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ORIGINAL ARTICLE

Pre-hospital rescue times and interventions in severe trauma in Germany and the Netherlands: a matched-pairs analysis

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Abstract

Purpose The aim of this study was to compare the pre-hospital treatment of major trauma patients with similar injury patterns in Germany and the Netherlands.

Patients and methods This matched-pairs analysis is based on the TraumaRegister DGU®. The authors compared major trauma patients (ISS ≥ 16) from 2009 to 2015 treated in Dutch and German Level 1 trauma centers (TC). Endpoints were the pre-hospital times and interventions performed until hospital admission. Additional endpoints included hospital mortality, 24-h mortality and standardized mortality ratio (SMR) which was calculated using the Revised Injury Severity Classification, version II (RISC II). Patients were matched by age, gender, injury pattern, vital status on-scene and involvement into a traffic accident. Three subgroups were formed according to the mode of transportation and level of care provided during transport: Ambulance/Physician, Helicopter/Physician and Ambulance/Emergency Medical Technician.

Results Patients were matched into 1094 pairs. German patients arrived at the TC after a mean pre-hospital time of 65.6 (± 29.6) min while Dutch patients arrived after 61.4 (± 28.7) min. Pre-hospital intubation rate was slightly higher in the Netherlands (44.1% GER vs 50.5% NL). Chest tubes were placed in 3.0% of German patients and 8.3% of Dutch patients. 63.5% of the German patients received analgesia/sedation which was below the rate of Dutch patients (71.1%). The hospital mortality was for 17.6% for German patients and 19.8% for Dutch patients. The SMR was about 1.0 for both groups.

Conclusion Multiple differences and some similarities in the treatment of major trauma patients with similar injury patterns were found but no clinically relevant differences in the chosen outcome parameters could be observed.

Keywords Rescue times · Major trauma · Emergency medical services · International comparison · Germany · The Netherlands

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Introduction

The Federal Institute for Occupational Safety and Health estimated that approximately 977 Mio. people in Germany were injured in accidents in the year 2013, resulting in the loss of 22,717 lives [1]. Every year about 18,000 patients with major trauma arrive at a hospital in Germany [2]. Injuries are the leading cause of mortality in the age group from 15 to 25 years [3]. As a tool to record and improve the quality of care for these patients, international databases provide the necessary comparability to describe, evaluate and improve national trauma systems. However, studies utilizing the international comparability of submitted data are scarce.

Germany and the Netherlands share a large border region with increasingly intertwined emergency medical services (EMS) but until recently a comparison of the Dutch and the German pre-hospital trauma system could not be found. In

a prior study, the authors assessed and described the pre-hospital phase in Germany and the Netherlands [4]. It had to remain unclear whether the described differences in the patient's treatment were results of organizational differences or varying injury patterns. A definitive conclusion was especially limited by the higher number of isolated head injuries in the Dutch collective. In their conclusion, the authors suggested to mitigate the differences in the patterns of injury to increase the comparability. Consequently, a matched-pairs approach was chosen for this study to answer the question whether there are differences between Germany and the Netherlands regarding the pre-hospital treatment of major trauma patients with similar injury patterns.

