลทนันทน์) วันที่  
คณบดี คณะแพทยศาสตร์ศิริราชพยาบาล



สำนักงานรองคณบดีฝ่ายวิจัย สำนักงานคณบดี  
ตึกอนันตราช ชั้น 3 โทร. 0 2419 9407, 9409

ที่ ศธ 0517.07/ 20041  
วันที่ 23 ธันวาคม 2551

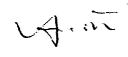
เรื่อง ยินดีให้ความอนุเคราะห์ข้อมูลประกอบการทำวิทยานิพนธ์

เรียน คณบดีคณะแพทยศาสตร์ มหาวิทยาลัยมหิดล

ตามที่ คณะแพทยศาสตร์ มหาวิทยาลัยมหิดล ได้ขอความอนุเคราะห์ให้ นางสาวศิริรัตน์ เนตรนิมิตรผล นักศึกษาหลักสูตรพยาบาลศาสตรมหาบัณฑิต สาขาการพยาบาลผู้ใหญ่ คณะพยาบาลศาสตร์ มหาวิทยาลัยมหิดล เข้าเก็บข้อมูล โดยวิธีการสังเกต จากผู้ป่วยอุบัติเหตุที่ได้รับบาดเจ็บรุนแรงที่มีภาวะคุกคามชีวิต ที่มารับการรักษาที่ หน่วยตรวจโรคอุบัติเหตุ สาขาศัลยศาสตร์อุบัติเหตุ ภาควิชาศัลยศาสตร์ จำนวน 95 ราย เพื่อเป็นข้อมูลประกอบการทำวิทยานิพนธ์ เรื่อง “ปัจจัยที่สัมพันธ์เกี่ยวข้องกับการตอบสนองของร่างกายผู้ป่วยอุบัติเหตุที่ได้รับบาดเจ็บรุนแรงภายหลังการจัดการภาวะคุกคามชีวิต.” ความละเอียดดังกล่าวนี้

คณะแพทยศาสตร์ศิริราชพยาบาล มหาวิทยาลัยมหิดล พิจารณาแล้วยินยอมให้ นางสาวศิริรัตน์ เนตรนิมิตรผล ทำการเก็บข้อมูลตามที่ขอความอนุเคราะห์มา ทั้งนี้ได้ผ่านการรับรองโครงการวิจัยจาก คณะกรรมการจริยธรรมการวิจัยในคน คณะแพทยศาสตร์ศิริราชพยาบาล เมื่อวันที่ 2 ธันวาคม 2551

จึงเรียนมาเพื่อโปรดทราบ

  
(รองศาสตราจารย์นายแพทย์อนุพันธ์ ดันดวงค์)  
รองคณบดี ปฏิบัติราชการแทน  
คณบดีคณะแพทยศาสตร์ศิริราชพยาบาล

## APPENDIX C

### CONSENT FORM

#### หนังสือแสดงเจตนายินยอมเข้าร่วมการวิจัย

วันที่.....เดือน.....พ.ศ. ....

ข้าพเจ้า นาย / นาง / นางสาว ..... อายุ.....ปี  
 อาศัยอยู่บ้านเลขที่ ..... ถนน..... ตำบล.....  
 อำเภอ..... จังหวัด..... รหัสไปรษณีย์.....  
 โทรศัพท์.....

ในฐานะเป็น  ผู้ป่วย

ผู้มีอำนาจกระทำการแทนในฐานะ .....ของผู้ป่วย

ชื่อ นาย / นาง / นางสาว.....อายุ.....ปี

ขอแสดงเจตนายินยอมเข้าร่วมการวิจัยเรื่อง ปัจจัยที่สัมพันธ์เกี่ยวกับการตอบสนองของร่างกาย  
 ผู้ป่วยอุบัติเหตุที่ได้รับบาดเจ็บรุนแรงภายหลังการจัดการภาวะฉุกเฉินชีวิต

ชื่อผู้วิจัย นางสาวศิริรัตน์ เนตรนิมิตรผล นักศึกษาหลักสูตรปริญญาโท สาขาการพยาบาล  
 ผู้ใหญ่ คณะพยาบาลศาสตร์ มหาวิทยาลัยมหิดล

สถานที่ทำวิจัย หน่วยตรวจโรคอุบัติเหตุ โรงพยาบาลศิริราช

โดย ข้าพเจ้าได้รับทราบเกี่ยวกับรายละเอียดของการวิจัย ดังต่อไปนี้

การวิจัยนี้มีวัตถุประสงค์เพื่อศึกษาถึงปัจจัยที่มีผลต่อการตอบสนองของร่างกายผู้ป่วย  
 อุบัติเหตุที่ได้รับบาดเจ็บรุนแรง ซึ่งเป็นผลลัพธ์ที่เกิดขึ้นภายหลังการจัดการภาวะฉุกเฉินชีวิต  
 ประโยชน์ที่ได้รับจากการวิจัยนี้ จะช่วยให้มีแนวทางในการพัฒนาคุณภาพการรักษาระยะยาว  
 ของผู้ป่วยอุบัติเหตุที่บาดเจ็บรุนแรงเพื่อเพิ่มประสิทธิภาพการรักษาระยะยาว โดย  ข้าพเจ้า  .....  
 ของข้าพเจ้า ได้รับเชิญเข้าร่วมการวิจัยเพราะ  ข้าพเจ้า  .....ของข้าพเจ้า เป็นผู้หนึ่ง

