ORIGINAL ARTICLE

A Comparison of the Treatment of Severe Injuries Between the Former East and West German States

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SUMMARY

Background: The annual number of persons killed in road-traffic accidents in Germany declined by 36% from 2001 to 2008, yet official traffic statistics still reveal a marked difference in fatalities between the federal states of the former East and West Germany twenty years after German reunification.

Methods: We retrospectively analyzed data from the Trauma Registry of the German Trauma Society (Deutsche Gesellschaft für Unfallchirurgie; TR-DGU). Patients receiving primary treatment that had an Injury Severity Score (ISS) of 9 or above were analyzed separately depending on whether they were treated in the former East Germany or the former West Germany.

Results: Data were obtained from a total of 26 866 road-accident trauma cases. With Berlin excluded, 2597 cases (10.2%) were from the former East Germany (EG), and 22 966 (89.9%) were from the former West Germany (WG). The percentage of the population living in these two parts of the country is 16.7% and 83.3%, respectively. The two groups did not differ significantly in either the mortality of injuries (EG 15.8%, WG 15.7%) or in the standardized mortality rate (0.89 [EG] vs. 0.88 [WG]). Over the years 2002–2008, the mean time to arrival of the emergency medical services on the scene was 19 minutes (EG) vs. 17 minutes (WG), and the mean time to arrival in hospital was 76 minutes (EG) vs. 69 minutes (WG).

Conclusion: Among the hospitals whose cases are included in the TR-DGU, there is no significant difference between the former East and West Germany with respect to mortality or any other clinically relevant variable. Hypothetically, the higher rate of death from road-traffic accidents in the former East Germany, as revealed by national traffic statistics, might be attributable to a difference in the quality of care received by trauma patients, but no such difference was found. Other potential reasons for it might be poorer road conditions, more initially fatal accidents, and lower accessibility of medical care in less densely populated areas.

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In 2008, around 8.27 million people were injured (not counting minor trauma) and 19 089 were killed in accidents in Germany. Road traffic accidents alone accounted for 436 368 injuries and 4949 deaths (1, 2). Inspection of the road accident statistics reveals that the states on the territory of the former East Germany have more deaths per 100 000 inhabitants than the old West German states. The city-states of Berlin, Bremen, and Hamburg form a category of their own (*Table 1*).

Not only the rates but also the absolute numbers of road traffic casualties differ markedly between the former East and West German states. While the overall number of deaths in the whole country was 1.08 per 100 casualties in 2008, the figure in the former East German states was not only higher than the total average but also exceeded the average for the former West German states. Here too, the city-states were a special case (*Table 1*).

In a survey of the treatment of multiple trauma in Germany, Kühne et al. established that while the country has sufficient hospitals with facilities for treating severely injured patients, the trauma centers are far from evenly distributed, and large areas are far from having an optimal infrastructure in this respect (3). An analysis of the road network and the bases for emergency physicians and air rescue services showed that the former East German states had the worst ratios of total area to well-developed road network and that the states of Brandenburg, Mecklenburg–West Pomerania, Thuringia and Saxony–Anhalt (all formerly in East Germany) had the largest land areas per emergency physician base. This was still true in 2008 (3).

Given these persisting verifiable differences between the former East and West German states 20 years after reunification, we set out to determine, on the basis of data from the Trauma Registry of the German Trauma Society, whether the differences in the structure of care for severely injured patients are accompanied by differences in actual preclinical and early clinical treatment that might explain the accident statistics.

Methods

The Trauma Registry of the German Trauma Society was set up in 1993 to collect prospective, anonymized,

