Length of stay as an indicator for efficient and effective trauma management pre and post implementation of a State Major Trauma Unit in Western Australia.

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This thesis is presented as part of the requirement for the degree of Bachelor of Nursing with Honours at Murdoch University,

June 19th 2009.
DECLARATION

I declare that this thesis is my own account of my research and contains as its main content, work that has not previously been submitted for a degree at any tertiary education institution.

..................................

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ABSTRACT

Background: Trauma is the leading cause of death of Australians aged between 14 and 50 years with trauma admissions to hospitals costing governments millions of dollars per year. Managing health budgets set by governments whilst still delivering quality health care is an important issue. Strategies for addressing effectiveness and efficiency are often focused on providing high quality, cost effective services, which are aimed at reducing hospital length of stay while providing appropriate care. One such strategy adopted by Royal Perth Hospital (RPH) has been the creation of a new State Major Trauma Unit (SMTU) that offers increased trauma services by allowing for greater contact between patients, nursing medical and allied health teams.

Aim: The aim of this study was to evaluate the new Western Australian State Major Trauma Unit and its impact on length of hospital stay in major trauma patients. Results can be used to analyse one indicator of effectiveness; namely, length of stay in relation to differing types of services offered pre and post implementation of the SMTU. This provides the basis for recommendations for further studies into effectiveness and efficiency in trauma management in areas such as cost analysis, delayed discharges and unplanned admissions.

Methodology: A retrospective analysis was conducted using data from the Trauma Registry from Royal Perth Hospital. Data on the length of stay (LOS) of patients with an Injury Severity Score (ISS) >15 who were admitted to any general ward at RPH in 2007, prior to establishment of the SMTU, were compared with data from patients who were admitted to the SMTU during the same period in 2008. Descriptive analysis included comparisons of median and interquartile range of age, sex, admission, specialty, discharge destination and ISS. A Chi Square Test of Contingencies or Mann Whitney U test was used to test for any differences in demographic data and the length of stay between these two groups. All p values < .05 are considered significant.

Results: There was no statistically significant difference found between the length of stay or Injury Severity Score of major trauma patients who were admitted to RPH in 2007 and 2008.

Conclusions: The results are useful in providing an indicator of trauma patient management in terms of length of stay. The lack of a significant finding suggests the need for a longer term analysis of the LOS for patients admitted to the SMTU and further research into other indicators of effectiveness and efficiency.
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DEFINITION OF TERMS

Length of Stay: a period of time a patient remains in a hospital or other healthcare facility as an inpatient (Harris, Nagy and Vardaxis 2006:996).

Efficiency: the productive use of resources.

Effectiveness: producing favourable results.

Major Trauma Centre: Is a hospital, usually one of the largest in the state, which is located within the capital city. The hospital is dedicated to the treatment of trauma patients within the State where it is located.

State Major Trauma Unit: A 30 bed ward located at Royal Perth Hospital which is dedicated to the treatment of major trauma patients in Western Australia.

Major Trauma Patient: A patient who has been injured physically and categorised by the type of injuries and injury severity. Major Trauma Patients are those who have an Injury Severity Score of >15.

Injury Severity Score: A scoring system for trauma patients which classifies the severity of injury into categories; minor and major.
Trauma: “occurs when an uncontrolled source of energy makes contact with the body and the body cannot tolerate exposure to that acute energy causing injury” Curtis, Ramsden & Friendship (2007).

Trauma System: A structured system formed to treat trauma patients.

Admission: The process of being accepted; made entry.

Discharge: The process of being dismissed from an institutional setting.

Episode of Care: The term used to describe the patient’s category of admission or nature of clinical service. The episodes of care are characterised by labels such as ‘acute care’, ‘rehabilitation care’, and ‘palliative care’. There are ten types of clinical service under which a patient can be placed.

High Dependency Unit: Department within the hospital where acutely ill patients are treated.

Intensive Care Unit: Department within the hospital where acutely ill patients are treated, however patients may be ventilated if they are unable to maintain their airway or if they need to be sedated due to pain.
Ventilation: The artificial support of a patient’s airway by a plastic tube which is placed into a patient’s trachea (structure which connects the mouth to the lungs). This plastic tubing is connected to a machine that breathes for the patient.

Multi Disciplinary Team: A team of professionals within each department of a hospital including: physiotherapists, psychologists, speech pathologist, doctors, nurses, occupational therapists and social workers.

Trauma Case Manager: A nurse who is dedicated the management of each trauma admission. These professionals manage each patient case by case. They facilitate communication between health care professionals to ensure the timely assessment and treatment of the patients’ injuries.

Diagnostic Related Groups: On admission, and after diagnosis patients are categorized into specific Diagnostic Related Groups (DRG), which are related to the aetiology of disease (Liberero, Martin, Peiro & Munujos, 2004).

Tertiary survey: The third and final physical assessment completed by medical staff to effectively diagnose and treat trauma patients. The tertiary survey should be completed within 48 hours or injury if the patient is not head injured or intubated.
CHAPTER 1- INTRODUCTION AND BACKGROUND

1.1 Introduction

This chapter introduces the relationship between trauma and the Australian healthcare system. It will discuss the demographics of the Western Australian population and describe the difficulties found within this geographically large State to treat trauma patients. The chapter will also outline the background of trauma patient management and trauma models of care in Australia as well as introduce the service created within Western Australia; the State Major Trauma Unit (SMTU).

1.2 Background to the study

1.2.1 Trauma management

Trauma is defined as the injury sustained as a result of contact with an uncontrolled source of energy (Curtis, Ramsden & Friendship, 2007). It is the leading cause of death of Australians between the ages of 15 and 40 with over 300,000 trauma admissions to Australian hospitals in 2002 (Delprado, 2007). Trauma patients within Australian hospitals are categorised by an internationally recognized scoring system termed the Injury Severity Score (ISS). The ISS is a tool that measures severity and expected outcomes of injury (Rutledge, Osler, Emery & Kromhout-Schiro, 1998) and ranges from 0-75. In the clinical setting the ISS is usually divided into groups from lower severity to higher severity (Fern et al, 1998). The category 0-15 is defined as minor trauma. Examples of injuries that would be included in this group include minor fractures, possible minor head injuries and lacerations. A detailed description of the ISS can be found in Appendix A.
The category of >15 is defined as major trauma. Injuries may include moderate to major head injuries, intra-abdominal injury, and complex fractured bones such as pelvic fractures (Rutledge et al, 1998). The higher the Injury Severity Score the higher the rate of mortality (Kilgo, Osler & Meredith, 2003). An ISS of 75 denotes an unsurvivable injury (see Appendix A). Mortality in the trauma setting has been of particular concern for many decades. From the 300,000 trauma admissions in Australia in 2002, almost 6,000 had an Injury Severity Score (ISS) of >15 placing those patients in the major trauma category and therefore at risk of dying (Delprado, 2007). Health services nationally and world wide have made attempts to reduce the death toll caused by trauma through legislative and policy changes (Department of Health and Aging, 2007-08).

1.2.2 Trauma management in Western Australia

As Western Australia is a unique state in its size and population, policy makers in recent years have placed increased emphasis on its trauma system. Australian health departments maintain a commitment to efficient and effective trauma services, including the Western Australian Department of Health (WADOH, 2008). Challenges presented to effective services because of distance include patients not being able to be treated within the 'golden hour'. This term is used to describe an urgent need for trauma care, which implies that morbidity and mortality are affected if patients do not receive this care within the first hour of injury (Lerner & Moscati, 2001). The realities of Western Australians reaching these services within this time due to the distances posed by the state are unlikely (Rao,
Western Australia is the largest state in the country with a population of approximately 2.1 million people, from many backgrounds and cultures (Australian Bureau of Statistics (ABS), 2006). Western Australia is also the fastest growing state in the country, largely driven by the industrial boom in the North West of the state, where the population has been boosted significantly by the migration of North Western Europeans (ABS, 2008).

The State’s capital, Perth, is situated on the west coast. The size of the state and its isolation, challenges medical services in terms of transport to definitive care in trauma related events. The Royal Flying Doctor Service and St John’s Ambulance Services are used to transport the critically ill trauma patient into the metropolitan area where trauma care can be administered. Emergency services can travel large distances across the State’s 2400 square kilometers to reach required destinations (Gupta & Rao, 2003). These large distances emphasize the need for a systematic approach to trauma care that includes pre-hospital care, emergency intervention and surgical services. This is particularly important for road trauma, which is the most common mechanism of injury in Western Australia with 44% occurring in rural areas (Gupta & Rao, 2003). In 2006, road trauma accounted for 58.4% of the total major trauma patients admitted to RPH (RPH Trauma Registry, 2006). Fifty-nine percent of the road trauma patients were injured in motor vehicle accidents, 25% motorbike accidents, 9% were injured pedestrians and 7% were pedal cyclists. There was a 34.7% increase in major trauma patients from road incidents in 2005-2006. The trauma presentation to RPH increases annually. The hospital admitted 517
patients with an ISS >15 in 2006. On average there has been an annual increase of 31.5 trauma patients admitted to Royal Perth Hospital since 1995 (RPH, Trauma Registry, 2006).

A major grant of eight million dollars was provided by the Commonwealth government as start up funding for the State Major Trauma Unit at Royal Perth Hospital as the hospital received up to 75% of all major trauma patients of WA. In addition, the unit is estimated to cost $7.5 million per year in operational costs (Rao, 2007).