ที่มีคุณสมบัติเหมาะสมตามเกณฑ์การคัดเลือกประชากรเข้าเป็นกลุ่มตัวอย่างในการวิจัยครั้งนี้ คือเป็นผู้ป่วยอุบัติเหตุที่ได้รับบาดเจ็บรุนแรงและได้รับการจัดการภาวะคุกคามชีวิต ซึ่งจะมีผู้เข้าร่วมการวิจัยรวมทั้งหมดประมาณ 95 คน โดยผู้วิจัยจะเป็นผู้สังเกตการจัดการภาวะคุกคามชีวิต และบันทึกข้อมูลซึ่งประกอบด้วย ข้อมูลส่วนบุคคล ข้อมูลการบาดเจ็บ และข้อมูลการจัดการภาวะคุกคามชีวิต การเข้าร่วมในการวิจัยนี้ไม่เกิดความเสียดังต่อไปนี้  ข้าพเจ้า  .....ของข้าพเจ้า และไม่เสียค่าใช้จ่ายใดๆทั้งสิ้น

หาก  ข้าพเจ้า  .....ของข้าพเจ้า ไม่เข้าร่วมในโครงการวิจัยนี้  ข้าพเจ้า  .....ของข้าพเจ้า จะได้รับการตรวจรักษาตามวิธีการมาตรฐาน และข้าพเจ้าได้ทราบถึงสิทธิที่  ข้าพเจ้า  .....ของข้าพเจ้า จะได้รับข้อมูลเพิ่มเติมจากการเข้าร่วมวิจัย และสามารถถอนตัวหรือขอเข้าร่วมวิจัยได้ทุกเมื่อ โดยจะไม่มีผลกระทบต่อค่าบริการและการรักษาพยาบาลที่  ข้าพเจ้า  .....ของข้าพเจ้าจะได้รับต่อไป ถ้าผู้วิจัยมีข้อมูลเพิ่มเติมทั้งด้านประโยชน์และโทษที่เกี่ยวข้องกับการวิจัยนี้ ผู้วิจัยจะแจ้งให้  ข้าพเจ้า  .....ของข้าพเจ้า ทราบอย่างรวดเร็วโดยไม่ปิดบัง

หากมีข้อสงสัยเกี่ยวข้องกับการวิจัย  ข้าพเจ้า  .....ของข้าพเจ้า สามารถติดต่อกับผู้วิจัย คือ นางสาวศิริรัตน์ เนตรนิมิตรผล ได้ที่หน่วยตรวจโรคอุบัติเหตุ โรงพยาบาลศิริราช หมายเลขโทรศัพท์ 08-1938-6163 ทั้งในและนอกเวลาราชการ

หาก  ข้าพเจ้า  .....ของข้าพเจ้า ได้รับการปฏิบัติที่ไม่ตรงตามที่ได้ระบุไว้ในเอกสารนี้ สามารถแจ้งให้ประธานคณะกรรมการจริยธรรมการวิจัยในคนหรือผู้แทนได้ที่สำนักงานคณะกรรมการจริยธรรมการวิจัยในคน ดิโกศลเวชวิกรม ชั้น 6 โรงพยาบาลศิริราช เบอร์โทร. (02)419-6405-6

ข้าพเจ้าได้รับทราบข้อมูลของการวิจัยข้างต้น และประโยชน์ที่ได้รับจากการเข้าร่วมการวิจัยในครั้งนี้ข้าพเจ้ายินยอมเข้าร่วมในการวิจัยโดยขอให้ผู้วิจัยจัดการเปิดเผยชื่อ ประวัติ ตลอดจนข้อมูลที่เกี่ยวข้องกับ  ข้าพเจ้า  .....ของข้าพเจ้าแก่ผู้อื่น แต่จะนำเสนอเป็นข้อมูลโดยรวมจากการวิจัยเท่านั้น

ลงชื่อ.....ผู้เข้าร่วมการวิจัย/ผู้มีอำนาจกระทำการแทน  
 (.....)  
 วันที่.....

ลงชื่อ.....ผู้ให้ข้อมูลและขอความยินยอม

(.....)

วันที่.....

ลงชื่อ.....พยาน

(.....)

วันที่.....

หมายเหตุ ในกรณีที่ผู้เข้าร่วมการวิจัยอ่านหนังสือไม่ออก ผู้ที่อ่านข้อความทั้งหมดแทนผู้เข้าร่วมการวิจัย คือ.....จึงได้ลงลายมือชื่อไว้เป็นหลักฐาน

ลงชื่อ.....ผู้อ่านข้อความแทนผู้เข้าร่วมการวิจัย

(.....)

วันที่.....

ลงชื่อ.....พยาน

(.....)

วันที่.....

**หนังสือแสดงเจตนายินยอมเข้าร่วมการวิจัย**  
**(สำหรับเด็กอายุ 15 - 18 ปี)**

วันที่.....เดือน.....พ.ศ. ....

ข้าพเจ้า นาย / นาง / นางสาว ..... อายุ.....ปี  
อาศัยอยู่บ้านเลขที่ ..... ถนน.....ตำบล.....  
อำเภอ.....จังหวัด.....รหัสไปรษณีย์.....  
โทรศัพท์.....