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TABLE 1

Casualties and deaths in road traffic accidents in 2008, by federal state

Federal state	Total casualties	Deaths	Casualties	Deaths	Deaths per 100 casualties
	Number	Number	per 100 000 inhabitants	per 1 million inhabitants	
			Number		
Baden-Württemberg	49 656	551	462	51	1.11
Bavaria	71 898	788	574	63	1.10
Berlin	17 685	55	518	16	0.31
Brandenburg	10 891	222	430	88	2.04
Bremen	3775	12	569	18	0.32
Hamburg	10 725	40	606	23	0.37
Hesse	30 406	318	501	52	1.05
Mecklenburg–West Pomerania	8332	132	496	79	1.58
Lower Saxony	44 612	595	560	75	1.33
North Rhine–Westphalia	80 842	694	449	39	0.86
Rheinland-Palatinate	21 081	227	521	56	1.08
Saarland	5995	43	578	41	0.72
Saxony	19 048	243	451	58	1.28
Saxony-Anhalt	12 302	223	510	92	1.81
Schleswig-Holstein	15 853	149	559	53	0.94
Thuringia	10 423	185	455	81	1.77
Total	413 524	4477	503	54	1.08

Populations as of 31 December 2007

Source: Road accident trends in Germany (Unfallentwicklung auf deutschen Straßen), Federal Statistical Office 2009

and standardized data on severely injured patients from many different centers. Participation in the Trauma Registry is voluntary. Besides basic personal information, data on the patients' preclinical and early clinical treatment and hospital stay are recorded and entered via a web-based form. The aim is comprehensive documentation of the management of severe injuries. The database is maintained at the Institute for Research in Operative Medicine (IFOM) in Cologne. A list of the hospitals that contribute data is available at the website of the Trauma Registry (www.traumaregister.de).

The data were evaluated using the statistical software package PASW Statistics 18. Constant variables were compared by means of the Mann–Whitney U-test, categorical variables with the chi-square test. A p-value below 5% ($p < 0.05$) was defined as statistically significant; given the large numbers of cases, the clinical importance of statistically significant differences has to be considered. Because of the explorative nature of the study, significant p-values should not be interpreted as proof of differences.

Exclusively data from German hospitals were used for this study, because its aim was to compare data from the states of the former East Germany with those of the former West Germany. Berlin was not included. Also excluded were patients transferred from other hospitals

and those with an Injury Severity Score (ISS) < 9 . The ISS grades the overall severity of injury from an anatomical viewpoint and is based on the Abbreviated Injury Scale (AIS) (4, 5). For the AIS each individual injury is scored on a scale of 1 (minor) to 6 (maximal). The ISS is calculated using the highest AIS scores from six regions of the body (head and neck, face, chest, abdomen, pelvis/extremities, skin). The scores of the three most severely injured body regions are squared and added together to produce the ISS score, ranging from 0 to 75. If any single injury is graded 6 on the AIS, the ISS is automatically assigned as 75.

In addition to observed mortality, a second outcome parameter was prognosis-related mortality. The prognosis was based on the Revised Injury Severity Classification (RISC), developed and calculated using data from the Trauma Registry (6). The observed mortality and the RISC prognosis were compared by means of the standardized mortality rate (SMR). The SMR is derived by dividing observed mortality by predicted mortality. Scores less than 1 indicate a favorable, scores greater than 1 an unfavorable outcome. SMR values were expressed as 95% confidence intervals and compared using the t-test.

To reveal any changes in the treatment of severe injuries in the course of time, the period 1993 to 2001

was compared with the period 2002 to 2008 in a subgroup analysis of selected parameters. Corresponding 95% confidence intervals are given below.

Results

Between 1993 and 2008, data on a total of 42 248 patients were documented in the Trauma Registry, of whom 31 858 received their primary treatment in German hospitals; 25 563 of these patients had an ISS ≥ 9 .

Comparison of the geographical distribution of the Trauma Registry data with the populations of the individual German states shows only small differences among them with regard to proportion of total accidents in relation to population. Bavaria and Lower Saxony accounted for higher proportions of accidents recorded in the Trauma Registry, North Rhine–Westphalia and Brandenburg for lower proportions. The proportion of former Trauma Registry data sets contributed by the former West German states was 6.5% higher than their proportion of the total population (*Table 2*).

Basic data

The basic data comprise age, sex, type of trauma (blunt, penetrating), cause of accident, and severity of injury (*Table 3*). The sex distribution is almost identical in the former East German and former West German states. Patients in the former East German states are on average younger (40.6 versus 42.4 years), more often involved in traffic accidents (72.0% versus 60.8%), and more severely injured (ISS 28.4 versus 25.6).