The cost of annual road trauma in Australia is substantial and has been estimated at 18 billion dollars per year; an expenditure that takes funds away from other health related programs and results in less resources for community members (Australian Transport Council, 2006). The cost of trauma continues to rise as technology in medicine results in reduced mortality rates. Although survival rates of trauma patients continue to improve these survivors are often left permanently impaired (Halcomb, Daly, Davidson, Elliot & Griffiths, 2005). This impairment has a significant impact on individuals, families, community, culture and society (Wills, Cameron & Igoe, 1997). The loss of productivity and ability to return to work is a major contributor to what can be considered a ripple effect from patient to the communities and so onto society. Clearly, the loss of productive life places financial burden on the family as well as governments and can have a negative impact on the individual’s self- esteem even leading to mental illness (Halcomb et al, 2005). An examination of the Trauma Registry at RPH (2007) found that of 50 patients who attended a Major
Trauma Outcome Clinic (MTOC) in 2006 only 18% were able to attend work three months following discharge. The quality of life of 33 patients who attended the MTOC was significantly affected. Fifty-eight percent of the patients claimed to have a mild deterioration of quality of life (QOL), 24% had a significant deterioration of QOL and 3% had a major handicap. So whereas in the past, mortality was considered the benchmark for effectiveness and efficiency in trauma management, “more recently, policymakers and governments have come to recognise the importance of measuring health outcomes as an integral component of health service evaluation and the justification of resource allocation” rather than focusing purely on mortality (Halcomb, et al, 2005, p 17).

1.2.3 The development of trauma systems.

Historically, trauma systems in the western world were influenced by the Korean and Vietnam wars. The key feature of wartime trauma treatment was the use of helicopters as a mode of transport for emergency services. Helicopter transport enables patients to reach acute surgical centres within the shortest possible time resulting in a reduction in mortality and morbidity rates across all levels of severity (Nathans, Brunet & Maier, 2004). This model has primarily been used in North America where the international benchmark for trauma services was established during its adoption of the system in the early 1970’s (Atkin et al, 2005). The development of Australian trauma systems has therefore been based on the high quality emergency services that were already established in places such as North America (Cameron, Dziukas, Hadj & Hooper, 1995). The most
recent development in trauma care has been the establishment of trauma centres.

Throughout the past decade, the Australian Government created the National Road and Trauma Advisory Council (NRTAC) to assess the growing needs of trauma services in Australia. In 1993, the Council published a report and delivered recommendations to State Governments in expectation of the development of effective trauma systems (Delprado, 2007). Within the NRTAC report, capital cities were required to create major trauma centres for their communities. Following the report State and Federal Governments created individual trauma agencies such as the Trauma Working Group of WA. Recommendations were also made for the implementation of hospital bypass, national standards for retrieval and transfer of trauma patients, trauma education, surgical services, rural and paediatric services, rehabilitation of those having experienced trauma, quality assurance activities of trauma management centres and trauma care research (Delprado, 2007). Hospital bypass is a system that has been put into place to redirect ambulance services to specific hospitals. Ambulances must bypass other hospitals in order to reach the major trauma centres. Following the release of the report most States implemented change within their organisations to improve the management of the trauma patient (Delprado, 2007). These components have been implemented in several stages over several years and each state in Australia has implemented them individually, with Victoria paving the way for others as the most established trauma system within the country (Delprado, 2007).
1.2.4 Models of trauma care

In developing a trauma centre, each Australian State has had the flexibility to tailor their trauma system to their particular needs, including the structure of their major trauma centres. The structure of Australian trauma centres may have some similarities in that they are often located in capital cities or major metropolitan areas and are all strongly affiliated with major universities. Hospitals designated as major trauma centres endeavour to have both the best emergency and surgical services within their State and to be leaders in research. The structural differences between centres are largely dependent on the leadership of the senior trauma consultants and clinicians (Demetriades, et al, 2005).

Lansink and Leenen (2007) describe trauma systems in terms of two categories, inclusive and exclusive. Inclusive trauma systems are designed to care for all trauma patients within a specific geographic area, therefore all hospitals within the region or state will participate as a whole trauma service. This system includes using a multidisciplinary approach to trauma care though all stages of treatment, including pre-hospital treatment, acute hospital care and rehabilitation. The hospitals within this system will be categorised depending on their ability to care for the most severe trauma patients, and emergency services will bypass to these hospitals following a ‘pre-planned triage scheme’ to enable the patient to reach the most appropriate service in the shortest time possible. Exclusive trauma systems are organized around a level one trauma centre or a major trauma centre: services that are for the severely injured patients. Western Australia would
be classified as using an ‘inclusive’ trauma system as it uses all services within the state to deliver definitive trauma care. This system uses six designated levels including major trauma, metropolitan trauma, urban trauma, regional trauma, rural trauma and remote trauma services (DOHWA, 2007).

Western Australia’s trauma system has been strongly influenced by the well established systems functioning in other states. Victoria is the leading Australian state in trauma services and introduced their trauma system in 2000, following additional recommendations from the Review of Trauma and Emergency services in 1999. Their ‘inclusive’ system involved shifting the focus from one hospital or centre to incorporate the entire State and all its emergency services and public health providers (VicHealth, 2005-2006). Victoria has two adult and one paediatric major trauma centres that are located in the State’s capital, Melbourne. Patients are admitted to the major trauma centers after meeting admission criteria such as ISS>15, or sustaining specific penetrating or blunt injuries and having unstable vital signs. The admission criteria and guidelines are provided by the Victorian Department of Health (VicHealth, 2009).

In most hospitals, patients who are admitted are placed on a ward where they can be best managed for the most dominant injury (VicHealth, 2005-06). For example, a patient who was in a motor vehicle accident who has sustained a fractured pelvis, a significant head injury, and a splenic laceration would be placed on a neurosurgical ward, as the head injury would be the most dominant injury (see Appendix A).
At the level one trauma centre for the state The Alfred Hospital, patients who have multi-system injuries are placed on the trauma ward. After 24 hours patients will receive a tertiary survey and will be placed under the surgical specialty of the dominant injury. If however, multi-system issues continue the patients will remain on the trauma ward until the injuries are resolved into a single system injury. Other single system trauma patients are admitted to the surgical specialty according to the injury (Alfred Health, 2009; L.Niggemeyer, Personal Communication, 12 November 2009.

There are other trauma centres that lie within the metropolitan area which are classed as level two centres and are utilized for specific issues such as spinal care and vascular surgery. The Victorian System uses all hospitals within the state to enable the patient to receive the most appropriate care to reduce morbidity and mortality. As some hospitals specialize in individual areas, for example, the Austin Hospital, specialises in spinal injuries, it is up to emergency services to determine the most appropriate hospital for the patient to be sent to. The Victorian system incorporates the entire scope of trauma care including paramedic education which allows these professionals to triage using specific criteria to determine which destination is best for the patient.

This type of system is similar across all Australian states, however the number of trauma centres per state may vary for example New South Wales has approximately eleven designated trauma centres. However, evidence from North America shows that fewer trauma centres improve rates of mortality and morbidity as the centres gain more experience with
the higher number of trauma admissions. It is also recommended there
should be one trauma centre per 1.5 million people in the population. An
excess of major trauma services causes confusion within the system because
definitive care may be scattered throughout the metropolitan area (Sampalis,
Denis & Lavoie, 1999).

A systematic review and meta-analysis of the use of trauma centres
conducted by Celeso et al (2006) reviewed data from 14 studies in North
America between the years of 1990 to 2004. The review found that eight of
the fourteen studies reported, improved the odds of patient survival. Three
showed worse odds of survival and three showed no statistically significant
improvements in survival where patients were treated in a trauma system.
One study reviewed in the meta-analysis, that was conducted by Mullins and
Mann (1999), found there was a significant reduction in the risk of mortality
if a patient was admitted to a designated trauma centre. Mullins and Mann
reviewed over 400,000 patients over an eight year period, comparing the
Washington trauma system, which had no structured trauma system, with
the Oregon system, which did have a structured trauma system. The
reduction in mortality for those treated in the structured system was
attributed in part to improved training of staff and advances in technology.
Another study included in the meta-analysis (Sampalis et al, 1999) showed
that reduced mortality rates of patients admitted to a trauma centre were due
to faster intervention as well as better access to resources provided by these
trauma centres. The researchers claimed that mortality decreased with a
higher level of experience. This information was used as a basis for
recommendations to limit the number of trauma centres in a population and therefore to increase the number of trauma admissions, which maximises trauma management experience. Additional studies analysed in the meta-analysis showed that in the elderly, survival rates may have improved; however mortality rates were insignificantly different within trauma systems as co-morbidities influenced treatment. Trauma systems were also found to reduce hospital length of stay, intensive care unit stay and improve patient survival in systems of greater experience. The meta-analysis concluded with recommendations for further studies into complication rates, delays in treatment, and management of co-morbidities. Celeso et al (2006) also suggested that other benchmarks such as functional return and cost saving would be better performance indicators for trauma systems.