**ขอแสดงเจตนายินยอมเข้าร่วมการวิจัยเรื่อง** ปัจจัยที่สัมพันธ์เกี่ยวข้องกับการตอบสนองของร่างกาย  
ผู้ป่วยอุบัติเหตุที่ได้รับบาดเจ็บรุนแรงภายหลังการจัดการภาวะฉุกเฉินชีวิต

**ชื่อผู้วิจัย** นางสาวศิริรัตน์ เนตรนิมิตรผล    นักศึกษาหลักสูตรปริญญาโท สาขาการพยาบาล  
ผู้ใหญ่ คณะพยาบาลศาสตร์ มหาวิทยาลัยมหิดล

**สถานที่ทำวิจัย** หน่วยตรวจโรคอุบัติเหตุ โรงพยาบาลศิริราช

โดย ข้าพเจ้าได้รับทราบเกี่ยวกับรายละเอียดของการวิจัย ดังต่อไปนี้  
การวิจัยนี้มีวัตถุประสงค์เพื่อศึกษาถึงปัจจัยที่มีผลต่อการตอบสนองของร่างกายผู้ป่วย  
อุบัติเหตุที่ได้รับบาดเจ็บรุนแรง ซึ่งเป็นผลลัพธ์ที่เกิดขึ้นภายหลังการจัดการภาวะฉุกเฉินชีวิต  
ประโยชน์ที่ได้รับจากการวิจัยนี้ จะช่วยให้มีแนวทางในการพัฒนาคุณภาพการรักษายาบาลผู้ป่วย  
อุบัติเหตุที่บาดเจ็บรุนแรงเพื่อเพิ่มประสิทธิภาพการรักษายาบาล โดยข้าพเจ้าได้รับเชิญเข้าร่วมการ  
วิจัย เพราะข้าพเจ้าเป็นผู้หนึ่งที่มีคุณสมบัติเหมาะสมตามเกณฑ์การคัดเลือกประชากรเข้าเป็นกลุ่ม  
ตัวอย่างในการวิจัยครั้งนี้ คือ เป็นผู้ป่วยอุบัติเหตุที่ได้รับบาดเจ็บรุนแรงและได้รับการจัดการภาวะ  
ฉุกเฉินชีวิต ซึ่งจะมีผู้เข้าร่วมการวิจัยรวมทั้งหมดประมาณ 95 คน โดยผู้วิจัยจะเป็นผู้สังเกตการ  
จัดการภาวะฉุกเฉินชีวิต และบันทึกข้อมูลซึ่งประกอบด้วย ข้อมูลส่วนบุคคล ข้อมูลการบาดเจ็บ และ  
ข้อมูลการจัดการภาวะฉุกเฉินชีวิต การเข้าร่วมในการวิจัยนี้ไม่เกิดความเสี่ยงต่อตัวข้าพเจ้า และไม่  
เสียค่าใช้จ่ายใดๆ ทั้งสิ้น

หากข้าพเจ้าไม่เข้าร่วมในโครงการวิจัยนี้ ข้าพเจ้าจะได้รับการตรวจรักษาตามวิธีการมาตรฐาน  
และข้าพเจ้าได้ทราบถึงสิทธิที่ข้าพเจ้าจะได้รับข้อมูลเพิ่มเติมจากการเข้าร่วมวิจัย และสามารถถอนตัว

หรือเข้าร่วมวิจัยได้ทุกเมื่อ โดยจะไม่มีผลกระทบต่อค่าบริการและการรักษา พยาบาลที่ข้าพเจ้าจะได้รับต่อไป ถ้าผู้วิจัยมีข้อมูลเพิ่มเติมทั้งด้านประโยชน์และโทษที่เกี่ยวกับการวิจัยนี้ ผู้วิจัยจะแจ้งให้ข้าพเจ้า ทราบอย่างรวดเร็วโดยไม่ปิดบัง

หากมีข้อสงสัยเกี่ยวกับการวิจัย ข้าพเจ้าสามารถติดต่อกับผู้วิจัย คือ นางสาวศิริรัตน์ เนตรนิมิตรผล ได้ที่หน่วยตรวจโรคอุบัติเหตุ โรงพยาบาลศิริราช หมายเลขโทรศัพท์ 08-1938-6163 ทั้งในและนอกเวลาราชการ

หากข้าพเจ้าได้รับการปฏิบัติที่ไม่ตรงตามที่ได้ระบุไว้ในเอกสารนี้ สามารถแจ้งให้ประธานคณะกรรมการจริยธรรมการวิจัยในคนหรือผู้แทน ได้ที่สำนักงานคณะกรรมการจริยธรรมการวิจัยในคน ตึกอศุขเวชวิกรม ชั้น 6 โรงพยาบาลศิริราช เบอร์โทร. (02)419-6405-6

ข้าพเจ้าได้รับทราบข้อมูลของการวิจัยข้างต้น และประโยชน์ที่ได้รับจากการเข้าร่วมการวิจัย ในครั้งนี้ข้าพเจ้ายินยอมเข้าร่วมในการวิจัยโดยขอให้ผู้วิจัยเปิดเผยชื่อ ประวัติ ตลอดจนข้อมูลที่เกี่ยวข้องกับข้าพเจ้าแก่ผู้อื่น แต่จะนำเสนอเป็นข้อมูลโดยรวมจากการวิจัยเท่านั้น

ลงชื่อ.....ผู้เข้าร่วมการวิจัย

(.....)

วันที่.....

ลงชื่อ.....ผู้ให้ข้อมูลและขอความยินยอม

(.....)

วันที่.....

ลงชื่อ.....พยาน

(.....)

วันที่.....

หมายเหตุ ในกรณีที่ผู้เข้าร่วมการวิจัยอ่านหนังสือ ไม่ออก ผู้ที่อ่านข้อความทั้งหมดแทนผู้เข้าร่วมการวิจัย คือ.....จึงได้ลงลายมือชื่อไว้เป็นหลักฐาน

ลงชื่อ.....ผู้อ่านข้อความแทนผู้เข้าร่วมการวิจัย

(.....)

วันที่.....

ลงชื่อ.....พยาน

(.....)

วันที่.....

**หนังสือแสดงเจตนายินยอมเข้าร่วมการวิจัย**  
**(สำหรับผู้แทนโดยชอบธรรมของเด็กอายุ 15 - 18 ปี)**

วันที่.....เดือน.....พ.ศ. ....

