Injury, Int. J. Care Injured 47 (2016) 26–31

Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

Direct transport versus inter hospital transfer of severely injured trauma patients

Stefan Mans [a,*], Eline Reinders Folmer [b], Mariska A.C. de Jongh [a], Koen W.W. Lansink [a,b]

[a] Trauma Centre Brabant, Elisabeth-Tweesteden Hospital, Tilburg, The Netherlands
[b] Department of Surgery, Elisabeth-Tweesteden Hospital, Tilburg, The Netherlands

ARTICLE INFO

Article history:
Accepted 26 September 2015

Keywords:
Trauma centre
Triage
Mortality
Trauma
Severely injured patients
Pre-hospital transport
Pre-hospital care
Trauma systems
Multi trauma
Inter hospital transfer

ABSTRACT

Introduction: Several studies have suggested that severely injured patients should be transported directly to a trauma centre bypassing the nearest hospital. However, the evidence remains inconclusive. The purpose of this study was to examine the benefits in terms of mortality of direct transport to a trauma centre versus primary treatment in a level II or III centre followed by inter hospital transfer to a trauma centre for severely injured patients without Traumatic Brain Injury (TBI).
Patients and methods: We used the regional trauma registry and included all patients with an Injury Severity Score (ISS) >15 and an Abbreviated Injury Score <4 for head injury. We adjusted for survival bias by including "potential transfers": patients who died at the nearest hospitals before transportation to a trauma centre.
Results: A total of 439 patients was included. The majority of patients (349/439, 79%) was transported directly to the level I trauma centre (direct group). The transferred group was formed by the remaining 90 patients, of whom 81 were transferred to the level I trauma centre after initial stabilisation elsewhere and 9 patients died in the emergency room before transfer to a level 1 trauma centre could occur. There were no significant differences in baseline and injury characteristics between the groups. Overall, 60 patients died in-hospital including 41 of the 349 patients (12%) in the direct group and 19 of the 90 patients (21%) in the transferred group. Nine of the 19 deaths in the transferred group were ascribed to potential transfers. After adjusting for prehospital Revised Trauma Score (RTS) and ISS, the odds ratio of death was 2.40 (95%CI: 1.07–5.40) for patients in the transfer group. When potential transfer patients were excluded from the analysis, the adjusted odds ratio of death was 1.14 (95%CI: 0.43–3.01).
Conclusions: After adjusting for survivor bias by including potential transfers, the results of this study suggest a lower risk of death for patients who are directly transported to a level I trauma centre than for patients who receive primary treatment in a level II or III centre and are transferred to a trauma centre. However, this finding was only significant when adjusting for survival bias and therefore we conclude that it is still uncertain if there is a lower risk of death for patients who are transported directly to a level I trauma centre.

Introduction

Severely injured patients that are treated in a designated trauma centre might have a lower risk of death than patients treated in a non-trauma centre [1,2]. This could suggest that severely injured patients should be transported directly to a trauma centre bypassing the nearest hospital. However, in some cases stabilizing patients in a non-trauma centre before transport to definitive care may be necessary. These patients will either be admitted to the hospital, transferred to a higher level centre after stabilisation, or die in the Emergency Department (ED) [3].

Several studies investigated the impact of direct transport to a trauma centre with stabilisation in the nearest hospital followed by inter hospital transfer to a trauma centre. Two recently published systematic reviews identified over 30 studies and found no evidence for a difference in mortality between transfer and direct admission to a trauma centre [4,5]. Although primary stabilisation in local hospitals seems to be associated with higher risk of death for trauma patients, the evidence was inconclusive [4,5]. However, most studies excluded deaths that occurred in the Emergency Departments of the non-trauma centres [4]. This approach may have led to biased estimates [3]. Haas et al.

* Corresponding author.
E-mail addresses: s.mans@students.uu.nl, s.mans@outlook.com (S. Mans).

http://dx.doi.org/10.1016/j.injury.2015.09.020
0020–1383/

demonstrated this by adjusting for "potential transfers": patients who died at the nearest hospitals before transportation to a designated trauma centre. They reported a significantly higher mortality for transferred trauma patients [3].

Our trauma region employs a system where patients are initially transported to the nearest hospital for treatment [6]. All hospitals within this region offer acute trauma care. If further treatment is required according to the attending surgeon, patients are transferred to a level I trauma centre. Patients suspected of traumatic brain injury (TBI) are always transported directly to a trauma centre with neurosurgical care. The purpose of this study was to examine the benefits in term of mortality of direct transport to a trauma centre versus primary treatment in a level II or II trauma centre followed by inter hospital transfer to a level I trauma centre for severely injured patients without TBI.

