1

General introduction and outline of the thesis
TRAUMA IN GENERAL

Worldwide, trauma-related injury is one of the leading causes of mortality, and the major cause of death in young (more than 10%), predominantly male adults.\(^1\) Severe injury is also the most important cause of functional limitations in adults younger than 45 years of age and causes more lost working years than heart disease and cancer combined.\(^3\)\(^4\)\(^5\) Therefore, adequate evaluation of, and improvements in early trauma care is important.

The initial assessment of injured patients, especially on the scene of the accident, is a big and difficult challenge in early trauma care. Decisions concerning treatment of these patients should therefore be adequate and taken fast, with the aim of reducing disability, infirmity, morbidity and mortality. Patient’s injuries have to be correctly assessed within minutes and important decisions concerning possible interventions must be made, often with big consequences for patient’s outcome. In order to provide the appropriate care as soon as possible after the accident to the injured patient, it is of big importance that all links in the “chain” of trauma care communicate and cooperate properly.

PREHOSPITAL TRIAGE

Trauma triage systems aid to identify and provide rapid treatment for severely injured trauma patients while at the same time identifying less-injured patients in need of only basic care. Earlier research showed that these systems considerably reduce injury-related morbidity and mortality.\(^6\)\(^7\)\(^8\) The ideal system would equally match the severity of injury and resources required for optimal care with the appropriate trauma facility and personnel. In practice though it is shown that a “perfect” triage system does not exist, resulting in considerable rates of overtriage and undertriage. As stated in the American College of Surgeons Committee On Trauma guidelines, “… in general, priority has been given to the decrease of undertriage, because undertriage may result in preventable morbidity or even mortality from delays in definitive care. An undertriage rate of 5-10% is considered unavoidable and is associated with an overtriage rate of 30-50%”.\(^9\)

Overtriage results in little impact to the patient, but it can result in increased workload at the receiving hospital and inappropriate use of healthcare. Overtriage may also cause longer out-of-hospital transport times and loss of medical service coverage ((i.e. Helicopter Emergency Medical Services (HEMS)) in the primary area, withholding essential care from patients who would really benefit from it. Even though decrease of undertriage should result in fewer missed injuries or delays in receiving definitive care, the inevitable result has been an increase in overtriage of patients with less-severe or negligible injuries.

A variety of scoring systems has been devised to grade and classify patient’s injuries. By providing a quick assessment of a patient’s injury, prehospital scoring systems aid in the prehospital triage of injured patients, separating the severely injured from those with lesser degrees of injury. Most triage systems combine criteria concerning the mechanism of injury, patient’s physiological state (Revised Trauma Score, Glasgow Coma Scale) and anatomical parameters. By combining the right criteria it is possible to reach high sensitivity in detecting major trauma patients.
HELIcopter EMERgENCY MEDICAL SERVICES

In the care for the severely injured, time is an essential factor. To improve survival of trauma patients, high quality care should be implemented as soon as possible following an accident. HEMS are nowadays standard in modern trauma care. The aim of this service is the delivery of a specialized (physician based) trauma team to the scene of the accident as quickly as possible, performing advanced medical procedures on the injured patient.

In the Netherlands, regular prehospital care for the injured is provided by highly trained EMS nurses following PHTLS protocol. To increase quality of care, HEMS were introduced in the Netherlands in 1995. The first HEMS team (also known as “Lifeliner One”) was a collaboration between the VU University Medical Centre in Amsterdam and the Royal Dutch Touring Club (ANWB). The HEMS team consists of a specialized trained trauma surgeon or anesthesiologist, a Emergency Department (ED) / Emergency Medical Services (EMS) nurse and a helicopter pilot. The HEMS team was able to be dispatched during daylight hours (7.00 – 19.00) and able to be airborne within 2 minutes after being dispatched. Since 2011, the Lifeliner One is stand-by 24 / 7.

The HEMS team adds advanced medical interventions to the on-scene therapeutic spectrum of the severely injured patient, including airway management, rapid sequence induction, placement of chest tubes, administration of advanced analgesia and specific medication and limited surgical interventions. The Lifeliner One is located at the VU University Medical Centre and covers a territory of almost four million inhabitants with five EMS dispatch centers. Each year, the Lifeliner One is dispatched approximately 1.200 times, of which almost 92% are trauma-related dispatches.

Primary overtriage in HEMS results in early dispatch cancellations. Analysis of the Lifeliner One results showed a considerable rate of cancellations, reaching almost 50% of all dispatches. The first Dutch studies concerning on-scene HEMS care showed a benefit for patients treated by HEMS compared with regular EMS care. This positive effect was mostly found in multitrauma patients and patients with neurological injuries after traffic accidents.

INHOSPITAL MANAGEMENT AND ASSESSMENT OF INJURIES

Regionalized trauma systems and trauma centre designation decrease mortality after severe injury. One of the aims of the assessment of injured patients is to early identify all injuries and treat these as soon as possible. According to the worldwide accepted Advanced Trauma Life Support (ATLS) guidelines, standard protocols for physical and radiological examinations are used during primary and secondary survey in all trauma patients who are suspected to have severe injuries.