ข้าพเจ้า นาย / นาง / นางสาว / ยศ ..... อายุ.....ปี  
อาศัยอยู่บ้านเลขที่ ..... ถนน..... ตำบล.....  
อำเภอ..... จังหวัด..... รหัสไปรษณีย์.....  
โทรศัพท์.....

ในฐานะเป็นผู้แทนโดยชอบธรรมของผู้ป่วยชื่อ นาย / นาง / นางสาว.....  
อายุ.....ปี

**ขอแสดงเจตนายินยอมให้เด็กในปกครองของข้าพเจ้าเข้าร่วมการวิจัยเรื่อง** ปัจจัยที่สัมพันธ์เกี่ยวข้อง  
กับการตอบสนองของร่างกายผู้ป่วยอุบัติเหตุที่ได้รับบาดเจ็บรุนแรงภายหลังการจัดการภาวะฉุกเฉิน  
ชีวิต

**ชื่อผู้วิจัย** นางสาวศิริรัตน์ เนตรนิมิตรผล นักศึกษาหลักสูตรปริญญาโท สาขาการพยาบาล  
ผู้ใหญ่ คณะพยาบาลศาสตร์ มหาวิทยาลัยมหิดล

**สถานที่ทำวิจัย** หน่วยตรวจโรคอุบัติเหตุ โรงพยาบาลศิริราช

โดย ข้าพเจ้าได้รับทราบเกี่ยวกับรายละเอียดของการวิจัย ดังต่อไปนี้

การวิจัยนี้มีวัตถุประสงค์เพื่อศึกษาถึงปัจจัยที่มีผลต่อการตอบสนองของร่างกายผู้ป่วย  
อุบัติเหตุที่ได้รับบาดเจ็บรุนแรง ซึ่งเป็นผลลัพธ์ที่เกิดขึ้นภายหลังการจัดการภาวะฉุกเฉินชีวิต  
ประโยชน์ที่ได้รับจากการวิจัยนี้ จะช่วยให้มีแนวทางในการพัฒนาคุณภาพการพยาบาลผู้ป่วย  
อุบัติเหตุที่บาดเจ็บรุนแรงเพื่อเพิ่มประสิทธิภาพการพยาบาล โดยเด็กในปกครองของข้าพเจ้า  
ได้รับเชิญเข้าร่วมการวิจัยเพราะเด็กในปกครองของข้าพเจ้าเป็นผู้หนึ่งที่มีคุณสมบัติเหมาะสมตาม  
เกณฑ์การคัดเลือกประชากร เข้าเป็นกลุ่มตัวอย่างในการวิจัยครั้งนี้ คือ เป็นผู้ป่วยอุบัติเหตุที่ได้รับ  
บาดเจ็บรุนแรงและได้รับการจัดการภาวะฉุกเฉินชีวิต ซึ่งจะมีผู้เข้าร่วมการวิจัยรวมทั้งหมดประมาณ  
95 คน โดยผู้วิจัยจะเป็นผู้สังเกตการจัดการภาวะฉุกเฉินชีวิต และบันทึกข้อมูลซึ่งประกอบด้วย  
ข้อมูลส่วนบุคคล ข้อมูลการบาดเจ็บ และข้อมูลการจัดการภาวะฉุกเฉินชีวิต การเข้าร่วมในการวิจัยนี้  
ไม่เกิดความเสี่ยงต่อตัวเด็กในปกครองของข้าพเจ้า และไม่เสียค่าใช้จ่ายใดๆ ทั้งสิ้น

หากเด็กในปกครองของข้าพเจ้าไม่เข้าร่วมในโครงการวิจัยนี้ เด็กในปกครองของข้าพเจ้าจะได้รับการตรวจรักษาตามวิธีการมาตรฐาน และข้าพเจ้าได้ทราบถึงสิทธิที่ข้าพเจ้าจะได้รับข้อมูลเพิ่มเติมจากการเข้าร่วมวิจัย และสามารถให้เด็กในปกครองของข้าพเจ้าถอนตัวหรืองดเข้าร่วมวิจัยได้ทุกเมื่อ โดยจะไม่มีผลกระทบต่อค่าบริการและการรักษาพยาบาลที่เด็กในปกครองของข้าพเจ้าจะได้รับต่อไป ถ้าผู้วิจัยมีข้อมูลเพิ่มเติมทั้งด้านประโยชน์และโทษที่เกี่ยวข้องกับการวิจัยนี้ ผู้วิจัยจะแจ้งให้ข้าพเจ้าทราบอย่างรวดเร็วโดยไม่ปิดบัง

หากมีข้อสงสัยเกี่ยวข้องกับการวิจัย ข้าพเจ้าสามารถติดต่อกับผู้วิจัย คือ นางสาวศิริรัตน์ เนตรนิมิตรผล ได้ที่หน่วยตรวจโรคอุบัติเหตุ โรงพยาบาลศิริราช หมายเลขโทรศัพท์ 08-1938-6163 ทั้งในและนอกเวลาราชการ

หากเด็กในปกครองของข้าพเจ้าได้รับการปฏิบัติที่ไม่ตรงตามที่ได้ระบุไว้ในเอกสารนี้ สามารถแจ้งให้ประธานคณะกรรมการจริยธรรมการวิจัยในคนหรือผู้แทน ได้ที่สำนักงานคณะกรรมการจริยธรรมการวิจัยในคน ตึกอคูยเดชวิกรม ชั้น 6 โรงพยาบาลศิริราช เบอร์โทร. (02)419-6405-6

ข้าพเจ้าได้รับทราบข้อมูลของการวิจัยข้างต้น และประโยชน์ที่ได้รับจากการเข้าร่วมการวิจัยในครั้งนี้ข้าพเจ้าจึงสมัครใจให้เด็กในปกครองของข้าพเจ้าเข้าร่วมในการวิจัยนี้ โดยขอให้ผู้วิจัยจัดการเปิดเผยชื่อ ประวัติ ตลอดจนข้อมูลที่เกี่ยวข้องกับเด็กในปกครองของข้าพเจ้าแก่ผู้อื่น แต่จะนำเสนอเป็นข้อมูลโดยรวมจากการวิจัยเท่านั้น

ลงชื่อ.....ผู้แทนโดยชอบธรรม (ระบุความ

(.....) เกี่ยวข้อง)

วันที่.....