1.2.5 Trauma management and the Australian health care system.

One of the Commonwealth’s programs related to trauma is the National Injury Prevention and Safety Plan 2004-2014 (National Public Health Partnership, 2004). The program includes initiatives addressing areas such as alcohol and drug prevention, trauma prevention in adults and children, mental health, childhood obesity, falls prevention in the elderly, road safety, water safety for children and Aboriginal and Torres Strait Islander health (Department of Health and Aging, 2008). The Australian Commission on Quality and Safety in Healthcare (ACQSH, 2009) also provide links to these programs. The role allows for the commission to direct policy changes within the health sector to improve the quality and safety of health care. The Commission reports publicly on the state of
quality and safety in comparison to national standards, and recommends changes for improvements within the health care sector (ACQSH, 2009). At a state level, and particularly in relation to trauma services, the Health Commission created a Trauma Working Group (TWG) to oversee health care within WA’s trauma system (Department of Health WA, (DOHWA), 2007).

The TWG of Western Australia was established in 2005, to review and monitor the implementation of changes to the trauma system that were initiated in 2007 (DOHWA, 2007). These changes include the appointment of a State Director of Trauma Services; a Director for Major Trauma Services within the two Major Trauma Centres at Princess Margaret Hospital (children’s hospital) and at Royal Perth Hospital (adult hospital); Directors in the Metropolitan Trauma Services, Trauma Coordinators for each Urban Trauma Services and Trauma Coordinators for each of the Regional Resource Centres. Structural changes were evidenced by the creation of State Trauma Centres at Royal Perth Hospital and at Princess Margaret Hospital (DOHWA, 2007).

As trauma services are clearly seen as a quality and safety issue for governments at both the Commonwealth and State levels, Australian trauma systems are structured on the basis of internationally accepted models. The major trauma centres throughout Australia generally conform to or maintain the North American structure that focuses on pre-hospital care and emergency department services (Atkin, Freedman, Rosenfeld, Fitzgerald & Kossmann, 2005). Once stable, patients are admitted to various areas of the
hospital, which may or may not include specialised trauma care. Where there is no dedicated trauma ward there is a danger that some patients can “become lost” in the hospital system as resources specific to specialised trauma care such as allied health, social work and clinical psychology may not be readily available (S. Jonescu; Personal Communication, October 2, 2008).

Western Australia had no facility designated as a trauma centre until 2004 when new trauma systems were implemented to assess and evaluate hospitals independently (Delprado, 2007; Rao, 2007). That year, the Western Australian Major Trauma Service was established at Royal Perth Hospital (RPH) to evaluate the hospital’s ability to perform as a state major trauma centre. Following the review of hospital performance in 2004, the TWG’s recommendations and the financial commitment provided by the DOHWA, in 2007, RPH was designated as the state major trauma centre and the new State Major Trauma Unit (SMTU) was opened in February 2008 (Ede & Burrell, 2008). The unit is a thirty-bed ward that includes a ten bed High Dependency Area. The SMTU was created to reduce pressure on the emergency department as well as allowing for a multi-disciplinary approach to trauma care. The unit creates a ‘pulling power’ as it allows for easy and quick transfers from the emergency department. The pulling power refers to the ability of the SMTU to ‘pull’ patients out of the emergency department at a quicker rate as the SMTU High Dependency Area can be used for the patients who may not have a clear diagnosis. This process is possible due to the Trauma Case Manager and Clinical Nurse Specialist having ‘admitting
rights’, where in conjunction with the Trauma Team, they will assess a patient in the emergency department, bypass bed management and admit the patient onto the ward (Ede & Burrell, 2008). This not only saves time and frees up beds in the Emergency Department but also allows for the patient to receive specialized trauma care on the SMTU. The High Dependency Area is also used as a step down unit from the Intensive Care Unit (ICU), which enables earlier discharges from this area. A step down unit is described as a specialized area of care within the hospital where patients who are not well enough to be cared for on the general ward can have respiratory support or invasive monitoring if required (McGibbon & Casey, 2002). Research has shown that step down units reduce pressure on ICU departments and cancellations of operations (McGibbon & Casey, 2002). As the SMTU’s high dependency area is classed as a step down unit, it allows improved patient flow throughout ICU and the emergency department as compared with the more traditional approach used in the past (Ede & Burrell, 2008). The unit consists of a large multi-disciplinary team including its own clinical psychologist, social workers, dieticians, occupational therapy and physiotherapy teams, pharmacists, speech pathologists, as well as a support team including ward clerk, cleaners and Patient Care Assistants (Ede & Burrell, 2008). An important additional resource for the unit is the Trauma Case Manager (Ede & Burrell, 2008). These services allow patients to be treated within one acute area rather than in various areas, allowing for all disciplines to be present within the unit at all times rather than wasting time finding patients who are located in the general ward setting. This
system also allows for improved communication across all disciplines as they are ward based.

Improved coordination of care is derived from a new trauma management system where the SMTU is funded independently from the hospital budget. The SMTU is then able to fund the independent multidisciplinary team, which includes medical, nursing, senior nursing, physiotherapy, occupational therapy, social work, clinical psychology and speech therapy (S. Jonescu, Personal Communication, October 2, 2008). This results in dedicated staffing, which, in turn, enables a more holistic approach to trauma management. Daily multidisciplinary meetings and weekly grand round meetings are aimed at co-coordinating care efficiently. These meetings facilitate discussion of all aspects of care in relation to patient needs. As the multidisciplinary team is ward based, there is no requirement for a consultation request as patients within the SMTU are discussed at the daily meetings and are reviewed by all disciplines (S. Jonescu, Personal Communication, October 2, 2008).

The Western Australian Government has clearly made an attempt to improve patient services in trauma care through the development of the State Major Trauma Unit. However, controversy surrounds the ability of trauma centres, such as Royal Perth Hospital, to manage patient flow when functioning at over capacity levels and when responding to external disasters such as terrorist attacks and large casualty events (Rivera, Nathans & Jurkovich, 2006).
At a time where there is a need to free up beds for an aging population, improving LOS for the trauma patient may allow for greater bed availability and improved patient flow.

1.3 Summary

The Australian Government is continually making improvements within the healthcare system, in particular the trauma system. There have been many strategies and plans put into place to make these improvements a reality, which are governed by State and National Health Departments. These departments have created trauma specific groups that make recommendations and regulations that are based on National and International research. Western Australia has made major changes within its trauma system in recent years due to these recommendations, including the creation of the new State Major Trauma Unit, not only in an attempt to improve the management of the trauma patient but to free up beds within the emergency department.

Trauma is the leading cause of morbidity and mortality in the youth of Australia. Technological advances in medicine in recent years have allowed for the trauma patients to survive longer, however, their physical capabilities may never again reach their pre-morbid state. Government allocation of funds plays a vital role in the type of treatment provided for the trauma patient. In the past mortality rates were used as the benchmark for funding allocations. However, in recent years the research base for funding allocations is directed towards evaluating health services in terms of
effectiveness and efficiency in trauma management in order to allocate funds appropriately. There are many benchmarks that can be analysed as a research base for funding, including improvements in patient outcomes such as infection rates and quality of life. Patient length of stay is one of these. The current research study, which is limited by time and resources, has focused on patient length of stay as an indicator of effectiveness and efficiency in the management of the trauma patient.
CHAPTER 2- REVIEW OF THE LITERATURE.

2.1 Introduction

This chapter reviews and critiques the literature in a number of areas relevant to the study particularly in relation to quality and effectiveness of surgical and trauma services. The main focus of the literature review is length of stay (LOS). MEDLINE, PUBMED, (Ovid), NURSING@OVID and Austhealth databases were used to search for the literature using terms such as ‘length of stay’, ‘trauma systems’, ‘nurse management’, ‘patient flow’, ‘trauma nursing’. Other information was sought out from government websites such as The Department of Health and Aging, Department of Health Western Australia, and Royal Perth Hospital. Studies addressing variables that may improve or impede length of stay were analysed in relation to the aims of the study with a view toward providing a foundation for the study. The critique is presented in three sections; patient length of stay, efficiency and effectiveness of patient flow and Royal Perth Trauma Management.

As the literature review revealed no documents from a trauma centre with a similar structure to that of Royal Perth Hospital State Major Trauma Unit, it is unknown whether there is a trauma centre with similar components. However, Stroke Units share many similarities in form and structure to the State Major Trauma Unit and have been used a basis for comparison to analyse length of stay for this review. Clearly there are gaps in the research agenda requiring further study.
2.2 Patient length of stay

Performance indicators are used in health care to analyse quality and safety issues within the health care system. Patient length of stay has been long used as an indicator for not only patient outcomes but cost analysis.

“LOS is defined as the period of time a patient remains in a hospital or other healthcare facility as an inpatient” (Harris, Nagy & Vardaxis 2006, pg 996).

It is the average number of days patients are admitted to a hospital for treatment. The numerical figure is calculated from the day of admission to the day of discharge minus days of leave (VicHealth, 2008). Terms used with length of stay such as expected LOS, actual LOS, optimal LOS, delayed LOS are used often to keep track of performance within the hospitals.

Length of stay (LOS) is a performance indicator in the public health sector that is used as a measure to attract funding allocation from federal governments. On admission, patients are categorized into specific Diagnostic Related Groups (DRG) (Liberero, Martin, Peiro & Munujos, 2004). Each DRG has an estimated LOS, based on the average LOS for that DRG across other institutions. Shrinking budgets have encouraged hospital managers to shorten LOS to promote efficiencies benchmarked to the national average (Kelly, 2008).