Patients and methods

TraumaRegister DGU®

This study is a retrospective matched-pairs analysis of major trauma patients in Germany and the Netherlands with a focus on pre-hospital time, mode of transportation and interventions performed by physicians or emergency medicine technicians (EMTs). The data were derived from the TraumaRegister DGU® (TR-DGU). From 2009 to 2015, three Level 1 Trauma Centers (TC) from the Netherlands and 81 German Level 1 TCs contributed data to the TR-DGU. Data before 2009 were not used in this study due to changes in the definition of the transportation categories and the limited number of Dutch Trauma Centers in that period. The TR-DGU was founded in 1993. The aim of this multi-center database is a pseudonymised and standardized documentation of severely injured patients. Data are collected prospectively in four consecutive time phases from the site of the accident until discharge from hospital: (A) Pre-hospital phase, (B) Emergency room and initial surgery, (C) Intensive care unit and (D) Discharge. The documentation includes detailed information on demographics, injury pattern, comorbidities, pre- and in-hospital management, course on intensive care unit, relevant laboratory findings including data on transfusion and outcome of each individual. The inclusion criterion is admission to hospital via emergency room with subsequent ICU/ICM care or reach the hospital with vital signs and die before admission to ICU. The infrastructure for documentation, data management, and data analysis is provided by AUC—Academy for Trauma Surgery (AUC—Akademie der Unfallchirurgie GmbH)—a company affiliated to the German Trauma Society. The scientific leadership is provided by the Committee on Emergency Medicine, Intensive Care and Trauma Management (Sektion NIS) of the German Trauma Society. The participating hospitals submit their data pseudonymised into a central database via a web-based application. Scientific data analysis is approved according to a peer review procedure established by Sektion NIS. The participating hospitals are primarily located in Germany (90%), but a rising number of hospitals of other countries contribute data as well (at the moment from Austria, Belgium, China, Finland, Luxembourg, Slovenia, Switzerland, The Netherlands, and the United Arab Emirates). Currently, approx. 40,000 cases from more than 600 hospitals are entered into the database per year. Participation in TraumaRegister DGU® is voluntary. For hospitals associated with TraumaNetzwerk DGU®, however, the entry of at least a basic data set is obligatory for reasons of quality assurance. For additional information and annual reports see: http://www.traumaregister-dgu.de. The registry uses the AIS 2005/ Update 2008 of the abbreviated injury scale (AIS) in the reduced version with 450 codes and an online help system for coding. Statistical analysis was conducted using SPSS (Statistical Package for the Social Sciences; version 21, IBM Inc., Armonk, NY, USA). Data are presented as percentages or as mean with standard deviation (± SD), as appropriate. For skewed data, the median is presented in addition. The Mann–Whitney U test was calculated to check for statistical significance.

The present study is in line with the publication guidelines of the TraumaRegister DGU® and registered as TR-DGU project ID 2017-033.

Inclusion criteria

- Patients from German and Dutch Level 1 TCs
- Availability of data needed for matching:
  - Age 16–80 years
  - Injury Severity Score(ISS) ≥ 16
  - Time period 2009–2015
  - Primary admission (i.e. no transfers in/no early transfer out)
  - GCS and injury mechanism (blunt/penetrating) available
- Availability of data needed for analysis
  - Mode of transportation
  - Pre-hospital interventions
  - Total pre-hospital time

Patients arriving at the TC with private/public transport were excluded from the study. Inclusion criteria were met by 15,097 German and 1632 Dutch patients (Fig. 1). German and Dutch patients were then matched into pairs according to the following criteria:

- Age group (16–54; 55–69 and ≥ 70 years)
- Gender (male/female)