ลงชื่อ.....ผู้ให้ข้อมูลและขอความยินยอม

(.....)

วันที่.....

ลงชื่อ.....พยาน

(.....)

วันที่.....

หมายเหตุ ในกรณีที่ผู้แทน โดยชอบธรรมอ่านหนังสือ ไม่ออก ผู้ที่อ่านข้อความทั้งหมดแทนผู้แทน โดยชอบธรรม คือ.....จึงได้ลงลายมือชื่อไว้เป็นหลักฐาน

ลงชื่อ.....ผู้อ่านข้อความแทนผู้แทน โดยชอบธรรม  
(.....)

วันที่.....

ลงชื่อ.....พยาน  
(.....)

วันที่.....

**หนังสือแสดงเจตนายินยอมเข้าร่วมการวิจัย**  
**(สำหรับเด็กที่มีอายุ 13 - 14 ปี)**

**ชื่อโครงการ** ปัจจัยที่สัมพันธ์เกี่ยวข้องกับการตอบสนองของร่างกายผู้ป่วยอุบัติเหตุที่ได้รับบาดเจ็บรุนแรงภายหลังการจัดการภาวะคุกคามชีวิต

**ความหมายของคำที่เกี่ยวข้อง**

การศึกษาวิจัย คือ โครงการที่วางแผนอย่างละเอียดเพื่อตอบคำถามเกี่ยวกับสุขภาพเพื่อช่วยเหลือผู้อื่นต่อไป

การตอบสนองของร่างกายผู้ป่วยอุบัติเหตุที่ได้รับบาดเจ็บรุนแรง คือ การเปลี่ยนแปลงของความดันโลหิต ปริมาณออกซิเจนในเลือด และกระบวนการเผาผลาญสารอาหารของร่างกาย

การจัดการภาวะคุกคามชีวิต คือ การรักษาพยาบาลเพื่อให้ผู้ป่วยรอดชีวิต

หนูได้รับเชิญเข้าร่วมโครงการนี้ เนื่องจากหนูเป็นผู้ป่วยที่ได้รับบาดเจ็บรุนแรงและได้รับการจัดการภาวะคุกคามชีวิต ซึ่งการบาดเจ็บรุนแรงนี้พบได้บ่อยในผู้ป่วยที่มีอายุ 13 ปีขึ้นไป ซึ่งหนูอยู่ในช่วงอายุนี้อดี

สิ่งที่ผู้วิจัยจะทำกับหนูคือ ผู้วิจัยจะเป็นผู้สังเกตการจัดการภาวะคุกคามชีวิต และบันทึกข้อมูลซึ่งประกอบด้วย ข้อมูลส่วนบุคคล ข้อมูลการบาดเจ็บ และข้อมูลการจัดการภาวะคุกคามชีวิต ตั้งแต่หนูมารับการรักษาจนกระทั่งสิ้นสุดกระบวนการรักษาเพื่อให้หนูรอดชีวิต

ประโยชน์ที่หนูจะได้รับ คือ โครงการนี้จะช่วยให้มีแนวทางในการพัฒนาคุณภาพและเพิ่มประสิทธิภาพในการรักษาพยาบาลเพื่อช่วยเหลือผู้อื่นต่อไป

โปรดอ่านข้อมูลนี้อย่างละเอียดหรือขอให้ผู้อื่นอ่านข้อมูลนี้ให้หนูฟัง และขอให้หนูใช้เวลาทบทวนข้อมูลเหล่านี้กับคุณพ่อคุณแม่ ถ้ามีข้อสงสัยเกี่ยวกับโครงการนี้ หนูสามารถโทรติดต่อ นางสาวศิริรัตน์ เนตรนิมิตรผล ได้ที่เบอร์ 08-1938-6163 ตลอด 24 ชั่วโมง

หนูไม่จำเป็นต้องเข้าร่วมโครงการถ้าหนูไม่ต้องการ จะไม่มีใครมาบังคับหนู การเข้าร่วมโครงการขึ้นอยู่กับหนูโดยสิ้นเชิง หนูสามารถถามคำถามได้ถ้าหนูไม่เข้าใจ และถ้าหนูตกลงเข้าร่วมโครงการ เราจะขอให้หนูลงลายมือชื่อในหนังสือแสดงความสมัครใจฉบับนี้ โดยจะมีการขอให้บิดามารดา

ผู้ปกครอง หรือผู้แทนตามกฎหมายของหนูลงลายมือชื่อในแบบฟอร์มเพื่ออนุญาตให้หนูเข้าร่วมโครงการด้วย

หนูสามารถหยุดการเข้าร่วมในโครงการวิจัยนี้ได้ทุกเมื่อโดยที่หนูไม่จำเป็นต้องให้เหตุผล และถ้าหนูตอบปฏิเสธจะไม่มีใครโกรธ ข้อมูลที่เกี่ยวข้องกับหนูจะถูกเก็บเป็นความลับและจะรายงานเป็นข้อมูลโดยรวมจากโครงการนี้เท่านั้น