To understand trends in LOS, it is necessary to address changes within the health care system in Australia and technological innovations in medicine. Over the past 50 years surgical services, infection control,
pharmaceutical treatments and rehabilitation have been largely influenced by evidence-based practice. Research evidence has enabled improved patient outcomes and has assisted in lowering hospital complications and LOS (Hillman, 1999; Maddern & Maddern, 2001). Surgical procedures that would take days to a week to recover from are now done in day surgery. Where patients are admitted for longer, post-operative recovery, it is typically only an overnight stay. In the past patients were also admitted for pre-operative care, which could be up to 2-3 days pre-surgery, a practice which is now largely eliminated (Zajac, 2003).

Surgical patients have become a focus for managers seeking to reduce LOS, because surgical complications are a major reason for extended hospitalization. In a retrospective quantitative study on postoperative patients conducted in Alberta, Canada, complications were reported to occur in 6.9% of the population. The study used a sample size of 7,457 patients who received non-cardiac surgery during a three year period. Hospital costs due to complications from these surgeries increased by 41%-112%, primarily driven by increased length of stay. Post-operative pneumonia was the most common complication and was responsible for an increase in hospital costs of 55% and a 75% increase of length of stay. Venous thromboembolic (VTE) complications increase LOS by 103%, with the hospital costs increasing to 106% (Khan et al, 2006). The importance of LOS is clear. It is a performance indicator for hospital efficiency, attracting financial incentives in an attempt to minimize the duration of hospitalisation (Thomas, 2005).
Trauma accounts for the greatest length of hospital stay in the public health sector (Rainer, 2003). The average cost of hospital care for a trauma patient is approximately three times higher than that of a non-trauma patient. This places considerable pressure on hospitals to maintain budgets set by governments, a goal that can be accomplished by adhering to estimated discharge dates (Thomas, McGwin & Rue, 2005). Factors that may reduce LOS include, focused surgical teams, case management and a multi-disciplinary approach to patient care. (S. Jonescu, personal communication, 2008).

2.3. Efficiency and effectiveness of patient flow.

LOS is not agreed upon universally as an indicator of patient care. In fact, despite its widespread use, hospital LOS has been a controversial topic for many years. Hartfield (2002) argues that LOS is simply a power tool used by governments and governing institutions to control hospital systems. Length of stay is directly correlated with age. The group most at risk of hospitalisation are those between the ages of 60-69 where complications increase LOS three to four times compared to a non-complicated admission (McAleese & Odling-Smee, 1994). As we move further into the 21st century the bed shortage will worsen as the baby boomers continue to age and experience ill health and injury. When there has been a need to free up beds, some researchers report that patients have been discharged from hospital too soon, causing an increased rate of unplanned readmissions to emergency departments (McAleese & Odling-Smee, 1994). This is inefficient as it creates additional costs.
Medical complications, poor discharge planning and lack of rehabilitation beds cause a back up of patients which is evident by overcrowding in emergency departments. Overcrowding compromises patient safety by stretching hospital resources to their maximum limit, with US hospitals often functioning at 90% over capacity (Cowan & Trzeciak, 2005). Like American researchers, a research team in Western Australia addressed the important issues of hospital overcrowding, concluding that overcrowding was directly attributable to access block. The study explains that access block is the event in which patients are unable to move from the emergency department due to a block of beds in the acute area, which increased patient length of stay and mortality rates (Fatovich, Nagree & Sprivilis, 2005). A retrospective data analysis was conducted from the Emergency Department Information System (EDIS) and The Open Patient Administration System (TOPAS), to find a difference between variables within the emergency departments within Perth, WA. These differences included Emergency Department overcrowding, block, capacity occupancy and ambulance diversion. The study provides recommendations on how to improve patient flow, including improving access to acute and rehabilitation beds, faster access to nursing home beds for the elderly, better organised discharge planning, faster assessments in emergency departments, faster transfers to ward beds, and prevention of illness by form of community education (Fatovich et al, 2005).

‘Bed blockers’ are major contributors to access block within every public Australian hospital, impacting on emergency and elective
admissions. This is particularly the case with older patients. Older persons remain within the acute setting due to the inadequate number of Residential Aged Care and rehabilitation beds, which increases patient length of stay unnecessarily. Without Government funding in these areas the mismatch of demand versus supply of these beds will continue into the future, and will become a larger problem as the baby boomers age and require care (Travers et al, 2008)

Patient flow can be hindered by many factors including some that can be controlled or improved and those that can not. Medical trauma teams play a large role in a patient’s length of stay. The team’s experience and ability to manage the trauma patient efficiently and effectively by diagnosing all injuries in a short time frame is imperative. A trauma team is the fundamental component of trauma care, which requires a multidisciplinary approach to not only improve efficiency and effectiveness of trauma management but also improve survival rates (Lu, Kolkman, Seger & Sugrue, 2000). Daily multidisciplinary rounds shortens length of stay for trauma patients and improves their overall care, as all concerns are discussed within meetings rather than issues being tackled by single disciplines (Dutton et al, 2003).

The Trauma Case Manager assesses patients in the emergency department and follows the patient’s progression during his/her hospital stay as well as ensuring follow up contact after discharged. Trauma case management improves inpatient length of stay by lowering the length of time of allied health consultation reducing the incidence of deep vein
thrombosis, and decreasing unplanned admissions into ICU as well as unplanned operations (Curtis, Zou, Morris & Black 2006). This style of trauma case management is not a new concept in trauma care as trauma case management has been used in Australian hospitals, including Royal Perth Hospital, for a number of years. What has changed, however, is that with patients located in one area, the State Major Trauma Unit allows for improved coordination of care (Curtis et al, 2006).

Specialised wards or units carry higher costs as the care received within these areas is more concentrated. Comparative studies have been conducted on the implementation of stroke units as compared with general medical wards (Chiu, Shen, Cheuk, Cordato & Chan, 2007). These studies have a similar focus to this research as they are both addressing length of stay and collaborative patient care in specific units or wards. Chiu et al (2007) compared mortality rates of stroke patients over a two year period where the patients’ mortality and morbidity rates using comparative data from March 2002 to March 2003 for the pre-stroke unit group, and from May 2003 to May 2004 as the stroke unit group. Independent t-tests and Mann U Whitney tests revealed that Australian Stroke Units decrease both mortality rates and the length of inpatient stay. Like trauma units, effective Stroke Units therefore include multidisciplinary teamwork, specialised staff and the involvement of the patient’s family and friends in rehabilitation. Additionally, patients in these units receive earlier mobilization and medical interventions. Patients who are cared for within stroke units have more frequent observations and experience less complications than those on a
general ward (Evans et al, 2001). Within both the trauma and stroke settings, where patients are waiting for rehabilitation beds their length of stay is extended unnecessarily and may be at higher risk of hospital acquired complications.

### 2.4 Royal Perth management

The National Trauma Registry Consortium collects all trauma data from all registries in Australia and New Zealand, and reported that the average length of stay for the major trauma patient was 16 days in 2005. Within the trauma setting in Victoria, length of stay of major trauma patients has been reducing annually since the improvements of the State trauma system in 2000. In Victoria, the major trauma service which includes the Alfred, Royal Melbourne and the Royal Children’s Hospitals, had the lowest length of stay for major trauma patients with an average of 7 days in 2007-2008. This number has reduced considerably from 8.8 days since 2001-2002 (Victorian State Trauma Registry (VSTORM), 2007-2008). At Royal Perth Hospital in 2006 the average length of stay for the trauma patient with an ISS >15 was 16.9 days (RPH, 2006). Differences and improvements in patient length of stay can be attributed to many factors which include the management of patients within the health services and advances in medicine.

Improvements in medical technology have also led to increased testing within the radiology and specimen laboratory such as CT scans and complex blood analysis, causing delays in diagnosis for the trauma patient
(Drummond, 2001). These delays are created by large patient bookings and poor resources in these areas. Reducing the delays within theatres and radiology departments will decrease patient length of stay in the trauma patient (Pendleton, Cannada, Guerrero-Bejarano, 2007). In addition, many delays for ward patients occur due to cancellations of surgery. Operating theatres are forced to cancel booked operations due to the higher clinical need for surgery of critically ill patients (Pendleton et al, 2007). These delays which result in a longer length of stay may increase the risk for hospital acquired complications (Beringer, Hagan & Goodman, 2009).

As trauma patients take up the most bed days, and therefore resources within the public health sector, there have been many programs implemented at RPH in an attempt to free up beds. Some of these include Hospital In The Home (HITH) and referral to the community based agency, Silver Chain Western Australia. The Department of Health of WA created an ambulatory care program called Healthy@Home. These services which are provided by the Healthy@Home program include Chronic Disease Service, Community Physiotherapy Services, Falls Linkage Independent Program, Hospital in the Home (HITH), Telehealth services including telephone coaching, and Wounds West. These programs have been put into place to reduce hospital LOS and to reduce the number of admissions of chronic disease patients (DOHWA, 2009). HITH is defined as active treatment of a patient within their home of a condition that would otherwise require acute hospital inpatient stay (Shepperd, 2001). HITH has not shown any significant difference in improving patient length of stay or improved
patient outcomes between patients treated in the home and patients treated in the hospital (Wilson & Parker, 2005). However, there have been improvements in satisfaction rates of patients as well a reduction in costs for governments for HITH patients (Wilson & Parker, 2005). In a Victorian trial 924 patients were treated at home, and their costs were compared to patients with the same DRG admitted to the acute sector. Those patients within the HITH system showed a reduction of 38% of costs, especially if they avoided an acute setting re-admission. The Victorian HITH scheme provided an extra 400 beds within the public health sector (Wilson & Parker, 2005). These beds provided the ability to reduce bed blocking and access block within the elderly population as they were treated within their homes (Wilson & Parker, 2005). This could be associated with a decrease in avoidable complications such as falls and hospital acquired infections (Wilson & Parker, 2005).