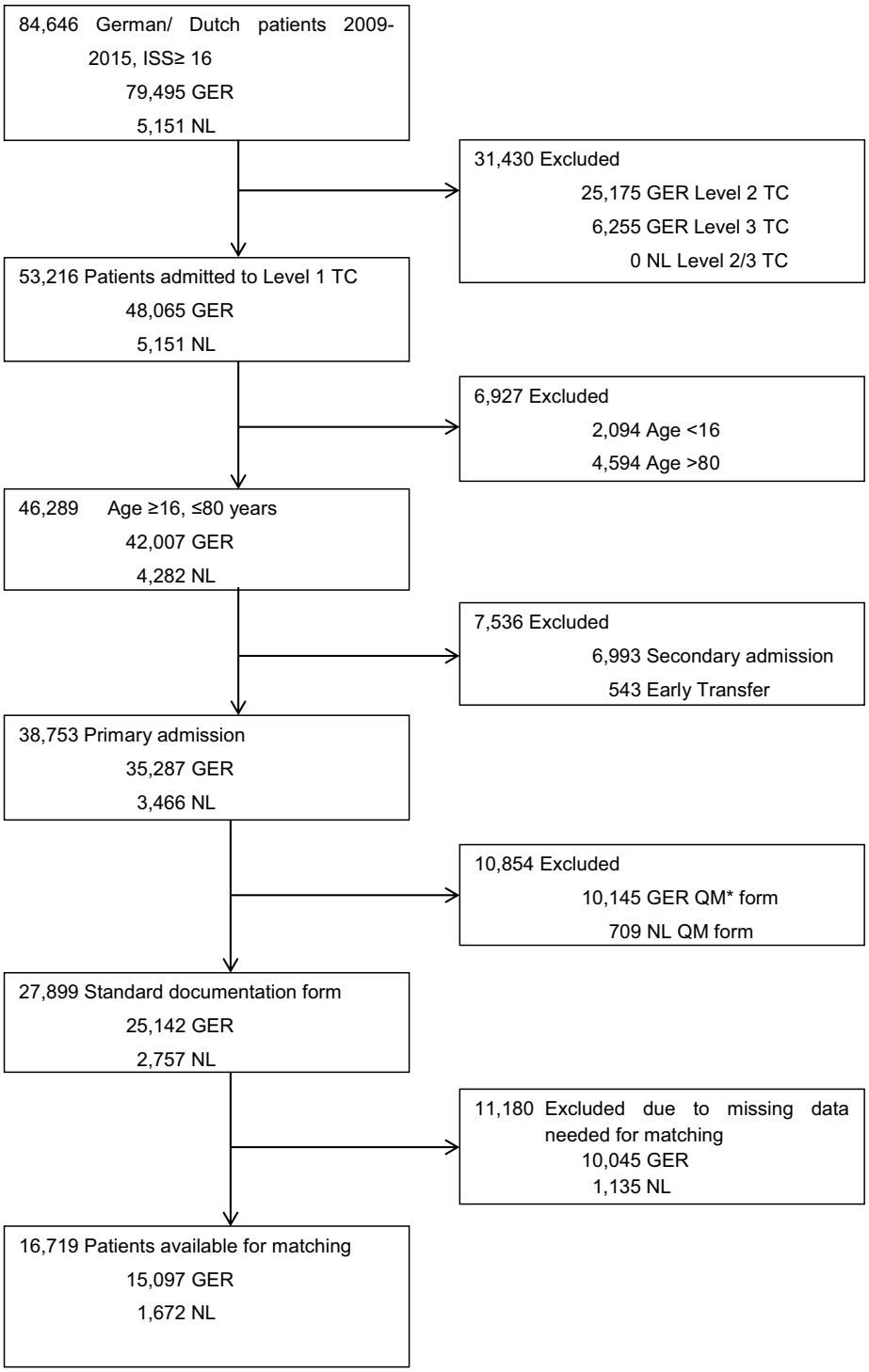

Fig. 1 Study flow diagram

- Identical most severe injury (matching AIS 3/4/5) in one of four anatomic body regions (head, thorax, abdomen, extremities)
- Identical pattern of relevant injuries (AIS ≥ 3) in four anatomic body regions (head, thorax, abdomen, extremities)
- Injury mechanism (blunt/penetrating)
- Unconsciousness (GCS ≤ 8/> 8)
- Hemodynamic instability on-scene (i.e. initial systolic blood pressure (BP) ≤ 90/> 90 mmHg)
- Traffic accident (yes/no)

- Mode of transportation: Ambulance with physician, Helicopter with physician, Ambulance with EMT

Besides the groups containing all patients, three subgroups were analyzed to the mode of transportation and whether a physician was present during transport or not.

The endpoints of this study were the pre-hospital times and interventions performed until hospital admission. Additional endpoints included early and overall hospital mortality as well as the standardized mortality ration (SMR) (observed divided by expected mortality). The expected hospital mortality was calculated using the Revised Injury Severity Classification, version II (RISC II) [5]. A 95% confidence interval (CI) was calculated for the SMR based on the respective CI of the observed mortality. For the surviving patients, the Glasgow Outcome Scale (GOS) was used to document the degree of recovery.

Results

Basic demographics

Germany and The Netherlands rely on different transportation strategies in the care for severe trauma patients. Helicopter transport was used for almost 40% of the 15,097 patients while only 2% of German patients arrived at the TC without the presence of an emergency physician (Fig. 2). Dutch patients were rarely transported by helicopter (5.6%) but by ambulance either with (52.7%) or without physician (41.7%).