Trauma care creates a “perfect storm” for medical errors: unstable patients, incomplete histories, time-critical decisions, concurrent tasks, involvement of many disciplines and often junior personnel working after-hours in busy ED’s. Studies in several countries have identified adverse events, including death, that occur in trauma and emergency care.

Missed injuries can occur due to hectic circumstances at the scene of the accident and in the trauma resuscitating room. Despite evaluating all trauma patients according to the ATLS guidelines, some injuries still remain undetected and patients may even be discharged
without all their injuries being diagnosed. For this purpose the tertiary trauma survey was introduced by Enderson et al. in the early 90’s. Their approach was that ‘after the patient had stabilized (and preferably when mobile and recovered from any head injury) each patient was re-examined to confirm the initial diagnosis and to determine any injuries that might have been missed in the primary and secondary surveys.

It remains difficult to find a balance between the overuse of resources for diagnostics of the injured patient (overtreatment) and missing injuries (undertreatment). Continuous efforts to identify and better understand specific factors that contribute to unfavourable outcomes are therefore critical for the improvement of trauma care.

**OUTLINE OF THE THESIS**

In this thesis several aspects of early trauma care are highlighted. Special attention has been given to the prehospital and early inhospital management of severely injured patients, especially to overtriage, overtreatment and inappropriate use of resources. Prehospital (EMS and HEMS) protocols, triage models and scoring systems were reviewed and evaluated by testing their accuracy for safely identifying severely injured patients. The primary inhospital assessment of level I injured patients was analyzed with special attention to triage, early diagnostics, radiation exposure, missed injuries and the role of the tertiary trauma survey in trauma care.

**Part I**

Part I describes several aspects of the prehospital emergency care, mostly focused on the inappropriate use of advanced facilities (i.e. HEMS), causes and suggestions for safely decreasing this phenomenon (overtriage).

Chapter 2 describes HEMS dispatch cancellations. Although much attention has been paid to improve dispatch criteria in our system, HEMS is often cancelled after being dispatched. We assessed which sorts of dispatches are being cancelled and if all cancellations were justified. One of the prehospital scoring systems which is used worldwide is the Revised Trauma Score (RTS), providing a snapshot of patient’s physiological state. In Chapter 3 we assessed the ability of a maximum on-scene RTS (= 12) to be used as a triage tool for HEMS dispatch cancellation. In Chapter 4 the ability of the primary HEMS dispatch criteria to identify major trauma patients was examined. Furthermore we evaluated the predictive power of other early prehospital parameters in order to design a safe triage model for HEMS dispatch cancellations. In the past, several studies have shown that HEMS have a positive effect on patient’s outcome. Though, it remains unclear which specific patients benefit most from its care and how to early identify these patients. Chapter 5 describes the effect of HEMS on the outcome of a large polytraumatized (IQI Severity Score (ISS) ≥ 16) population. Secondly, early parameters were identified predicting beneficial effect of HEMS care on patient’s outcome.

**Part II**

In Part II several aspects of the primary assessment of severely injured patients in a level I trauma centre are described, with special attention given to trauma team activation, radiological examinations and radiation exposure in the ED, missed injuries during hospitalization and the role of the tertiary trauma survey in trauma care.
In Chapter 6 we analyzed all trauma patients who were presented in the trauma resuscitating room of our Level I trauma centre, assessing the amount of overtriage and the possible causes of this phenomenon. Because of this overtriage, a considerable amount of patients is unnecessarily presented in the trauma resuscitating room, receiving full (radiological) diagnostics. In Chapter 7 we describe the amount and findings of all radiological examinations separately during initial assessment of adult level 1 trauma patients. Secondly the radiation exposure of these diagnostics was determined.

Despite the presence of diagnostic guidelines for the initial evaluation in trauma care, the reported incidence of missed injuries in the literature is considerable. A missed injury can lead to increased morbidity, prolonged hospital stay, increased costs and even mortality. In Chapter 8 we determined the frequency, type and implications of missed injuries in a large cohort of trauma patients in two Dutch Level-1 trauma centers. Secondly, we detected factors that contributed to the injuries being missed. We also determined in which survey or period of treatment the missed injuries were finally diagnosed. The widely used ATLS guidelines have introduced primary survey to prioritize the detection of the most life-threatening injuries and secondary survey performed in the trauma resuscitating room to address all other important injuries. However, the complexity of managing severely injured patients makes the two surveys insufficient in detecting all injuries. Therefore tertiary trauma survey was introduced performed at least after 24 hours or when the patient has regained consciousness again to detect all injuries. In Chapter 9 we reviewed the literature in order to assess the importance of a tertiary trauma survey and the association between this survey and patient’s outcome.

REFERENCES