Evaluative research into the management of trauma centres has been conducted since their inception. The ability to utilise these resources is dependent on the correct diagnosis and treatment of patients (Enderson, Reath, Dallas, DeBoo & Maull, 1990). Diagnostic tools have been created to minimize missed injuries and to improve discharge processes. One such tool is the tertiary trauma survey, which was created in 1989 due to the incidence of missed injuries in trauma patients. This assessment involves analysing the results from the initial resuscitation surveys, following up on the injuries by looking at radiological and laboratory results, as well as completing a final physical assessment to make sure there are no missed
injuries. This approach was developed by Enderson, Reath, Dallas, DeBoo & Mauull (1990). The tertiary survey has since evolved into common practice and should be conducted within the first 24-48 hours of admission to avoid delays in patients being either transferred to a rehabilitation centre and being discharged home (Thompson & Greaves, 2007).

All research studies have their challenges, given the need to focus on only designated variables. In the current study, the researcher was mindful that length of stay is not only impacted upon by physical problems which exist within the hospital system but also by errors in coding systems used to label a patient’s episode of care. Episode of care is the term used to describe the patient’s category of admission or nature of clinical service. The episodes of care are characterised by labels such as ‘acute care’, ‘rehabilitation care’, and ‘palliative care’. There are ten types of clinical service in which a patient can be allocated. These are coded and placed into a computer program called the ‘grouper’, which was developed by the Commonwealth Department of Health and Aging. The ‘grouper’ holds this information, with the episode of care being changed only by the administrative personnel (D. Koh, Business Manager RPH, Personal Communication, 2009; DOHA, 2009). If the episode of care is not changed when a patient physically changes in episode of care then length of stay is inaccurate, for example, a patient is in ‘acute care’ for ten days and ‘rehabilitation care’ for five days. If the episode of care is changed at day 12 of the ‘acute care’ episode then the acute episode is increased an extra two days (D. Koh, Business Manager RPH, Personal Communication, 2009).
Length of stay is affected by many factors some which have been discussed including dedicated trauma systems and structures, hospital complications, delays in radiology and laboratory testing, co-morbidities, administration errors and other factors such as poor patient flow. Despite these difficulties, length of stay is an important benchmark for comparative studies. The ability of length of stay to be an accurate or appropriate indicator of efficient and effective patient management was considered viable for this research. Length of stay remains an issue for hospital management as budgets set by governments need to be adhered to, especially with recent economic concerns. The overriding need is to cut costs without impacting on quality patient care. The focus of this study was to evaluate the new SMTU created within Royal Perth Hospital and the management of trauma patients. As the new system has had increased funding and services provided, the impact of these financial benefits need to be evaluated and assessed in relation to the annual funding the SMTU receives.

2.5 Summary

There are many gaps within the literature, including comparative evaluation of a similar trauma centre structure, effects on length of stay from the tertiary survey on Australian trauma patients, effects of specific medical specialties on length of stay and the difficulties of linking LOS to management when it is an important factor of cost containment measures (Aiken 2008; Chiang 2009). Gaps within the literature include Australian data from models of trauma care and the variable effects on trauma patient’s
length of stay. Information on LOS for patients admitted to the SMTU will contribute another increment of knowledge to the research that already exists and provide recommendations for further studies.

2.6. Factors impacting on length of stay.

Diagram 1: This diagram shows the numerous factors impacting on patient length of stay, trauma management being one small component. Therefore when looking at LOS in the trauma patient all other factors must be considered.

2.7 Significance of the study

The aim of this study was to investigate whether a significant difference exists in the LOS of patients, with an ISS > 15, who were admitted to RPH pre and post implementation of the SMTU. These results can then be examined in relation to the contribution this knowledge makes towards improvements in the quality and safety of healthcare in regard to trauma management. The study will be significant in providing evidence for
planning and evaluating the efficiency and effectiveness of trauma centres on the basis of LOS indicators.
CHAPTER 3- METHODOLOGY

This study method was a comparative, ex post facto analysis of two independent samples of major trauma patients who were admitted to Royal Perth Hospital (RPH) in 2007 and 2008. The aim was to investigate whether there was a significant difference between lengths of stay for patients admitted to the SMTU during 2008, compared to those major trauma patients who were admitted to the general wards at RPH in 2007, prior to the inception of the SMTU. The LOS data could then be discussed in relation to the differences in trauma management services provided at RPH to patients in these two samples.

3.1. Hypothesis

The null hypothesis used in this study was:

there is no difference between length of stay in trauma patients with an ISS >15 who were admitted to a general ward at Royal Perth Hospital in 2007 compared to those who were admitted into the State Major Trauma Unit at Royal Perth Hospital 2008.

3.2. Ethics approval

Ethics approval to conduct the study was first obtained from Murdoch University in September 2008, permit number 2008/210. As data were accessed from the RPH trauma registry additional permission was obtained from the Quality Improvement Activity Committee. Past medical history and previous admissions were not obtained for this study as is was
outside the scope of this research. All data were collected from the trauma registry at Royal Perth Hospital. Patients were individualized by case numbers which were unknown to the researcher. The researcher did not have access to names of the patients or any means of identifying the patients from the case numbers.

3.3. Inclusion criteria

All major trauma patients included in this study were admitted to RPH due to injury during the time period of 2007 and 2008. All patients were major trauma patients who had an ISS >15. Patients’ information was obtained from the trauma registry at RPH. The only information obtained from the registry related to a patient’s traumatic event.

3.4. Exclusion criteria

Patients who were admitted from or had spent any time in the Intensive Care Unit (ICU) or the High Dependency Area (HDA) within Royal Perth Hospital were excluded. These patients were excluded as they were treated under the ICU medical team. As patients are treated under different medical staff and teams it is unknown what treatment was received within these units, and this care within the unit may have impacted on length of stay. As this study focused on the State Major Trauma Unit’s ability to manage the trauma patient, those admitted to ICU or HDA were excluded. Additionally, patients who were transferred from another health service or hospital were also not considered.
3.5. Data Collection

Following receipt of ethics approvals the Trauma Registry was contacted to obtain the data. The registry required a document to be completed describing the study in brief together with a list of variables required by the researcher. Variables requested for inclusion consisted of patient’s sex, age, ISS, LOS, admitting ward, admitting specialty, discharge destination, date of admission, date of discharge, time of admission, time of discharge and race as these data are collected annually by the trauma registry. Exclusion of cases was based on mortality, discharge to another ward during admission and ICU or HDA admissions. Excluded cases were removed from the data set by the Registry team prior to accessing the registry’s data. The data for this research was received from the Trauma Program Manager in an excel format. Data received were categorised by a trauma specific episode number rather than an identifiable hospital UR number and the excel sheet was split into two groups: those admitted during 2007, prior to the inception of the SMTU and those admitted during 2008, after the inception of the trauma unit.

Data from 239 patients were received. All multi-trauma patients with an ISS>15 who were admitted to the SMTU at Royal Perth Hospital from 17th February to 27th December 2008, and met the inclusion and exclusion criteria, formed the study group. A purposive sampling method was used to include all patients who were admitted to the SMTU, and met the criteria, since it was opened in February 2008. The comparison group was comprised of all multi-trauma patients with an ISS>15 who were admitted
to a general ward at Royal Perth from 1st January to 25th December 2007, being the twelve months immediately prior to the opening of the SMTU.

3.6. Statistical analysis

Data were analysed using SPSS 17 for Apple Macintosh MacOS 10.3. Descriptive and demographic data was analysed using means and standard deviations or medians and interquartile ranges (IQR), according to normality. As data on LOS, ISS, discharge destination, admission, specialty and ward admission were not normally distributed, non-parametric statistics were indicated and a Mann Whitney U test and Chi-square tests of contingencies were used to determine whether there was a significant difference between the two groups (general ward and SMTU) in regards to LOS, ISS, discharge destination, admission, specialty and ward admission.
CHAPTER 4- FINDINGS

This chapter examines the data collected from the trauma registry at RPH. The findings are presented in four sections; age, admission, Injury Severity Score and length of stay. Medians and interquartile range will be presented as well as comparisons of means through either a Pearson’s Chi Square of Contingencies test or a Mann U Whitney test.

4.1. Characteristics of the sample

The proportion of men and women in each group was similar with 80.2% \( (n=105) \) men and 19.8% \( (n=26) \) women \( (n=26) \) in the general ward group \( (n=131) \) and 76.1% \( (n=83) \) men \( (n=83) \) and 23.9% \( (n=25) \) women \( (n=25) \) in the SMTU group \( (n=108) \). This represents a much larger proportion of males compared to the general population in Perth, where there are 102 males per 100 females of the population (ABS, 2008). Indigenous patients formed a small proportion of both groups, that is 10.7% \( (n=131) \) in the general ward group \( (n=131) \) and 4.6% \( (n=108) \) in the SMTU group. In the greater population of Western Australia, 3.8% are Indigenous (ABS, 2006). This over representation in the data may be due to cultural or lifestyle behaviours placing people within the Indigenous community at higher risk of injury than those who are not indigenous.
Figure 1. Grouped ages of patients admitted to the general ward (pre-trauma unit) in 2007 and the SMTU (trauma unit) in 2008.

