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ITemporal delays in patients with traumatic brain injury in need of urgent surgical evacuation: retrospective analysis of the emergency department of a non-level I trauma center

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Abstract

Time to surgical hematoma evacuation is important in the treatment of traumatic extraduraland subdural hematomas. The goal of this study was to characterize the time performance of the emergency department in the treatment of traumatic brain injury (TBI) in need of urgent surgical evacuation.

This retrospective study analyzed all TBI patients in need of a urgent surgical evacuation between 2010 and 2016, presenting to the emergency department of a large non-university teaching hospital. Time intervals were calculated. Demographic data, neurological status and outcome data were collected, the effects of these variables on time delay and in-hospital mortality were studied.

Of 235 patients, 43 were included in this study (median age 52, 44.2% women). The median time from the emergency department (ED) to computed tomography scan (CT), the median time from the CT to the operating room (OR) and the median ED-to-OR time were 24 minutes (IQR 13.5-35.5 minutes), 40 minutes (IQR 29.5-68 minutes) and 67 minutes (IQR 47-109 minutes), respectively. Patients brought in by their own medical intervention team had a shorter time interval between arrival at the ED and CT, but there was no difference in the CT-OR interval or ED-OR interval. Initial Glasgow Coma Scale score, age and time of arrival had no effect on the temporal delay between arrival, CT imaging and OR.

Mortality was higher in patients with lower GCSand in older patients. There was no correlation between faster neurosurgical decompression and mortality.

The time interval for getting patients from the ED to CT and the OR in this study were in line with earlier studies. Time delays seem longer in the elderly patients. There was no benefit in survival in patients who had an earlier decompression in our small retrospective analysis.

Keywords: **Traumatic brain injury, neurosurgery, emergency department.**

Introduction

Guidelines on brain trauma recommend performing surgical evacuation of traumatic extradural and subdural hematomas early on[1,2]. This recommendation was based on a series of studies that found a positive association between better outcome and shorter delay to surgery[3-6].

A single center study at a Belgian level 1 trauma center, examined the time intervals for emergent trauma craniotomies between 2010 and 20167. The median time between emergency department(ED) arrival and skin incision for primarily referred patients was 140 minutes.

The goal of this study is to characterize the performance of the time to decompression in our non-university non level 1 trauma center in Belgium during the same period.

Ethical approvement: All protocols were approved by the institutional board of Ziekenhuis Oost-Limburg. Informed Consent was waived by institutional board and ethical committee of Ziekenhuis Oost-Limburg due to retrospective nature of the study.

Methods

Design

This study is a monocentric retrospective analysis.

Setting

A large non-university teaching hospital in Genk, Belgium with a total of 805 beds. The emergency department (ED) admits approximately 50 000 patients a year of which 40-50% with trauma. The hospital has a level 2 accreditation of the Deutsche Gesellschaft für Unfallchirurgie (DGU). The hospital is part of a hospital network, for which it serves as the referral center for neurosurgery. In the ED the Manchester triage is used to prioritize the patients. The the computed tomography scan(CT)is located within theED, while the operating rooms(OR) aresituated one floor higher.

Data collection and variables

The OR database was used to identify all patients for whom an emergency neurosurgical decompression was performed between January 1, 2010, and December 31, 2015. The search terms were based on the surgical procedures: “extradural hematoma”, “subdural hematoma”, “decompressive craniectomy” and “intracranial hemorrhage”. The patients’ reports from the emergency department were used to determine which patients had a traumatic injury. Patients who were transferred from another hospital, who had nontraumatic intracranial hemorrhage, who had surgery for late clinical or radiological deterioration and patients with missing data were excluded.

Following timings were extracted: arrival at the ED, time of CT and arrival in the OR. The time of arrival at the ED was extracted from the electronic administrative file, which is created on arrival. Timing of the CT was defined as the time on the first image acquired (scout view). The time of arrival in the OR was recorded in the OR database.

The demographic data (i.e., age, sex) and Glasgow Coma Scale (GCS) score were collected from the ED reports. The patient’s arrival time at the ED was classified as during regular office hours (Monday to Friday between 8.00 am and 6.00 pm) or during evenings, nights, or weekends when surgeons and operating staff are on call. The mode of entrance was also reviewed, patients were brought in by the medical intervention team (MIT) of the hospital of Genk, by ambulance or on their own initiative. Patients transferred from other hospitals were excluded.

The outcome variables were time from ED to CT, time from CT to OR room and total time from ED to OR. In a secondary analysis, in hospital mortality was considered as an outcome variable.

Statistics

Categorical variables were described as proportions. Normality assumptions were tested using the Shapiro-Wilk test. Depending on the distribution continuous variables were summarized by mean (standard deviation) or median (interquartile range (IQR)). Comparison of groups was done using the Student t-test and Mann-Whitney U test. Correlations were tested using the Spearman’s rank correlation coefficient. P-values below 0.05 were deemed significant. Data were analyzed using R version 4.0.1.