We were able to form a total of 1094 pairs whereof 215 pairs were in the Ambulance/EMT subgroup, 789 pairs are in the Ambulance/Physician subgroup and 81 pairs in the Helicopter/Physician subgroup. Tables 1 and 2 display the basic demographics and vital parameters on-scene. Most of the patients sustained blunt trauma (95.7%). The mean age in both collectives was about 45 years. It is remarkable that the patients in the Ambulance/EMT subgroup had a mean age of about 50 years while the patients transported by helicopter were in their early 40 s. More than 75% of the patients were male and more than 50% of the injuries

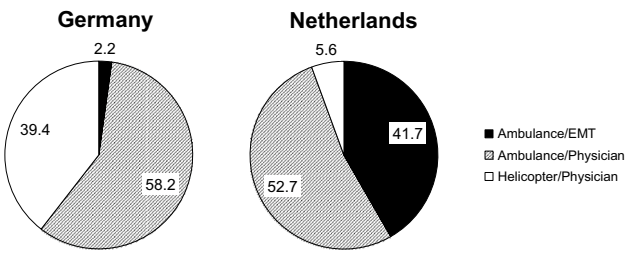

Fig. 2 Mode of transportation (numbers in percentages)

Table 1 Patient and trauma characteristics 1

	All patients	Ambulance/Physician	Helicopter/Physician	Ambulance/EMT
Number of pairs (*n*)	1094	798	81	215
Male (%)	77.2	77.7	82.7	73.5
Blunt trauma (%)	95.7	94.6	98.8	98.6
Traffic accident (%)	57.2	59.6	64.2	45.6
$AIS_{Head} \geq 3$ (%)	65.4	65.4	76.5	60.9
$AIS_{Thorax} \geq 3$ (%)	52.7	55.3	66.7	37.7
$AIS_{Abdomen} \geq 3$ (%)	12.2	13.5	16.0	6.0
$AIS_{Extremities} \geq 3$ (%)	27.6	31.7	25.9	13.0
$BP_{Sys} \leq 90$ mm Hg (%)	12.1	13.9	21.0	1.9
GCS ≤ 8 (%)	38.8	45.9	54.3	6.5

were related to traffic. Nearly 40% of the patients were recorded as being unconscious (GCS ≤ 8) on-scene. In the Helicopter physician subgroup about 75% of the patients sustained severe head injury (AIS ≥ 3).

Pre-hospital time

The mean and median pre-hospital times are shown in Fig. 3 and Table 3. Patients from the Netherlands arrived at the TC after a median time of 60 min which was about 5 min earlier in comparison with German patients. The mean pre-hospital time was 65.6 (± 29.6) min for German and 61.1 (± 28.7) for Dutch patients. This difference was statistically highly significant ($p < 0.001$). The longest pre-hospital time was found in the German Helicopter Physician subgroup (84.4 (± 26.7) min) arriving about 10 min after the Dutch Helicopter Physician subgroup (75.0 (± 33.0) min). The only mean pre-hospital time within 60 min was found in the Dutch Ambulance/EMT subgroup (56.9 (± 31.6) min).

Pre-hospital interventions

Intubation

The pre-hospital interventions are displayed in Table 4. A total of 44.1 and 50.5% of the patients were intubated during the pre-hospital phase in Germany and the Netherlands, respectively. The highest rate of intubation was found in the Dutch helicopter subgroup with 86.4% which was 7% above the respective German subgroup (79.0%). The intubation rate in the EMT subgroups was negligibly low (3.7% GER vs 1.4% NL).

Table 2 Patients and trauma characteristics 2

	GER	NL	Ambulance/Physician		Helicopter/Physician		Ambulance/EMT	
			GER	NL	GER	NL	GER	NL
Age (years) (mean) (SD)	46.5 (18.1)	45.6 (18.6)	45.4 (17.9)	44.4 (18.5)	42.5 (18.6)	42.7 (18.6)	52.5 (17.7)	50.9 (18.5)
ISS (mean) (SD)	27.7 (11.1)	27.8 (11.0)	28.9 (11.5)	29.0 (11.2)	31.8 (12.1)	32.1 (12.5)	21.7 (5.6)	21.6 (5.6)
Initial BP_{Sys} (mm Hg) (mean) (SD)	128.2 (36.9)	130.7 (36.2)	126.6 (38.5)	130.1 (38.6)	120.8 (41.4)	118.5 (33.4)	137.2 (26.5)	137.7 (25.3)
Initial HR (1/min) (mean) (SD)	89.4 (26.7)	90.2 (25.0)	90.1 (27.3)	90.4 (26.5)	94.0 (35.1)	92.7 (26.0)	85.1 (19.3)	87.8 (17.0)
Initial GCS (mean) (SD)	10.2 (5.0)	10.0 (4.7)	9.5 (5.0)	9.4 (4.7)	8.7 (5.1)	8.2 (4.9)	13.7 (2.7)	13.1 (2.8)