The general ward group ($n=131$) had a median age of 39 years (IQR, 25,62) compared to the SMTU ($n=108$) with a median of 32 years (IQR: 23.25, 46.75). There was a higher number of patients in the 16-25 age category for both groups; 26.7% in the general ward group ($n=131$) and 34.3% in the SMTU group ($n=108$). (see Figure 1)
4.2. Demographics of the sample

4.2.1. Age

A Pearson’s chi square test of contingencies was conducted to analyse whether there was a significant difference between age groups in the general ward and SMTU in the period of 2007 and 2008, respectively. The ages of major trauma patients who were admitted to Royal Perth Hospital in the study period of 2007 and 2008 did not vary significantly $\chi^2 (N = 239) = 14.130, p = 0.078$.

Figure 2: Age of patients in the General Ward group and SMTU group. The variation at each reference sample collection point is demonstrated graphically by the median surrounded by a box, which represents the interquartile range, containing 50% of values. The whiskers are lines that extend from the box to the highest and lowest values.
4.2.2. Type of admission

Patients in the general ward group \((n=131)\) were admitted under different specialties at Royal Perth Hospital in 2007 with 38.2% of patients being admitted under the neurosurgical team, 18.3% under the Orthopaedic team and 23.7% under the trauma team (see Figure 3).

Figure 3: Specialty patients admitted under in the General ward group (2007).

In contrast to the general ward group, the majority \((82.4\%, n=108)\) of the major trauma patients who were admitted to the SMTU \((n=108)\) were placed under the trauma team, 8.3% under the Orthopaedic team, 3.7% under General Surgery, and 2.8% under Neurosurgery (see Figure 4).

Figure 4: Proportions of patients in the SMTU group (2008) who were admitted under various specialties.
A Pearson’s chi square of contingencies analysis showed a significant difference, $\chi^2=(239)= 98.708, \ p < .001, \ V = 0.643$, in the numbers of patients admitted under the various specialties between the general ward group ($n=131$) and the SMTU group ($n=108$). As illustrated in figures 3 and 4, since the implementation of the SMTU patients with an ISS $>15$ were more likely to be under the care of the trauma team at RPH.

Patients in the General ward cohort were admitted to two main wards in the hospital with 42.0% of patients admitted to the neurosurgical ward and 22.1% to the Orthopaedic ward. The remainder of the cohort were scattered throughout various medical and surgical wards within the hospital (see Figure 5). Patients who were admitted in 2008 to the SMTU were either admitted directly to the High Acuity section (68.5%) or the normal acuity section of the unit (31.5%).

Figure 5. Proportions of patients in the general ward group (2007) who were admitted to either 5G-Orthopaedics; 5H-Neurosurgery; 6G- Cardiothoracic and vascular; 6H-General Surgery; 5A, 5B & 5F-General Medicine;7A- Surgical overflow;7B-Plastic surgery, ENT & Maxillo facial; 5E-Short Stay Medical Unit; 4A-Emergency Demand Unit.
4.2.3. Discharge destination

The discharge destinations for patients in the 2007 and 2008 cohorts are presented in Table 1. A chi-square test of contingencies indicated that there was no significant difference between the groups according to their discharge destination ($\chi^2=11.175, p = 0.131$). However patients from the SMTU group were more likely to be discharged to the RPH rehabilitation centre rather than directly to their homes.

<table>
<thead>
<tr>
<th>Discharge Destination</th>
<th>Percentage of patients in the 2007 group</th>
<th>Percentage of patients in the 2008 (STMU) group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home</td>
<td>56.5 (n=74)</td>
<td>46.3 (n=50)</td>
</tr>
<tr>
<td>Rehabilitation RPH Metropolitan hospital transfer</td>
<td>27.5 (n=36)</td>
<td>41.7 (n=45)</td>
</tr>
<tr>
<td>Non-Metro hospital transfer</td>
<td>6.1 (n=8)</td>
<td>2.8 (n=3)</td>
</tr>
<tr>
<td>Residential home transfer</td>
<td>0.8 (n=1)</td>
<td>0.9 (n=1)</td>
</tr>
<tr>
<td>Own risk</td>
<td>5.3 (n=7)</td>
<td>0.9 (n=1)</td>
</tr>
<tr>
<td>Private Hospital</td>
<td>1.5 (n=2)</td>
<td>3.7 (n=4)</td>
</tr>
<tr>
<td>Other</td>
<td>0.8 (n=1)</td>
<td>0.9 (n=1)</td>
</tr>
<tr>
<td>Total</td>
<td>100 (n=131)</td>
<td>100 (n=108)</td>
</tr>
</tbody>
</table>

Table 1. Discharge destination for the general ward group (2007) and the SMTU (2008), shown in percentage.
4.3. Injury Severity Score

The median Injury Severity Score for the 2007 general ward group ($n=131$) was 19.0 (IQR: 17.0, 25.0) compared to 21.0 (IQR range: 17.0, 25.8) for the 2008 SMTU group ($n=108$) (see Figure 6).

Figure 6: Injury Severity Score for the periods 2007 (general ward group) and 2008 (SMTU group). The variation at each reference sample collection point is demonstrated graphically by the median surrounded by a box, which represents the interquartile range, containing 50% of values. The whiskers are lines that extend from the box to the highest and lowest values, excluding outliers. Outliers (>2 box lengths) are shown as ●.

ISS data were not normally distributed therefore a Mann Whitney U test was conducted ($U = 6280.500$, $z = -1.516$, $p = 0.129$) indicating there was no significant difference between the ISS of patients who were admitted to a general ward in 2007 and those who were admitted to the SMTU in 2008.
Removal of outliers and extremes did not result in a significant change of the median Injury Severity Scores (2007 group median 19.0, IQR range: 17.0, 25.0; 2008 group median 21.0, IQR: 17.0, 21.8. $U = 6064.500$, $z = -1.744$, $p = 0.081$). A Pearson’s chi-square of contingencies was used to evaluate whether there was a difference between Injury Severity Score between the general ward and the SMTU when the ISS is broken into groups. The chi-square was statistically significant ($\chi^2 (n=239) = 19.281$, $P < .001$). A Cramer’s V test showed that the difference between the groups was small, $V = 0.284$. Figure 6, illustrates that this small effect may be due to the lower injury score, and therefore lower acuity, of the 2007 group of patients in the 16-20 ISS range.

![Figure 7: Grouped Injury Severity Scores of patients admitted to the general wards (2007) and SMTU (2008).]
4.4 Length of stay

The median length of stay for the general ward group from 2007 was 9.0 days (IQR: 5.0, 17.0) compared to a median of 11.0 days (IQR: 7.0, 17.0) for the 2008 STMU group. A Levene’s test was non-significant (0.684) therefore equal variances can be assumed and the third assumption is met. A Shapiro-Wilk statistic was significant violating the assumption of normality. A Mann-Whitney U test indicated no significant difference between trauma patient length of stay on a general ward (mean rank= 112.33, n=131) compared to the State Major Trauma Unit (mean rank=127.24, n=106) \( U=6069.500, z = -1.666 \) (corrected for ties), \( p = 0.096 \), two tailed.

Figure 8: Length of Stay in days at Royal Perth Hospital for the General ward and in the State Major Trauma Unit cohorts. The variation at each reference sample collection point is demonstrated graphically by the median surrounded by a box, which represents the interquartile range, containing 50% of values. The whiskers are lines that extend from the box to the highest and lowest values, excluding outliers. Outliers (>2 box lengths) are shown as ● and extremes (>3 box lengths) as *.
Extreme outliers were removed from the Length of Stay samples denoted by a ‘star’ (Figure 8) in an attempt to reach normality. However, medians for each group remained similar (2007 group: median 9.0, IQR: 5.0, 16.3; 2008 SMTU group: median 10.5, IQR: 9.0, 16.8 and the difference was not significant \( U = 5963.500, z = -1.550, p = 0.121, \text{ two tailed} \). The null hypothesis is therefore accepted. There was no significant difference between length of stay of major trauma patients with an ISS > 15 who were admitted to a general ward at Royal Perth Hospital in 2007 compared to that of the State Major Trauma Unit in 2008.

In summary, of the 239 cases there was no significant difference found between the general ward group and the SMTU in relation to LOS, therefore the null hypothesis is accepted. There was also no significant difference in age or discharge destination. There was however a significant difference in admission specialty. Chapter five discusses the findings in terms of the aims of this research.
CHAPTER 5- DISCUSSION

This chapter brings together the aim and outcomes of this study. The beginning of this chapter discusses the findings from the data analysis and describes the interpretation of these findings. The strengths and weaknesses of the study will be discussed as well as recommendations on how the study could be extended in future research. The chapter is presented in four sections: discussion of the findings, length of stay as an indicator of efficiency and effectiveness, patient length and patient outcomes.