โครงการวิจัยนี้มีผู้ตรวจสอบว่างานวิจัยดีพอที่จะทำได้ คือ คณะกรรมการจริยธรรมการวิจัยในคน คณะแพทยศาสตร์ศิริราชพยาบาล มหาวิทยาลัยมหิดล ซึ่งได้ตรวจสอบการศึกษาวิจัยอย่างละเอียดแล้ว พวกท่านได้อ่านทุกอย่างที่เกี่ยวกับการศึกษาวิจัยและได้อนุญาตให้ดำเนินโครงการวิจัยได้

โครงการวิจัยนี้จะมีผู้ป่วยที่ได้รับบาดเจ็บรุนแรงเข้าร่วมการวิจัยจำนวน 95 คน ซึ่งมีอายุตั้งแต่ 13 ปีขึ้นไป

หนู/ผม ชื่อ.....อายุ.....ปี อยู่บ้านเลขที่ .....  
 หมู่ที่.....ถนน.....ตำบล.....อำเภอ.....  
 จังหวัด.....รหัสไปรษณีย์.....

ผู้วิจัยได้อธิบายข้อมูลและขั้นตอนต่างๆ ในการเข้าร่วมการวิจัยให้ฟังแล้ว และหนู/ผมทราบว่า จะยินดีเข้าร่วมโครงการหรือไม่ก็ได้ โดยไม่มีผลกระทบต่อการศึกษาพยาบาลของหนู/ผม หนู/ผมเข้าใจโครงการนี้ และด้วยความเห็นชอบของผู้ปกครองของหนู/ผม จึงตกลงเข้าร่วมโครงการวิจัยนี้

.....	.....
(.....)	(.....)
เด็กที่เข้าร่วมโครงการวิจัย	ผู้ชี้แจงและเชิญให้เข้าร่วมโครงการวิจัย
วันที่.....	วันที่.....

.....  
 (.....)

หมายเหตุ      ในกรณีที่มีผู้อ่านข้อความให้เด็กฟัง ผู้อ่านข้อความทั้งหมด คือ.....  
..... จึงได้ลงลายมือชื่อไว้เป็นหลักฐาน

.....

(.....)

ผู้อ่านข้อความแทน

วันที่.....

.....

(.....)

พยาน

วันที่.....

**หนังสือแสดงเจตนายินยอมเข้าร่วมการวิจัย**  
**(สำหรับผู้แทนโดยชอบธรรมของเด็กอายุ 13 - 14 ปี)**

วันที่.....เดือน.....พ.ศ. ....

ข้าพเจ้า นาย / นาง / นางสาว / ยศ ..... อายุ.....ปี

อาศัยอยู่บ้านเลขที่ .....ถนน.....ตำบล.....

อำเภอ.....จังหวัด.....รหัสไปรษณีย์.....

โทรศัพท์.....

ในฐานะเป็นผู้แทน โดยชอบธรรมของผู้ป่วยชื่อ เด็กชาย / เด็กหญิง.....

อายุ.....ปี

**ขอแสดงเจตนายินยอมให้เด็กในปกครองของข้าพเจ้าเข้าร่วมการวิจัยเรื่อง ปัจจัยที่สัมพันธ์เกี่ยวข้องกับการตอบสนองของร่างกายผู้ป่วยอุบัติเหตุที่ได้รับบาดเจ็บรุนแรงภายหลังการจัดการภาวะคุกคามชีวิต**

**ชื่อผู้วิจัย** นางสาวศิริรัตน์ เนตรนิมิตรผล นักศึกษาหลักสูตรปริญญาโท สาขาการพยาบาล ผู้ใหญ่ คณะพยาบาลศาสตร์ มหาวิทยาลัยมหิดล

**สถานที่ทำวิจัย** หน่วยตรวจโรคอุบัติเหตุ โรงพยาบาลศิริราช

โดย ข้าพเจ้าได้รับทราบเกี่ยวกับรายละเอียดของการวิจัย ดังต่อไปนี้

การวิจัยนี้มีวัตถุประสงค์เพื่อศึกษาถึงปัจจัยที่มีผลต่อการตอบสนองของร่างกายผู้ป่วยอุบัติเหตุที่ได้รับบาดเจ็บรุนแรง ซึ่งเป็นผลลัพธ์ที่เกิดขึ้นภายหลังการจัดการภาวะคุกคามชีวิต ประโยชน์ที่ได้รับจากการวิจัยนี้ จะช่วยให้มีแนวทางในการพัฒนาคุณภาพการรักษายาบาลผู้ป่วยอุบัติเหตุที่บาดเจ็บรุนแรงเพื่อเพิ่มประสิทธิภาพการรักษายาบาล โดยเด็กในปกครองของข้าพเจ้าได้รับเชิญเข้าร่วมการวิจัยเพราะเด็กในปกครองของข้าพเจ้าเป็นผู้หนึ่งที่มีคุณสมบัติเหมาะสมตามเกณฑ์การคัดเลือกประชากร เข้าเป็นกลุ่มตัวอย่างในการวิจัยครั้งนี้ คือ เป็นผู้ป่วยอุบัติเหตุที่ได้รับบาดเจ็บรุนแรงและได้รับการจัดการภาวะคุกคามชีวิต ซึ่งจะมีผู้เข้าร่วมการวิจัยรวมทั้งหมดประมาณ 95 คน โดยผู้วิจัยจะเป็นผู้สังเกตการจัดการภาวะคุกคามชีวิต และบันทึกข้อมูลซึ่งประกอบด้วย