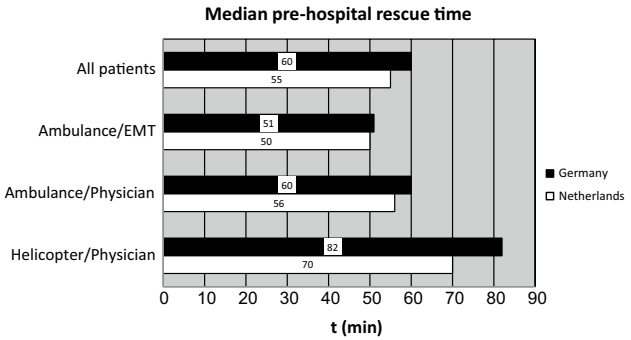

Fig. 3 Median pre-hospital rescue time

Table 3 Mean pre-hospital rescue time (numbers in minutes, SD in brackets)

	Germany	Netherlands	*P* value
All patients	65.6 (29.6)	61.4 (28.7)	< 0.001
Ambulance/Physician	65.0 (28.4)	61.2 (27.7)	< 0.005
Helicopter/Physician	84.4 (26.7)	75.0 (33.0)	< 0.016
Ambulance/EMT	60.2 (32.2)	56.9 (31.6)	< 0.15

Chest tubes

The rate of chest tubes placed in Dutch patients was more than two times higher than in the German patients (3.0% GER vs 8.3% NL). In the Ambulance/Physician subgroup 3.4% of the German patients and 9.0% of the Dutch patients received a chest tube during the pre-hospital phase. The highest rate of chest tubes was found in the subgroup transported by helicopter. In this subgroup, 22.2% of the Dutch and 6.2% of the German patients were treated with a chest tube before arriving at the TC. There was one record of a chest tube in each EMT subgroup.

Catecholamines

Catecholamines were administered to 10% of the patients during the pre-hospital phase in both countries.

Analgesia/sedation

63.5% of the German patients received analgesia/sedation which is 7.6% points below the rate of Dutch patients (71.1%). While rates of analgesia/sedation were similar

Table 4 Pre-hospital interventions (numbers in percent)

	Germany	Netherlands	Ambulance/EMT		Ambulance/Physician		Helicopter/Physician	
			GER	NL	GER	NL	GER	NL
Intubation	44.1	50.5	3.7	1.4	51.5	60.2	79.0	86.4
Volume administration	87.3	79.8	58.4	63.3	94.0	83.9	97.5	84.0
CPR[a]	4.5	4.9	0.0	0.0	5.5	6.0	6.2	7.4
Catecholamine administration	10.0	10.5	0.0	0.5	11.3	12.4	23.5	18.5
Chest tubes	3.0	8.3	0.5	0.5	3.4	9.0	6.2	22.2
Analgesia/Sedation	63.5	71.1	13.5	38.6	74.8	78.6	85.2	84.0

[a]Cardiopulmonary resuscitation

in the physician-led subgroups, there is a difference of 25% between German and Dutch patients (13.5% GER vs 38.6% NL) in the EMT subgroup.

Volume replacement

Nine out of ten patients (87.3%) transported to a German TC received volume replacement, while eight out of ten (79.8%) patients transported to a Dutch TC were documented having received volume replacement. Almost every German patient (97.5%) transported by helicopter received fluid replacement but only 84.0% of the Dutch patients flown to hospital were registered as having received volume replacement. If patients were treated with volume replacement they received a mean of 800 to 900 ml in both countries (952 ± 618 ml GER vs 856 ± 722 ml NL) (Fig. 4).

Mortality statistics/Glasgow outcome scale

During the first 24 h after admission, 8.7% of the German patients died while the total observed hospital mortality was 17.6% (Table 5). In the Dutch overall group, 10.9% died within the first 24 h and a total of 19.8% died during hospital stay. The highest hospital mortality was found in the Helicopter/Physician subgroup (19.8% GER vs 28.4% NL) and the lowest hospital mortality was in the Ambulance/Physician subgroup (6.5% GER vs 11.6% NL). RISC II score was used to calculate the expected hospital mortality [5]. The RISC II score was 17.5% for German and 20.2% for Dutch patients. The observed mortality divided by the RISC II score results in the standardized mortality ratio (SMR). The SMR was close to 1.0 in Germany and the Netherlands with an equal 95% confidence interval of 0.9–1.1. The highest SMR was 1.5 (95% CI 0.5–1.6) in the Dutch Ambulance/EMT subgroup, while it was 1.1 (95% CI 0.27–1.61) in the German equivalent. Of the surviving patients 55% of the German patients and 64% of the Dutch patients made a good