5.1 Discussion of the findings

5.1.1 Type of admission

Patients in 2007 were predominantly admitted into the specialty areas associated with their major injury, for example, more patients were admitted to the neurosurgery ward and were more likely to be placed under the neurosurgical team. In 2008, all patients were admitted to the SMTU and were more likely to be managed under the trauma team regardless of injury. As the trauma medical unit has taken over the management of most trauma patients the team can be placed under increased pressure since the implementation of the SMTU. However, patients still receive input from other specialties such as Orthopaedics, and patients may be under the care of several specialties if the injury is multi-system. This may result in poor cohesiveness of care in the trauma setting if the medical teams do not communicate with one another. This could compromise efficiency if one team believes the other is completing the task, potentially causing treatment
delays. Further studies, specific to trauma management would be important to analyse patient length of stay. These studies should include analysis of daily ward rounds, delays in treatment and management of injuries as well as comparisons across specialist teams who are treating patients in conjunction with the trauma team. This type of analysis would enable to assess whether delays of length of stay are attributed to poor input from outlying specialty teams (i.e. neurosurgery) or to poor communication and cohesion of the trauma team.

5.1.2 Discharge

The results show that in 2008, 50% of patients were discharged home and 45% were discharged to the rehabilitation centre at RPH. Over the two year study period there was an increase in patients discharged to a rehabilitation centre than to their own homes (see Table 1). The cause of this change is beyond scope of this study, however once RPH had been designated as the State Major Trauma Centre of WA the number of major trauma cases increased. RPH has had an increased number of trauma admissions and emergency admissions since its designation as a State Major Trauma Centre. In 2007, the emergency department had 57,894 presentations to the emergency department and 23,389 hospital admissions, compared to 59,159 presentations and 25,091 admissions in 2008 (S. Perryman, personal communication, 2009). As the hospital has the designation of State Major Trauma Centre, effective discharge of patients must occur to manage this new influx of patients.
The tertiary survey is a tool, used by the trauma medical team to diagnose and therefore treat patients. It is a detailed assessment where the medical staff analyse all pathology and radiology results such as blood work and X-rays, as well as a complete physical assessment. Delays of the tertiary survey can delay treatment of injuries and lengthen hospital stay. In conjunction with the increased services and dedicated trauma team at the SMTU, the tertiary survey could also have the ability, to not only pick up missed injuries but find undiagnosed medical issues patients live with at home unknowingly. The hospital is then morally and ethically bound to address these issues, which may then increase length of stay. Further study in this area would be important to be able to manage these issues outside the SMTU or in a less acute area if possible (Personal communication, Dr S Rao, April 20, 2009).

5.1.3 Injury Severity Score

At Royal Perth Hospital the Injury Severity Score has been used to categorise trauma patients especially since the implementation of the Trauma Registry in 1994. The ISS has long been a controversial tool, which initially, when developed, was used to predict mortality. However it has also been used for resource allocation in recent years (Stevenson, Segui-Gomez, Lescohier, Di Scala & McDonald-Smith, 2001). It is assumed that patients with a higher ISS, need more resources such as increased operating theatre times and medical management (Brenneman, Boulanger, McLellan, Culhane, & Redelmeier, 1995). This assumption does not necessarily apply for patients who are labeled with an ISS of 50-75. These patients are at a
high risk of mortality and often die within the first 24 hours. Operating
theatre resources may not be used, whereas patients who may have a lower
injury severity who do survive may need repeated surgeries for their
continuing survival and quality of life (Brenneman et al, 1995). This has
implications for funding, as well as quality of treatment, and therefore has
an implication for the efficient use of resources. Assessing this level of
efficiency is beyond the scope of this research, however, as length of stay is
a particularly important aspect of funding allocation it is important to
highlight the vast differences between injury severity scores, and should be
research in greater detail.

When analysing patient length of stay in relation to injury severity
the ISS may not be an accurate measure. There are variations in severity not
only between the minor and major trauma groups but also within the groups,
especially in relation to the major trauma group. For example; patients who
score a 75 are classed as unable to survive the injury whereas patients who
have an ISS of 16 have significantly lower rates of mortality (Fern et al,
1998). A further comparison can be between two types of injuries e.g. a
patient with an ISS of >15 from a pelvic fracture and another with a serious
splenic laceration with a similar grading. The patient with the splenic
laceration may have the same or higher ISS, however the patient with the
pelvic fracture is more likely to have increased operating theatre time as
well as patient length of stay (Stevenson et al, 2001).

For this study it was important for the researcher to see if there was a
significant difference between the major trauma groups. As there is a large
difference between an ISS of 15 and 75 it was necessary to determine if the
ISS varied between the general ward group and the SMTU. The ISS data
were given cut-points of a numerical value of four, beginning from 15 to
34+. Although a significant difference did not exist statistically it does
appear (Figure 7) that the general ward group had more data that fell within
the ISS group of 16-20. The SMTU group however had slightly more
evenly distributed data. This study did not find that the ISS in this particular
grouping method was correlated with length of stay. ISS may be used to
attempt to predict these outcomes within Royal Perth Hospital, however
increased length of stay can not be attributed to particular injuries using this
tool.

5.1.4 Length of stay

Factors that impact upon length of stay range from government’s
allocation of funds to specified treatment given to patients and effective
discharge planning. In this research there was no significant difference in
length of stay found between the 2007 and 2008 groups, however, there was
an increase of two days per patient in the SMTU group. At a cost of $925
per day (Rao, 2007) this becomes significant to administrators and the
hospital budget. The increased admissions since designation as the State
Major Trauma Centre is costly. This study has discussed the idea that there
is a large variation between individuals ISS’ and potential use of resources
and funds within the trauma system. Another study conducted by Chiang
(2009) describes the relationship of hospital costs and the increased need for
hospital resources as some patients are expected to be fit for discharge
quicker. The study addressed the difficulties with common funding received on the basis of bed days regardless of illness or acuity of the patient. Even though some patients need minimal care and others need high acuity care, in a DRG system patients will receive the same amount of funds as per their DRG (Chiang, 2009). Like other researchers, Chiang (2009) concluded that funding is a complex topic, which is not only influenced by LOS but many other factors which are clearly outside the scope of this research.

The State Major Trauma Unit has the ability to ease ‘emergency access block’ and the figures have so far shown that the SMTU is reducing access block to some degree (M. Burrell, personal communication, 2009). Further studies however, should examine the radiology waiting times, and the time taken to report these findings, as well as orderly availability and transport between the services. The extent of the pressure on all resources needs to be determined to make this State Major Trauma Centre become as effective and efficient as its counterparts in other systems such as that provided at The Alfred in Victoria.

Further research may assist in illuminating some of these issues. For example, studies should address operating theatre delays as they may impact on the entire hospital system. At a major trauma centre, patients awaiting theatre in the wards who are stable must be delayed when an unstable trauma patient presents to the emergency department. It is unknown whether the operating theatres have had increased services provided since the designation. It is also unknown if there has been an increase in operating theatre demand. Research is needed in this area, so that sufficient funding
can be allocated to RPH theatres to improve patient flow across the hospital if these delays are found to impact significantly on unnecessary increases in length of stay.

Other areas of interest for further research are whether the SMTU prevents unplanned readmissions and missed injuries, improves quality of life and reduces negative patient outcomes following discharge. It is also unknown if the increase in length of stay can be attributed to rehabilitation bed delays or simple administration errors through the episode of care classification system. As patient admissions are increasing from a hospital wide perspective it is thought that these numbers are putting pressure on the rehabilitation waiting lists. Although it is known that in the near future the aging population will require more and more health care services, governments continue to ignore the need for appropriate rehabilitation services within the public health sector. These delays cause bed blockers to wait in acute care beds instead of receiving intensive rehabilitation for their injuries. Future research in the SMTU could also examine the possible effects that may occur if exercise equipment such as a gym was provided on the ward for patients as well as increasing funding for physiotherapy and occupational therapy sessions.

5.2 Length of stay as an appropriate indicator of efficiency and effectiveness

Efficiency and effectiveness of patient management can be measured by many indicators and this study made an attempt to analyse LOS as one
such indicator. Hospital management is encouraged to put pressure on wards to discharge patients according to DRG as funding is established on the basis of a specific DRG rather than individual needs. This may come at a medical cost to some patients who may experience negative outcomes from the need to be released from hospital quicker. This can also cause readmission soon after discharge, and thereby extending the total time of hospitalisation.

LOS is not likely to change as a benchmark for establishing budgets in the near future, and the difficulties in achieving accurate cost analysis will likely get worse as the baby boomers get older and sicker and put pressure on hospital systems. There are simply not enough acute beds within the public health system for patients to stay in longer than expected as, even now, some patients continue to wait on trolleys in emergency department corridors. There needs to be greater attention to patient flow and the structures and throughput within the system as patients are processed. This is a problem for all major trauma centres, which are located in large teaching hospitals that host new technologies and innovations. When money is spent on extra bed days funds are taken away from these areas, which may delay advances in technologies and ultimately affect patient care.

Royal Perth Hospital continues to have an annual increase in patient presentations to the emergency department and increases in hospital admissions. However there has only been a 30-bed trauma ward that has been used to increase beds within the hospital and the other services within the hospital have not been increased, including operative treatment,
radiological services and rehabilitation beds. Clearly, there is a need for research into efficient and effective trauma management that extends beyond LOS. One study currently being conducted at RPH involves the SMTU being analysed for improvements in access block. Further studies that should be conducted are those that involve delays in discharge including analysing operative and radiological delays and lack of rehabilitation beds. This current research is a beginning to present to governments to finally make improvements within the pubic health system. Governments also need evidence as a basis for making improvements within the rehabilitation sector, more specifically, to increase beds. Without these changes there will be a continuing problem, with increases in LOS. Other studies that would benefit management would be analysis of episode of care to review the processes of maintaining accuracy by the individuals who are responsible for entering care classifications into the system.