Results

Between 2010 and 2015 we could retrieve 235 procedures. Of those, 192 were excluded because of missing clinical or time data (n = 5), nontraumatic intracranial hemorrhage(n=80), delayed clinical or radiological deterioration (n=24), transferred from another hospital (n=83) (Figure 1). Patients’ characteristics are shown in Table I.

The median ED-to-CT time was 24 minutes (IQR 13.5-35.5 minutes), the median CT-to-OR time was 40 minutes (IQR 29.5-68 minutes) and the median ED-to-OR time was 67 minutes (IQR 47-109 minutes). In this period of 6 years there was no shortening of time intervals of ED-to-OR (Figure 2). In this study patients brought in by a Medical Intervention Team(MIT) had a significantly shorter time interval between arrival at the ED and CT imaging (p=0.017). CT-to-OR time and the overall ED-to-OR time did not differ between patients brought in by the MIT or without medical escort (Table II). Time intervals were similar during working hours and on call periods. There was also no association between the

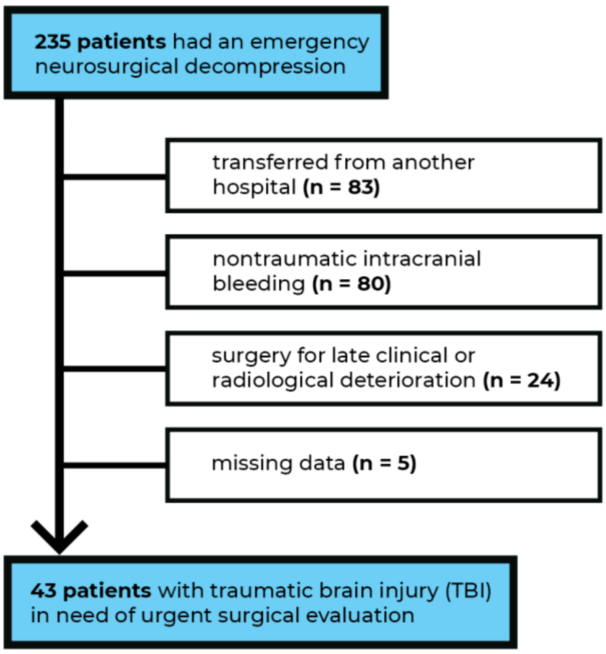

Fig. 1 — Patient exclusion process.

Table I. — Patient characteristics (n=43).

Mean age, yrs (range)	52 (34.5-61.5)
Male/Female ratio	24/19
Mean initial GCS score (range)	7 (4-10)
Office hours/on call ratio	26/17
MIT/no medical escort ratio	29/14
Hospital mortality rate, %	41.9%

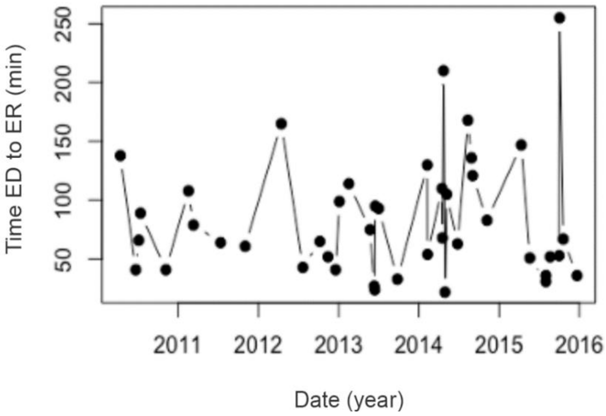

Fig. 2 — ED-to-OR time visualized chronologically.
ED: Emergency Department; OR: Operating Room.

initial GCS and the time intervals. However, the CT-to-OR (R^2 0.12, p=0.018) and ED-to-OR (R^2 0.11, p=0.028) times were significantly correlated with age, with longer times in older patients (Figure 3). ED-to-CT times were not correlated to age (R^2 0.002, p=0.73). In a secondary analysis, mortality was considered as an outcome variable. Patients who died had a significantly lower median GCS (3 (IQR 3-9)) than the survivors (8 (IQR 6-12) (p=0.004). The age in non-survivors was also significantly higher (58 years (IQR 48-70) than in the survivors (41(IQR 30-47) (p=0.022). Median ED-to-OR time did not differ between survivors (79 (IQR 52-112) and non-survivors (58 (IQR 36-111) (p=0.22). Eight (47%) out of 17 patients who were admitted during working hours died, while 10/26 patients admitted during an on-call did not survive (38%) (p=0.57).

Table II. — Time intervals as a function medical intervention support during transport.

Time intervals, min median (IQR)	MIT	No medical escort	p-value
ED-to-CT	18 (11-27)	34 (20-50)	0.017*
CT-to-OR	39 (28-82)	51 (29-65)	0.71
ED-to-OR	63 (41-100)	94 (63-125)	0.11

IQR: Inter Quartile Range; ED: Emergency Department; CT: Computerized Tomography scan; OR: Operating Room; MIT: Medical Intervention Team; *Statistically significant.