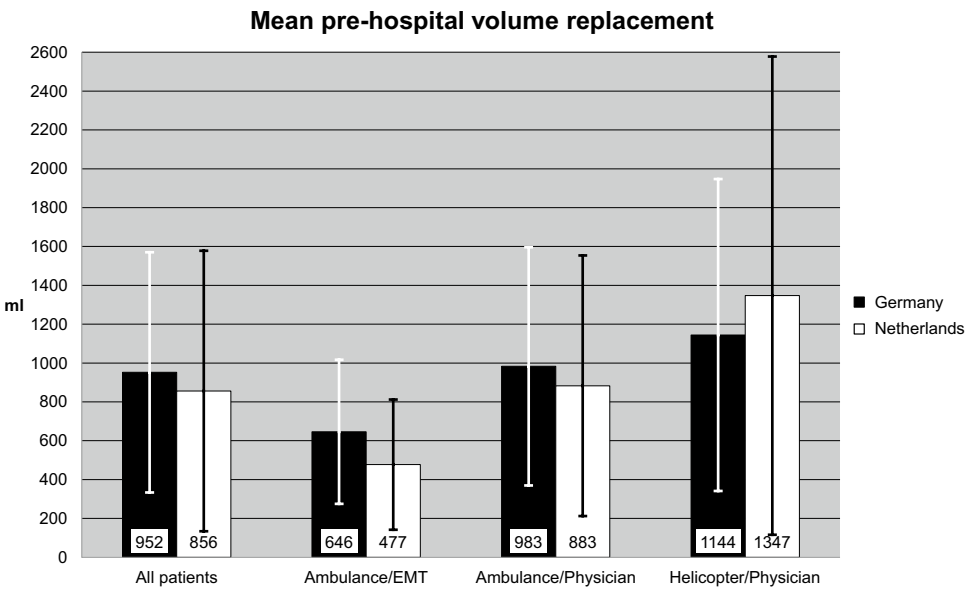

Fig. 4 Mean pre-hospital volume replacement (whiskers display 1 standard deviation per side)

Table 5 Standardized mortality ratio, RISC prognosis and observed hospital mortality

	Germany	Netherlands	Ambulance/EMT		Ambulance/Physician		Helicopter/Physician	
			GER	NL	GER	NL	GER	NL
Number of patients (*n*)	1094	1094	215	215	798	798	81	81
Number of patients who died in hospital (*n*)	192	217	14	25	162	169	16	23
Hospital mortality observed (%)	17.6	19.8	6.5	11.6	20.3	21.3	19.8	28.4
Expected RISC II prognosis (%)	17.5	20.2	6.2	7.7	20.0	22.7	22.6	27.9
SMR (observed/expected)	1.0	0.9	1.1	1.5	1.0	0.9	0.9	1.0
95% CI	[0.9–1.1]	[0.9–1.1]	[0.5–1.6]	[1.0–2.1]	[0.9–1.2]	[0.8–1.1]	[0.5–1.3]	[0.7–1.4]
Died within 24 h (%)	8.7	10.9	1.4	2.8	10.7	12.5	8.6	16.0

Table 6 Glasgow Outcome Scale of surviving patients (GOS) (numbers in percent)

	Germany	Netherlands
Persistent vegetative state	3.8	0.7
Severe disability	14.8	8.7
Moderate disability	26.2	26.6
Good recovery	55.1	64.0

recovery (Table 6). 26% of the patients in both countries survived with moderate disability. About 15% of the German and 9% of the Dutch patients recovered with severe disability. Only 0.7% of the Dutch and 4% of the German patients were recorded as "persistent vegetative state".

Discussion

Our findings demonstrate that there are a lot of similarities but also some interesting differences between Germany and the Netherlands in the pre-hospital treatment of major trauma patients with similar injury patterns. Both systems offer highly qualified physician-based on-scene care but the deployment strategy, on-scene time (OST), the rate and extent of interventions differ.

