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External factors and the incidence of severe trauma: Time, date, season and moon

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ABSTRACT

Background: To detect whether external factors (time of day, day of week, month and season, lunar phases) influence incidence and outcome of severely injured trauma patients.
Patients and methods: A retrospective cohort analysis of the TraumaRegister DGU® (TR-DGU) was carried out over a period of 10 years (January 2002–December 2011). Data of 35,432 primary admitted patients from Germany with a severe trauma (Injury Severity Score (ISS) >15) were analysed in this study. For the outcome evaluation transferred patients were excluded as well as those who did not have a valid Revised Injury Severity Classification (RISC) prognostic score. The outcome analysis could be performed in 31,596 (89.2%) patients. Incidence, demographics and injury pattern were analysed. For outcome analysis the observed hospital mortality was compared with the expected prognosis.
Results: Time of day was the factor that showed the highest variation in trauma incidence due to rush hours. Saturday was the day with the highest accident rate. Most accidents in the night happened on weekends. June and July were the months with the highest trauma rate with a large portion of two-wheel drivers. The days of year with the lowest trauma incidence rate were those between Christmas and New Year, and the highest rate was observed on May 1st. The outcome of the trauma patients was close to the prognosis in all investigated subgroups.
Conclusion: There are clear differences in incidence but not in outcome of the patients due to external factors.

Introduction

Trauma is the leading cause of death in people younger than 40 years of age world-wide accounting for approximately 10% of deaths [1]. Therefore, it is essential to evaluate trauma incidence and outcome subject to several factors in order to deliver the highest quality medical care for trauma patients. Obviously, internal factors like experience and organisation of the trauma team or hospital resources influence the quality and outcome of trauma patients. Therefore, guidelines have been implemented to improve these conditions [2].

However, external factors like time of day or day of week have also been made responsible for variation in quality and outcome of care for patients with different diseases [3–6]. These studies have demonstrated worse outcomes and generally higher mortality rates at night and/or during weekends, in patient cohorts defined by selected medical conditions, including acute myocardial infarction, stroke, aortic aneurysm and cardiac arrest. For trauma, however, the results are heterogeneous [7–9]. These studies show the whole range of results, from 'higher mortality', 'no change', or 'lower mortality' during weekends and nights. Seasonal effects have been demonstrated to influence the incidence of trauma but not the number of trauma deaths [10,11]. Studies investigating the lunar effect could not show any effects [12,13].

Detecting incidence pattern and changes in quality of outcome due to these factors would help to improve trauma care when necessary. Therefore, the aim of this study was to analyse the association of external factors and incidence of severe trauma using a large national dataset, the TraumaRegister DGU®

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(TR-DGU). The evaluation of a potential influence of external factors on mortality, especially on weekends and during the night, was a further aim of this study.

Patients and methods

Study design

The study was conducted as a retrospective cohort study by analysing data from the TraumaRegister DGU® (TR-DGU) over a period of 10 years (January 2002–December 2011). This analysis was applied for and approved according to a peer review procedure established by the Sektion NIS of DGU (No. 2012-057).

Data source

TraumaRegister DGU®

The TraumaRegister DGU® (TR-DGU) is a prospective, multicenter, standardised, and anonymous documentation of severely injured patients. Data were collected at four consecutive phases from injury to hospital discharge: (A) prehospital phase; (B) emergency room and initial surgery (until admission to ICU); (C) intensive care unit (ICU); and (D) outcome status at discharge with description of injuries and procedures. The registry contains detailed information on demographics, injury pattern, comorbidities, pre- and in-hospital management, time course, relevant laboratory findings, and outcome of each individual. All injuries are coded with the Abbreviated Injury Scale (AIS, version 2005) which includes an injury grading ranging from 1 (minor) to 6 (actual untreatable) [17]. An injury of grade 3 or more was considered as relevant.