Analysis of the causes of accidents shows that accidents involving automobiles are more frequent in the former East German states, while accidents involving two-wheeled vehicles, pedestrian accidents, and falls from height occur with similar frequency in the two groups of states (*Table 4*). The proportion of suicide attempts is somewhat higher in the former West German (5.7%) than in the former East German states (4.6%).

Preclinical phase

The data recorded for the preclinical phase of treatment include time to arrival of the emergency physician at the accident site, time to arrival of the patient at the hospital, type of transport (road or air), vital parameters, and treatment measures carried out by the emergency physician (*Table 3*).

The initial Glasgow Coma Scale (GCS) score of the patients at the accident site is almost identical in the former East German and West German states, differing by only 0.1. The same is true for the patients' systolic blood pressure. While the time from accident to arrival of the emergency physician and the number of preclinical treatment measures carried out by the emergency physician (thoracic drainage, intubation, etc.) differ only slightly—albeit statistically significantly—the time from accident to hospital admission is 7 minutes longer in the former East German states. The proportion of patients transported by air is virtually identical (41.0% versus 41.1%).

TABLE 2

Distribution of injuries documented in the Trauma Registry of the German Trauma Society, compared with the populations of the federal states

Federal State	Trauma Registry		Population	
	Number of cases	Cases %	Inhabitants (thousands)	Inhabitants (% of total)
Baden-Württemberg	3451	12.8%	10 750	13.1%
Bavaria	5013	18.7%	12 520	15.2%
Berlin	1303	4.8%	3416	4.2%
Brandenburg	227	0.8%	2536	3.1%
Bremen	308	1.1%	663	0.8%
Hamburg	896	3.3%	1771	2.2%
Hesse	2407	9.0%	6073	7.4%
Mecklenburg–West Pomerania	103	0.4%	1680	2.0%
Lower Saxony	3278	12.2%	7972	9.7%
North Rhine–Westphalia	5060	18.8%	17 997	21.9%
Rheinland-Palatinate	1600	6.0%	4046	4.9%
Saarland	490	1.8%	1037	1.3%
Saxony	957	3.6%	4220	5.1%
Saxony-Anhalt	779	2.9%	2412	2.9%
Schleswig-Holstein	463	1.7%	2837	3.5%
Thuringia	531	2.0%	2289	2.8%
Total	26 866	100.0%	82 219	100.0%
Former East German states*	2597	10.2%	13 137	16.7%
Former West German states*	22 966	89.8%	65 666	83.3%

* without Berlin

Hospital treatment

The investigated parameters of hospital treatment were duration of shock-room treatment, rate of computed tomography (CT) scanning, and durations of ventilation, intensive care, and hospital stay.

The average duration of shock-room treatment was 7 minutes lower in the former East German than in the former West German states (65 minutes versus 72 minutes). Moreover, in the former East German states a higher proportion of patients had diagnostic CT (86.5% versus 80.4%) and patients received more blood products; the ratio of fresh frozen plasma (FFP) to packed red blood cells (pRBC) was similar in the two groups of states. The durations of ventilation, intensive care, and hospital stay differed only slightly (*Table 3*).

Mortality

The mortality is almost identical in the former East and West German states, at 15.8% and 15.7% respectively (*Table 3*). *Table 5* shows the observed mortality, RISC prognosis, and standardized mortality rate (SMR) for the two groups. The SMR is somewhat higher in the

TABLE 3

Demographics and treatment data: comparison of former East German and former West German states