Discussion

The time interval in getting patients from the ED to the OR at this large non-university hospital compares to what is reported in literature, with a median of 67 minutes from ED arrival to arrival in the OR. The reported median time interval for primarily referred traumatic brain injury patients by Marcoux et al.[8] and De Vloo et al.[7] were 110 minutes and 111 minutes, respectively. Both studies were conducted in a trauma level 1 center. Other studies were not considered because they measured different time intervals[9,10].

It is encouraging that there was no difference in temporal intervals for patients arriving during working hours or during the on-call hours, which is a requirement in a well-functioning emergency department and trauma center.

There was no correlation between initial GCS and delays from arrival at the ED to CT and to the OR. Patients who suffer severe TBI and have a lower initial GCS are usually brought in by the MIT. Often patients are stabilized and intubated at the scene by a trained doctor of the MIT, also the receiving ED will be notified and so less time will be lost at the ED.

In this study patients brought in by MIT were transferred to the CT faster than patients brought in by ambulance or on their own initiative. This could be a result of immediate prehospital medical investigation and notification of the ED. However, it did not result in shorter intervals for

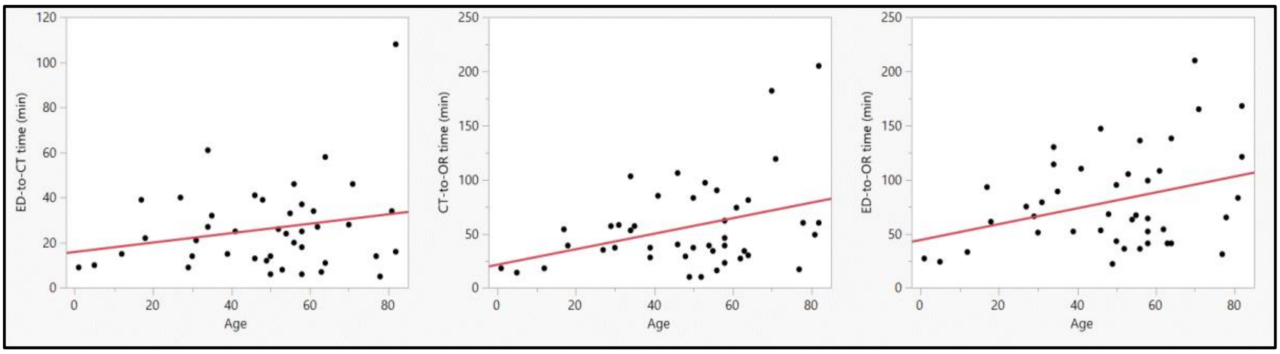

Fig. 3 — Correlations between time intervals and age.
ED: Emergency Department; CT: Computerized Tomography scan; OR: Operating Room; CT-to-OR (R^2 0.12, p=0.018) and ED-to-OR (R^2 0.11, p=0.028) times were significantly correlated with age, with longer times in older patients (Figure 3). ED-to-CT times were not correlated to age (R^2 0.002, p=0.73).

CT-to-OR and the ED-to-OR. Introduction of a better (prehospital) notification system could enable to a shorter ED-to-OR interval.. A revised trauma system was activated, all staff members of the department of anesthesiology and emergency medicine were educated in the advanced trauma life support (ATLS).

In a secondary analysis, mortality was considered as an outcome variable. There was no positive effect of shorter time intervals on mortality. In this period of 6 years, we also saw neither shortening of time intervals nor reduction in mortality, despite efforts have been made in training of staff and in the transmission of critical information. Age and first GCS were most likely more influential factors of mortality, in a study with such a small sample size. As noted in the article of Bullock et al.[1,2] time from neurological deterioration to surgery is more important than time between trauma and surgery. Unfortunately, this could not be analyzed due to lacking data. However, the article stated that there is evidence that patients who undergo surgery within 2 to 4 hours after clinical deterioration have a better outcome than those who undergo delayed surgery, this study showed that 79.1% of the patients were in the OR in less than 2 hours after admission in the emergency department and 97.7% were in the OR in less than 4 hours.

The mortality in this study (41.9%) was higher than reported by Marcoux et al.[7] (38%). The 30-day mortality in the article of De Vloo et al.[8] (27%) was lower than in our study (37.2%). A lower GCS and higher age were correlated with higher mortality in this study. The median initial GCS in this study is 7, this is lower than the median GCS of 9 reported in Marcoux et al.[7] but higher than the median initial GCS reported by De Vloo et al.[8] which was 6.

The correlation between age and time intervals after the CT scan is somewhat surprising. While age is an important factor for poor outcome in TBI, time delays seem much longer in the elderly patients. Discussions on the appropriateness of care may have caused these delays.

The weaknesses of this study arethe small sample size and the retrospective nature of data collection. Until 2017 most of the input was written down by the doctors and later digitized by an employee. Since then, various software systems have been used to collect data digitally, causing complex fragmentation. Many other important variables in the initial phase of TBI, such as hypotension, hypoxemia, pupillary defects, and adequacy of initial treatment were lacking.

Conclusion

The time interval for getting patients from the ED to CT and the OR in this study were in line with earlier studies. Time delays seem longer in the elderly patients. There was no benefit in survival in patients who had an earlier decompression in our small retrospective analysis.

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