5.3 Length of stay and patient outcomes.

As already discussed, LOS is a useful but limited indicator of efficient and effective services in terms of patient flow and budget allocation. However, from a trauma management perspective, benchmarking patient outcomes may be another appropriate area to study. Researching factors such as time to tertiary survey, reduced complication rates, reduced delays in surgery due to efficient trauma management and trauma systems could be helpful in planning quality care. A study conducted by a group of researchers in the United Kingdom found that trauma nurses compared to non-trauma nurses managed the trauma patient better than those patients
who were admitted to a general ward (Lloyd et al, 2004). These improvements lead to faster times to theatre for patients who were treated with simple procedures such as ice and elevation. The trauma management also led to less complications as patients were monitored more efficiently with improvements linked to trauma nursing experience and education provided by the hospital (Lloyd et al, 2004). Further studies in patient length of stay and trauma management would also be of benefit to see whether improvements in trauma nursing management leads to improvements in quality of life.

5.4 Limitations

Most limitations of this study are attributed to time restrictions and use of a single trauma centre. However, the data showed no significant difference between the injury severity or patient length of stay of patients between 2007 and 2008. A higher percentage of patients in 2007 were admitted to the neurosurgical ward or the Orthopaedic wards whereas all patients analysed in 2008 were admitted to the SMTU. The number of patients who were admitted in 2008 had a higher percentage of patients who were transferred to a rehabilitation centre compared to 2007. It is unknown what this was attributed to and if the increase stay by two days at the trauma unit actually improved patient outcomes.

The study did not indicate whether differences in length of stay are attributable to individual discharge processes. However, factors that may have had an impact on the findings could be time of tertiary survey
completion from medical staff, increased allied health services and case management. Even though medical, allied health and nursing staff may regularly rotate in and out of these areas the trauma patients will be definitively managed under the same consultants. The SMTU is in the early stages of development and this may impact on the length of stay of trauma admissions. As it is a new trauma system that has been implemented it may be beneficial to replicate the study when the SMTU has been operational for a number of years.

A further limitation of the study is not including the rate of unplanned readmissions following discharge from the hospital as it was beyond the scope of this study due to time restrictions. What is unknown, is the mix of causes of any increase in LOS. This may include suboptimal efficiency and effectiveness in trauma management because of the time limitations placed on the entire hospital system. The literature suggests that a specialised trauma system improves patients’ length of stay, mortality and decreased negative patient outcomes. Length of acute stay as an indicator for efficient and effective trauma management may not be an appropriate marker to assess because it does not indicate patient outcomes such as quality of life and loss of productive life, which is important to communities and governments. Yet, in the current system hospital managers continue to place emphasis on reaching appropriate discharge dates because budget allocations are based on aggregated patient hospitalization data.

Limitations to the research design include low numbers of patients admitted to the SMTU. Initially it was thought that the sample population
could be obtained within a four month study period, however the exclusion of patients who were admitted to the Intensive care Unit or the High Dependency Area may have negatively impacted on a true representation of the population of major trauma patients admitted to Royal Perth Hospital. It would be useful to compare the difference of LOS between ICU/HDA patients and those who are admitted straight to the SMTU. This finding could be used to analyse the patients’ length of stay and obtain a better understanding of factors that increase LOS and ways to improve it.
CHAPTER 6- CONCLUSION

This chapter summarises the findings in terms of what is not known about patient length of stay and efficiency and effective trauma management. It will briefly describe the methodology of the study and the results found by this research in relation to the aims of the study. Finally it will summarise the discussion of the findings and conclude by recommending further research into patient length of stay.

6.1 Conclusions of the study

Trauma is such an important topic as our youngest citizens of Australia are the highest affected by injury. This may be due to higher risk taking behaviour as well as the use of alcohol and illicit drugs. This affects the country in terms of a patient’s quality of life following injury, in relation to the loss in productive work life. The cost of care of the trauma patient, in treatment and lifelong management of injury costs the Australian government 18 billion dollars a year annually. This research reviewed a new trauma system put into place by the Western Australian government in 2007 where the Royal Perth Hospital was designated as the State Major Trauma Centre. In 2008, the State Major Trauma Unit was opened to manage the majority of major trauma patients of WA. To review the quality of care and the effectiveness and efficiency of the service now provided at Royal Perth Hospital, length of acute stay was analysed.

Patients with an ISS>15 who were admitted to the SMTU in 2008 were compared to patients who were admitted to RPH in 2007. The aim of
this study was to evaluate the new Western Australian State Major Trauma Unit and its impact on length of hospital stay in major trauma patients at Royal Perth Hospital. The results showed that there was not a significant difference in length of stay and the null hypothesis was accepted.

Length of stay may not be an appropriate indicator of efficiency and effectiveness in relation to hospital budgets within the acute health sector in that it excludes such markers as quality of life and productive life. It would be of particular benefit to the new trauma system of WA to conduct further research into other factors which impact upon length of stay. These studies could include access block at RPH and ways to improve patient flow, tertiary survey analysis, ISS and its reflection on quality of life outcomes, communication between medical teams on the SMTU, SMTU affect on ICU and HDA in reducing length of stay, analysis of episode of care and its accuracy in the classification of acute care and its affects on ‘LOS’, time to operating theatre and radiology, quality of life of the trauma patient after admission into the SMTU, analysis of complications delayed discharge and readmission rates at the SMTU, the SMTU’s affect on rehabilitation as well as a critical analysis bed shortages and waitlist times at RPH.
REFERENCES


Rutledge, R., Osler, T., Emery, S. & Kromhout-Schiro, S. (1998). The End of the Injury Severity Score (ISS) and the Trauma and Injury Severity Score (TRISS): ICISS, an International Classification of Diseases, Ninth Revision-Based Prediction Tool, Outperforms Both ISS and TRISS as Predictors of Trauma Patient Survival, Hospital Charges, and Hospital Length of Stay. Injury, 44 (1), 41-49.


APPENDICES

APPENDIX A- Injury Severity Score

Injury Severity Scoring System- http://www.trauma.org/archive/scores/iss.html

ABBREVIATED INJURY SCALE
The Abbreviated Injury Scale (AIS) is an anatomical scoring system first introduced in 1969. Since this time it has been revised and updated against survival so that it now provides a reasonably accurate ranking of the severity of injury. The latest incarnation of the AIS score is the 1998 revision. The AIS is monitored by a scaling committee of the Association for the Advancement of Automotive Medicine.

Injuries are ranked on a scale of 1 to 6, with 1 being minor, 5 severe, and 6 a nonsurvivable injury. This represents the 'threat to life' associated with an injury and is not meant to represent a comprehensive measure of severity. The AIS is not an injury scale, in that the difference between AIS1 and AIS2 is not the same as that between AIS4 and AIS5. There are many similarities between the AIS scale and the Organ Injury Scales of the AAST.

Injury AIS Score
1 Minor
2 Moderate
3 Serious
4 Severe
5 Critical
6 Unsurvivable

• Copes WS, Sacco WJ, Champion HR, Bain LW, "Progress in Characterising Anatomic Injury", In Proceedings of the 33rd Annual Meeting of the Association for the Advancement of Automotive Medicine, Baltimore, MA, USA 205-218

INJURY SEVERITY SCORE (ISS) & NEW INJURY SEVERITY SCORE (NISS)
The Injury Severity Score (ISS) is an anatomical scoring system that provides an
overall score for patients with multiple injuries. Each injury is assigned an AIS and is allocated to one of six body regions (Head, Face, Chest, Abdomen, Extremities (including Pelvis), External). Only the highest AIS score in each body region is used. The 3 most severely injured body regions have their score squared and added together to produce the ISS score.

An example of the ISS calculation is shown below:

<table>
<thead>
<tr>
<th>Region</th>
<th>Injury Description</th>
<th>AIS</th>
<th>Square Top Three</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head &amp; Neck</td>
<td>Cerebral Contusion</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Face</td>
<td>No Injury</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Chest</td>
<td>Flail Chest</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>Abdomen</td>
<td>Minor Contusion of Liver Complex Rupture Spleen</td>
<td>2 5</td>
<td>25</td>
</tr>
<tr>
<td>Extremity</td>
<td>Fractured femur</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>External</td>
<td>No Injury</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

**Injury Severity Score:** 50

The ISS score takes values from 0 to 75. If an injury is assigned an AIS of 6 (unsurvivable injury), the ISS score is automatically assigned to 75. The ISS score is virtually the only anatomical scoring system in use and correlates linearly with mortality, morbidity, hospital stay and other measures of severity. Its weaknesses are that any error in AIS scoring increases the ISS error. Many different injury patterns can yield the same ISS score and injuries to different body regions are not weighted. Also, as a full description of patient injuries is not known prior to full investigation & operation, the ISS (along with other anatomical scoring systems) is not useful as a triage tool.

As multiple injuries within the same body region are only assigned a single score, a proposed modification of the ISS, the "New Injury Severity Score" (NISS), has been proposed. This is calculated as
the sum of the squares of the top three scores regardless of body region. The NISS has been found to statistically outperform the traditional ISS score.