The TR-DGU has been a voluntary register in the past but now became the obligatory tool for quality assessment in the newly founded regional trauma networks [14,15]. It is in compliance with institutional requirements for data protection of the participating hospitals. As part of legally required initiatives for quality assessment in hospitals no patient consent was required for this anonymous data collection. Until December 2011, a total of 93,024 patients from 552 hospitals from 8 countries had been registered in the TR-DGU. About 90% of the registered cases were from Germany.

Patients

In the analysed time period from 2002 to 2011, 46,552 patients were registered. Only primary admitted patients from Germany with an Injury Severity Score (ISS) >15 were eligible for this study [16,17]. Furthermore, it was required that date and time of admission to hospital was documented (available in 97.5% of cases). Finally, 35,432 patients were included in the present study. For the outcome evaluation patients transferred in and out were excluded, as well as those who did not have a valid Revised Injury Severity Classification (RISC) prognostic score [18]. This score has been developed and validated with data from the TR-DGU, and it allows for comparing the observed hospital mortality with the expected prognosis derived from the RISC score, for groups of patients. The outcome analysis could be performed in 31,596 (89.2%) patients.

Analysis

All patients were characterised by typical descriptors like age, sex, ISS, New ISS, type of injury (blunt/penetrating), cause of accident, means of transport (ground/helicopter), the pattern of relevant injuries (AIS ≥ 3), hospital and 24 h mortality, length of stay in the ICU and in hospital, and duration of intubation (see Table 1).

Table 1
Patient characteristics ($n = 35,432$).

Variable	Value
Age (years)	46.5 ± 21.5
Males (%)	72.2
Helicopter transport (%)	33.1
ISS	28.3 ± 12.1
New ISS	34.5 ± 14.4
Blunt trauma (%)	96.0
Hospital mortality (%)	18.3
24 h mortality (%)	10.5
Duration of intubation (days)	6.11 ± 10.8
Length of ICU stay (days)	12.1 ± 13.2
Length of stay in hospital (days)	22.5 ± 24.8
Cause of accident (%)	
Car	28.7
Motorbike	14.2
Bicycle	7.9
Pedestrian	8.3
High fall >3 m	18.5
Low fall <3 m	13.8
Others	8.6
Suicide (%)	5.9
Pattern of relevant injuries (AIS ≥ 3, %)	
Head	55.3
Thorax	56.9
Abdomen	18.9
Extremities	35.0

The following external factors were analysed:

1. Time of day: hourly and in four periods of 6 h each: night 0:00–5:59 AM, morning 6:00–11:59 AM, afternoon12:00 AM–5:59:PM, evening 6:00–11:59 PM.
2. Day of week, for each individual day and also weekdays versus weekend (Saturdays and Sundays).
3. Month of year and season: the days were subdivided into four seasons starting on March 21, June 21, September 21 and December 21, respectively.
4. Lunar phase: For evaluation of the lunar phases we defined
   - Full moon (FM): day of the full moon plus the previous and the following day.
   - New moon (NM): day of new moon plus the previous and the following day.
   - Waning moon (WNM): all days between full moon and new moon.
   - Waxing moon (WXM): all days between new moon and full moon.

For each subgroup trauma incidence rates and characteristics of patients were determined. Since the TR-DGU does not cover all German trauma cases it was not possible to calculate population-based incidence rates. However, relative differences between the subgroups and deviations from expected rates could well be calculated. For the outcome analysis we calculated the standardised mortality rate (SMR). SMR is the quotient of the observed hospital mortality and the RISC prognosis. SMR values >1 correspond to an outcome worse than expected, while values <1 show a better outcome than expected. For the observed mortality rates 95% confidence intervals were calculated. The confidence interval for the SMR was then derived by dividing the confidence bounds by the expected mortality rate [19].

The Revised Injury Severity Classification (RISC) score was developed with data from the TR-DGU (1993–2000) and was validated in the subsequent years [18]. The TR-DGU uses the RISC score since 2003 as the standard tool for outcome adjustment. While observed mortality rates fitted very well the expected ones in the initial years, actual hospital mortality is about 2% lower than the prediction.