ข้อมูลส่วนบุคคล ข้อมูลการบาดเจ็บ และข้อมูลการจัดการภาวะคุกคามชีวิต การเข้าร่วมในการวิจัยนี้ ไม่เกิดความเสี่ยงต่อตัวเด็กในปกครองของข้าพเจ้า และไม่เสียค่าใช้จ่ายใดๆ ทั้งสิ้น

หากเด็กในปกครองของข้าพเจ้าไม่เข้าร่วมในโครงการวิจัยนี้ เด็กในปกครองของข้าพเจ้าจะได้รับการตรวจรักษาตามวิธีการมาตรฐาน และข้าพเจ้าได้ทราบถึงสิทธิที่ข้าพเจ้าจะได้รับข้อมูลเพิ่มเติมจากการเข้าร่วมวิจัย และสามารถให้เด็กในปกครองของข้าพเจ้าถอนตัวหรืองดเข้าร่วมวิจัยได้ ทุกเมื่อโดยจะไม่มีผลกระทบต่อค่าบริการและการรักษาพยาบาลที่เด็กในปกครองของข้าพเจ้าจะได้รับต่อไป ถ้าผู้วิจัยมีข้อมูลเพิ่มเติมทั้งด้านประโยชน์และโทษที่เกี่ยวข้องกับการวิจัยนี้ ผู้วิจัยจะแจ้งให้ข้าพเจ้าทราบอย่างรวดเร็วโดยไม่ปิดบัง

หากมีข้อสงสัยเกี่ยวข้องกับการวิจัย ข้าพเจ้าสามารถติดต่อกับผู้วิจัย คือ นางสาวศิริรัตน์ เนตรนิมิตรผล ได้ที่หน่วยตรวจโรคอุบัติเหตุ โรงพยาบาลศิริราช หมายเลขโทรศัพท์ 08-1938-6163 ทั้งในและนอกเวลาราชการ

หากเด็กในปกครองของข้าพเจ้าได้รับการปฏิบัติที่ไม่ตรงตามที่ได้ระบุไว้ในเอกสารนี้ สามารถแจ้งให้ประธานคณะกรรมการจริยธรรมการวิจัยในคนหรือผู้แทน ได้ที่สำนักงานคณะกรรมการจริยธรรมการวิจัยในคน ตึกอคูยเดชวิกรม ชั้น 6 โรงพยาบาลศิริราช เบอร์โทร. (02)419-6405-6

ข้าพเจ้าได้รับทราบข้อมูลของการวิจัยข้างต้น และประโยชน์ที่ได้รับจากการเข้าร่วมการวิจัย ในครั้งนี้ข้าพเจ้าจึงสมัครใจให้เด็กในปกครองของข้าพเจ้าเข้าร่วมในการวิจัยนี้ โดยขอให้ผู้วิจัยงดการเปิดเผยชื่อ ประวัติ ตลอดจนข้อมูลที่เกี่ยวข้องกับเด็กในปกครองของข้าพเจ้าแก่ผู้อื่น แต่จะนำเสนอเป็นข้อมูลโดยรวมจากการวิจัยเท่านั้น

ลงชื่อ.....ผู้แทนโดยชอบธรรม(ระบุความ

(.....) เกี่ยวข้อง)

วันที่.....

ลงชื่อ.....ผู้ให้ข้อมูลและขอความยินยอม

(.....)

วันที่.....

ลงชื่อ.....พยาน

(.....)

วันที่.....

หมายเหตุ ในกรณีที่ผู้แทน โดยชอบธรรมอ่านหนังสือ ไม่ออก ผู้ที่อ่านข้อความทั้งหมดแทนผู้แทน โดยชอบธรรม คือ.....จึงได้ลงลายมือชื่อไว้เป็นหลักฐาน

ลงชื่อ.....ผู้อ่านข้อความแทนผู้แทน โดยชอบธรรม

(.....)

วันที่.....

ลงชื่อ.....พยาน

(.....)

วันที่.....

## APPENDIX D

### RESEARCH INSTRUMENT

#### แบบบันทึกในการวิจัยเรื่อง

ปัจจัยที่สัมพันธ์เกี่ยวข้องกับการตอบสนองของร่างกายผู้ป่วยอุบัติเหตุ  
ที่ได้รับบาดเจ็บรุนแรงภายหลังการจัดการภาวะคุกคามชีวิต

วันที่บันทึกข้อมูล...../...../.....

เลขที่แบบบันทึก.....

**คำชี้แจง** แบบบันทึกนี้ประกอบด้วย 3 ส่วน ได้แก่

**ส่วนที่ 1** แบบบันทึกข้อมูลส่วนบุคคลของผู้ป่วยอุบัติเหตุที่ได้รับบาดเจ็บรุนแรงที่มีภาวะ  
คุกคามชีวิต

**ส่วนที่ 2** แบบบันทึกปัจจัยที่เกี่ยวข้องกับการตอบสนองของร่างกายผู้ป่วยอุบัติเหตุที่ได้รับ  
บาดเจ็บรุนแรงที่มีภาวะคุกคามชีวิต

ตอนที่ 1 แบบบันทึกเวลาในการจัดการภาวะคุกคามชีวิต

ตอนที่ 2 แบบวัดความรุนแรงของการบาดเจ็บ

ตอนที่ 3 แบบประเมินการจัดการภาวะคุกคามชีวิต

**ส่วนที่ 3** แบบบันทึกการตอบสนองของร่างกายผู้ป่วยอุบัติเหตุที่ได้รับบาดเจ็บรุนแรงใน  
การจัดการ ภาวะคุกคามชีวิต

ตอนที่ 1 แบบบันทึกการตอบสนองของร่างกายผู้ป่วยอุบัติเหตุที่ได้รับการจัดการ  
ภาวะคุกคามชีวิต