Patients and methods

Study design and setting

The Netherlands employs an inclusive trauma system in which all hospitals are assigned a level of trauma care, ranging from I to III. All trauma regions are organised around a level I trauma centre. The Netherlands has a population of 17 million and covers an area of approximately 43,000 km^2. One of the trauma regions is the province of North-Brabant, where the St. Elisabeth Hospital is the regional level I trauma centre with 650 beds [6]. We conducted a retrospective cohort study using the trauma registry database of our trauma region (North-Brabant). North-Brabant has a population of 2.5 million and covers an area of approximately 5000 km^2. Within this region, there are twelve other hospitals that have well-equipped emergency departments and provide round the clock acute trauma care. Only the level I trauma centre offers neurosurgical care. Patients suspected of traumatic brain injury (TBI) are therefore transported directly to a level I trauma centre. Traumatic brain injury is suspected per protocol if Glasgow Coma Scale is decreasing, the patient has unequal pupil sizes combined with GCS below 15 or there is open trauma to the skull. All other patients are initially transported to the nearest hospital for treatment. The majority (60%) of trauma patients is transported and admitted to one of the level II or III hospitals. Patients are only transferred to the level I centre if additional treatment is required according to the attending surgeon.

Participants

The trauma registry is a prospective comprehensive registration of all trauma patients who are admitted after presentation to the Emergency Department of one of the hospitals within the trauma region. Additionally, trauma patients who are referred from the ED to another hospital for admission, and trauma patients who die in the ED are all included in the trauma registry. For this analysis, we examined data of patients that presented to the Emergency Department of one of the hospitals within the trauma region between January 2009 and December 2013. We included all non-TBI patients aged $\geq$16 years who arrived at the ED with medical transportation and an Injury Severity Score $>$15. We excluded patients who were (1) dead at the scene; (2) transported or transferred to or from a hospital outside the trauma region; or (3) with an Abbreviated Injury Scale (AIS) head score of 4 or higher.

We were interested in the relative in-hospital mortality of direct transport versus transfer to a level I trauma centre. Therefore we compared in-hospital mortality for both routes to the level I trauma centre (directly transported to a level I centre or transferred to a level I centre). Patients admitted to level II or III centres were excluded from the analysis because once patients are admitted to a level II or III centre, they are no longer eligible for acute care at a level I trauma centre.

Patients who died in the emergency or operating room of the level II or III centre were recorded as "potential transfers" and included in the transfer group. Patients were only recorded as potential transfers if transportation to a level I centre could have occurred. If for instance a patient died within 20 min of arrival at a level II or III centre, while the transportation time to a level I centre was 50 min, the patient was not recorded as a potential transfer and excluded from the study. This was determined independently by two authors.

Data collection and variables

Prehospital variables (blood pressure; heart rate; respiratory rate and Glasgow Coma Scale [GCS]) were assessed by Emergency Medical Services (EMS) staff on the scene and during transportation. EMS staff entered data into an electronic database. This data was linked to the existing trauma registry database. The prehospital Revised Trauma Score (RTS) was calculated with the GCS, respiratory rate and systolic blood pressure according to the published algorithm [7].

Upon presentation at the Emergency Department, variables were collected by the attending physician and were recorded in the trauma registry after the emergency department evaluation was completed. These included: type of trauma (blunt or penetrating); blood pressure; heart rate; respiratory rate; GCS; injury description for the Abbreviated Injury Scale; destination of discharge from resuscitation room. The Abbreviated Injury Scale (AIS) is based on the injury description in the patient medical records. A six-digit AIS code number with a post decimal place is assigned to each injury. The first digit represents the region of the body where the injury is located and the post decimal place represents the severity of injury. These score range from 1 (minimal injury) to 6 (maximum injury) [8]. The AIS is used to calculate the Injury Severity Score (ISS) [9]. For each of the three most injured body regions, the highest AIS is squared and summed, producing the ISS.

Registration nurses completed the registry with in-hospital data from the electronic patient files. For this study, we crosschecked missing registry data in the electronic patient files. Additionally, we recorded zip codes of the place of injury from the EMS registry. These allowed us to calculate the road distance to the hospitals and the trauma centre. Road distances were calculated by hand with Google Maps. The zip code of the scene of injury location was used as the starting point for distance calculations. The physical address of the designated hospital was used as the end point.

Outcome

The primary outcome of this study was in-hospital mortality as recorded in the trauma registry.

Statistical analysis

For efficient statistical analysis [10,11] we used multiple imputation with five iterations to impute the missing values in the prehospital RTS. The prehospital RTS was missing in 97 patients (22%), similar across both groups. An imputation model was considered that contained the variables prehospital respiratory rate, prehospital GCS, prehospital systolic blood pressure, age, sex, mechanism of injury, ISS, length of Intensive Care Unit (ICU) stay, length of hospital stay and mortality. We reported medians and interquartile range (IQR) for non-parametric variables, and means and standard deviations (SD) for normally distributed variables. Continuous variables (age, hospital length-of-stay, RTS) were compared using independent *T*-test or the Mann–Whitney *U* test,