The basic demographics and on-scene vital parameters were similar to those found in other studies conducted with the TR-DGU [4, 6]. The matched patterns of injury and on-scene vital parameters balanced differences found in previous studies [4].

The mean and median pre-hospital time for both countries was about 1 h with an advantage of about 5 min for Dutch patients. This finding is supported by previous studies [4, 6]. The effect of this 5-min advantage on the patient's status is seen as negligible by the authors. As weather permits, Dutch trauma physicians are flown to the scene as part of a Mobile Medical Team (MMT) but helicopters are not seen as primary transport option for the patient due to the flat topography and easy accessibility of supra-regional TCs [7, 8]. In contrast, the helicopter is used routinely to transport trauma patients in Germany. Evidence for a pre-hospital time advantage through helicopter transport is lacking since it is often associated with a prolonged on-scene time and a longer distance to the TC when compared to patients transported by ground EMS [4, 9–11]. It has to be considered that the experience gained from the treatment of major trauma patients in Germany is distributed among HEMS and EMS physicians and not within a limited group of MMT physicians as in the Netherlands.

Pre-hospital intubation has been critically assessed recently but for patients with an insufficient respiratory pattern, hypoxia, severe TBI, hemodynamic instability and severe thorax trauma endotracheal intubation remains the key intervention of emergency medicine [12–16]. Both overall groups showed different rates for endotracheal intubation when taking into consideration the matching rates of patients with severe head injury, severe thorax trauma, hemodynamic instability (BP ≤ 90 mm Hg) or unconsciousness (GCS ≤ 8). In the Ambulance/Physician subgroup, Dutch patients were intubated at a higher rate than German patients (60.2% NL vs 51.5% GER) while the percentage of patients with a GCS ≤ 8 on-scene was equal (38.8%). A separate analysis dedicated to the intubation rate of the patients meeting intubation criteria should be conducted to gain a more detailed insight into the quality of care and guideline adherence. On closer inspection in both EMT subgroups, the rate of unconscious patients (GCS ≤ 8) on-scene was higher than the intubation rate. A possible explanation from the Dutch point of view can be the conflict between the Dutch national EMT guideline and the international guideline of the Brain Trauma Foundation (BTF) which has already been described by Franschman et al. [17–19]. Dutch EMTs are only allowed to intubate patients with a GCS = 3 without administering drugs and as a result resorted to "scoop-and-run" tactics in urban areas which may lead to a disadvantageous undertriage resulting in an increased number of secondary referrals without time gain and prolonged time until intubation [17, 19–21]. An underutilization of HEMS in the Dutch setting was also documented by Ringsburg et al. [22]. This finding gains relevance when looking at recent legislative changes in Germany where a new EMT profession was created in 2013. Studies have to critically assess whether a comparable situation arises in Germany.

There is a large difference in the rate of thorax drains placed in Germany and The Netherlands. This high rate of pre-hospital chest tubes placed in the Ambulance/Physician subgroup is particularly remarkable since the Dutch patients were treated by HEMS crews but were then transported by ambulance. HEMS physicians generally apply pre-transport thorax drainage even in non-ventilated patients more frequently than EMS physicians due to the special characteristics of air transport, the limited space inside the helicopter and the increased rate of severe thorax trauma which leads to increased experience with the intervention [4, 14, 23, 24]. In contrast to the Netherlands, German EMS/HEMS is not limited to (trauma) surgeons or anesthesiologists but also physicians from non-surgical fields with limited experience in thorax drain insertion participate [25]. The number of procedures required to qualify as German EMS physicians varies slightly due to federal state-based EMS legislation. As an example, in North Rhine-Westphalia an experience of placing only two thorax drains is required to participate in an EMS. This seems to be low respecting the complexity of the procedure and may partly explain the low rate of thorax drains in Germany. Only the tension pneumothorax

and massive hemothorax require immediate treatment but if indicated the pre-hospital thorax drainage can be performed safely and without prolonging overall trauma resuscitation time [14, 21, 23]. The method used (surgical or needle drainage) was not recorded.

The limited number of 10% of the patients receiving catecholamines in both countries demonstrated that primary care physicians in Germany and the Netherlands rarely resorted to catecholamine therapy in trauma patients as it is recommended in current German trauma guidelines [14].