ตอนที่ 2 แบบประเมินผลการตอบสนองของร่างกายผู้ป่วยอุบัติเหตุภายหลังการ  
จัดการภาวะคุกคามชีวิต

**ส่วนที่ 1 แบบบันทึกข้อมูลส่วนบุคคลของผู้ป่วยอุบัติเหตุที่ได้รับบาดเจ็บรุนแรงที่มีภาวะคุกคามชีวิต**  
**คำชี้แจง** โปรดทำเครื่องหมาย ✓ ลงใน  หรือเติมข้อมูลที่ตรงกับความเป็นจริงลงในช่องว่างในแต่ละข้อ

1. เพศ  ชาย  หญิง
2. อายุ .....ปี
3. วัน / เดือน / ปี ที่เกิดเหตุ.....เวลาที่เกิดเหตุ.....
4. เวลาที่มาถึงโรงพยาบาล.....เวลาจำแนกประเภท.....
5. ....
6. ....
7. ....
8. ....
9. ....
10. ....
11. ....
- 12.คะแนน CRAMS scale  
.....

**ส่วนที่ 2 แบบบันทึกปัจจัยที่เกี่ยวข้องกับการตอบสนองของร่างกายผู้ป่วยอุบัติเหตุที่ได้รับบาดเจ็บรุนแรงที่มีภาวะคุกคามชีวิต**

**ตอนที่ 1 แบบบันทึกเวลาในการจัดการภาวะคุกคามชีวิต**

**คำชี้แจง** โปรดเติมข้อมูลที่ตรงกับความเป็นจริงลงในช่องว่างในแต่ละข้อ โดยบันทึกเป็นชั่วโมง นาที และวินาที

1. การจำแนกประเภทเวลา.....น. ถึงเวลา.....น. รวมเวลา.....วินาที
2. ....
3. ....



รายการ	การจัดการภาวะฉุกเฉินชีวิต			หมายเหตุ
	ได้รับ	ได้รับไม่ครบถ้วน	ไม่ได้รับ	
1. การประเมินอาการและการบาดเจ็บภายในเวลา 2 นาที				
2. การจัดบริเวณคอกอยู่หนึ่งและอยู่ในท่าตรง				
3. การประเมินทางเดินหายใจและการหายใจ				
4. ....				
5. ....				
6. ....				
7. ....				
8. ....				
9. ....				
10. ....				
11. ....				
12. ....				
13. ....				
14. ....				



**ตอนที่ 2** แบบประเมินผลการตอบสนองของร่างกายผู้ป่วยอุบัติเหตุภายหลังการจัดการภาวะคุกคามชีวิต

**คำชี้แจง** โปรดทำเครื่องหมาย ✓ ที่ตรงกับความเป็นจริงลงในช่องว่างในแต่ละข้อ จาก

อาการดีขึ้น                      หมายถึง                      ผู้ป่วยอุบัติเหตุที่ได้รับบาดเจ็บรุนแรง มีค่า  $SpO_2 \geq 95 \%$ ,  
SBP  $\geq 90$  mmHg และระดับแลคเตทในเลือด  $\leq 2$   
mmol/L ภายหลังการจัดการภาวะคุกคามชีวิต

.....

.....

.....

.....

ผลการตอบสนองของร่างกายผู้ป่วยอุบัติเหตุที่ได้รับบาดเจ็บรุนแรงภายหลังการจัดการภาวะคุกคามชีวิต

- อาการดีขึ้น
- อาการไม่เปลี่ยนแปลง
- อาการเลวลง

## APPENDIX E

### MORE RESULT

**Table A** Demographic Data of Major Trauma Patients

Characteristics	Number	Percentage
<b>Triage</b>		
Correct	65	78.3
Incorrect	18	21.7
Over triage	0	0
Under triage	18	21.7
<b>Pre-hospital Care</b> (One patient had more than one procedures)		
None	32	38.55
Primary assessment	51	61.45
Airway management	4	4.8
Oxygen therapy	8	9.6
Bleeding control and fluid management	7	8.4
Spinal board splinting	47	56.6

**Table B** Time for management of life threatening conditions

<b>Factors</b>	<b>Number</b>	<b>Percentage</b>
<b>Triage time</b> (minutes)		
< 0.30	4	4.8
0.30 – 1.00	66	79.5
> 1.00	13	15.7
(Mean = 0.86, S.D.= 0.68, Min = 0.15, Max = 5.00)		
<b>Resuscitation time</b> (minutes)		
< 5.00	3	3.6
5.01 – 10.00	19	22.9
10.01 – 20.00	41	49.4
20.01 – 30.00	16	19.3
> 30.00	4	4.8
(Mean = 16.02, S.D.= 8.97, Min = 4.40, Max =52.42)		

**Table C** The management of life threatening conditions scores

<b>Management life-threatening conditions</b>	<b>Received</b>	<b>Percentage</b>
1. Identify patient's conditions in 2 minutes	82	98.8
2. C – spine protection	54	65.1
3. Assess airway and breathing	79	95.2
4. Evaluating of patency and adequacy of ventilation	81	97.6
5. Oxygen therapy	61	73.5
6. Assess circulation and shock	81	97.6
7. Fluid management	27	32.5
8. Assess level of consciousness	82	98.8
9. Completely remove clothing	81	97.6
10. Keep warm and environment control	6	7.2
11. Monitoring	40	48.2
12. Documentation	4	4.8
13. Co-operate with TNC	81	97.6
14. Perform rapid management together with physicians	82	98.8

## **BIOGRAPHY**

<b>NAME</b>	Miss Sirirat Netnimitphol
<b>DATE OF BIRTH</b>	23 August 1970
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