The high difference in the rate of patients with analgesia/sedation may be attributed to two main factors; first, due to the high difference of 25% in the EMT subgroups. This was interpreted as a reflection of organizational and legal differences in Germany and the Netherlands. In Germany, EMTs are not allowed to provide analgesia/sedation unless a physician is present. There are no nationwide protocols or guidelines aiding German physicians or non-physician EMTs in pre-hospital pain management. This is different in the Netherlands: the Dutch nationwide EMT protocol offers a fixed algorithm for pain management and for complex cases a physician-led MMT should be activated [19, 26]. For MMTs, there is a different pain management algorithm available than for EMTs [26]. Second, the high rate of analgesia/sedation in combination with the high rate of endotracheal intubation in the Netherlands especially in the Ambulance/Physician subgroup suggests that general anesthesia is induced more frequently in the Netherlands than in Germany.

German patients who were transported under the care of a physician were more likely to receive volume replacement in comparison with their Dutch counterpart. After bilateral consultations, the prominent contrast of more than 10% difference in the physician-led subgroups seemed to be unrealistically high. This was classified as resulting from a possible registration error but further evaluation on this topic seems necessary. If volume was administered only minor differences in the extent of volume replacement were recorded. These seem to be of questionable clinical relevance.

Patients transported to a TC in the Netherlands showed a higher early (24 h) mortality rate, total hospital mortality and RISC II prognosis. The SMR was equal in both overall groups and the physician-led subgroups. It can be concluded that both systems performed equally in aforementioned groups. The SMR of 1.1 (95% CI 0.5–1.6) for German and 1.5 (95% CI 1.0–2.1) for Dutch patients in the Ambulance/EMT subgroups was not described previously but since only few patients died in the Ambulance/EMT subgroups there was a large 95% CI with a broad overlap in both countries. This overlap limits further interpretation but the finding should be revisited when more data become available. In the view of the authors, the interpretation of the GOS of the surviving patients is problematic due to a number of reasons. The recovery of the patients is influenced by a multitude of variables: the treatment on-scene, the treatment in the trauma room, the surgical procedures and the quality of care in the ICU and last the rehabilitation. The authors do not think that it is possible to link the differences in the pre-hospital treatment to the differences in the GOS without analyzing the entire process from accident to recovery which is beyond the scope of this study.

Limitations

This retrospective study was conducted using registry data contributed by the many different TCs, which resulted in limitations concerning the completeness and integrity of the submitted data. Other than in clinical trials, verification of data correctness is performed only in a small sample of cases. Some aspects (such as the time sequence of interventions, qualification of personnel, and distance to the hospital) are not part of the documented registry data and, therefore, could not be evaluated. All three participating Dutch Level 1 TCs are located in regions with different population density (one rural area, one urban area, one mixed area) but since the majority of the data came from a rural area, regional representation may be disproportionate. Although three Level 1 facilities from the Netherlands cooperate with the TR-DGU, another eight facilities are missing to provide a representative picture. To overcome these limitations in the future, it would be desirable to collect representative and regionally complete data sets (including all levels of TCs) of participating countries to enhance the comparability of national data sets to an international level. The TR-DGU only contains the kind of EMS, which admits the patient to the ER. Therefore, it is not unlikely that a number of patients in Germany were treated by a physician at the scene but were not accompanied by a doctor during the transport and, therefore, were documented in the Ambulance/EMT subgroup.

Conclusions

Multiple differences and some similarities in the treatment of major trauma patients with similar injury patterns were found in this study. The rate of pre-hospital intubation and the rate of chest tubes were higher while the pre-hospital time was shorter in the Netherlands but no clinically relevant differences in the chosen outcome parameters could be observed. The low intubation rate in the Dutch Ambulance/EMT subgroup illustrates a conflict between guidelines recommending intubation at GCS ≤ 8 and national protocols allowing EMT intubation at GCS $= 3$ without administration of drugs. Increased MMT activation guideline adherence and extended authorities for EMTs when MMTs are unavailable

could potentially improve the quality of care. The low rate of analgesia/sedation in the German EMT subgroup may indicate potential for a nationwide pre-hospital pain management guideline for physicians and non-physicians following the example of the Netherlands.

Compliance with ethical standards

Conflict of interest Alexander Timm, Marc Maegele, Klaus Wendt, Rolf Lefering and Hendrik Wyen declare that there is no conflict of interest.

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