		Former East German states (n = 2597)	Former West German states (n = 22 966)	p-value
Treatment level	Supraregional TC	82.8% (2151)	86.5% (19 870)	<0.001
	Regional TC	15.7% (407)	11.2 (2582)	
	Local TC	1.5% (39)	2.2 (514)	
Demographics	Male	72.8% (1891)	72.6% (16 643)	0.80
	Age (years)	40.6 (19.7) [38]	42.4 (20.7) [40]	<0.001
Trauma	Blunt	96.1% (2494)	94.8% (21 712)	0.004
	Traffic accidents	72.0% (1871)	60.8% (13 961)	<0.001
	Suicide attempts	4.4% (115)	5.7% (1292)	0.009
	Injury Severity Score (ISS)	28.4 (14.0) [26]	25.6 (14.0) [24]	<0.001
Preclinical phase	Glasgow Coma Scale (GCS)	10.9 (4.7) [13]	11.0 (4.7) [14]	0.048
	SBP	118 (34) [120]	118 (34) [120]	0.94
	Air transport	41.1% (1014)	41.0% (8831)	0.90
	Time from accident to hospital admission (min)	76 (35) [70]	69 (35) [62]	<0.001
	Time from accident to arrival of emergency physician (min)	19 (13) [15]	17 (13) [15]	<0.001
	Number of measures	2.5 (1.1) [3]	2.4 (1.1) [3]	<0.001
	Packed red blood cells (pRBC)	2.5 (5.4) [0]	2.3 (6.1) [0]	<0.001
Clinical phase	Fresh frozen plasma (FFP)	1.1 (3.7) [0]	1.0 (4.0) [0]	<0.001
	Minutes in shock room	65 (40) [55]	72 (43) [61]	<0.001
	Computed tomography	86.5% (2246)	80.4% (18 468)	<0.001
	Hospital stay (days)	25.0 (21.7) [21]	25.3 (28.1) [18]	<0.001
	ICU stay (days)	11.1 (13.6) [6]	10.3 (14.0) [5]	<0.001
	Days of intubation	6.6 (10.8) [2]	6.6 (11.3) [2]	0.78
Outcome	Mortality	15.8% (411)	15.7% (3604)	0.86

For categorical variables the percentage and the number of cases (in parentheses) are given, for constant variables the mean, median (in square brackets), and standard deviation (in parentheses) are given. TC, trauma center; blunt, blunt mechanism of injury; SBP, patient's systolic blood pressure at site of accident; ICU, intensive care unit

former East German than in the former West German states (0.89 versus 0.88). The difference is not statistically significant ($p = 0.89$).

Subgroup analysis

In the period from 1993 to 2001, a total of 6531 cases were documented in the former West German states and

507 cases in the former East German states (Table 6). From 2002 to 2008, the corresponding figures were 16 435 in the former West German and 2090 in the former East German states. The patients' mean age rose by 4 (± 0.6) years from 39.3 to 43.3 years. The proportion of total traffic accidents decreased by 5.5% (± 1.3) overall, by 9% (± 4.0) in the former East German states,

and by 5.7% (± 1.4) in the former West German states. This was also true for the number of automobile accidents, which fell much more sharply in the former East German states ($13.1\% \pm 4.8$) but was still higher than in the former West German states. The proportion of patients undergoing CT increased in the second period (2002 to 2008) and was higher in the former East German than in the former West German states (92.3% versus 86.5%). The times from accident to arrival of emergency physician and from accident to hospital admission increased in the former West German states (by 1.2 ± 0.5 minutes and 1.7 ± 1.1 minutes respectively) and decreased in the former East German states (by 0.2 ± 1.5 minutes and 2.7 ± 3.7 minutes respectively). Despite this development, these times were still longer in the former East German states in the second period (by 1.2 ± 0.7 minutes for time from accident to arrival of emergency physician and 6.5 ± 1.7 minutes for time from accident to hospital admission).

Discussion

First of all, it is very positive that the relative proportions of documented cases in the individual states are similar to the proportions of the total German population resident in the states (Table 2). The composition of the patient collective does not differ greatly between the former East and West German states, and—in common with other studies and other registries of severe injury—middle-aged men predominate (7).

The present study shows that the preclinical phase of treatment is on average 7 minutes longer in the former East German states. One explanation could be the lower density of hospitals, which may mean that emergency physicians tend to carry out a higher number of invasive measures to ensure safe transport. It seems beyond doubt that the preclinical emergency treatment phase influences the survival of the severely injured (8–10). Liberman et al. showed that patients treated according to the principles of basic life support (BLS) have a survival advantage over those treated with advanced life support (ALS) (11). Sampalis et al. confirmed that a shorter preclinical phase correlates significantly with survival (12). Together with many other factors, the number and type of preclinical treatment measures affect the duration of this phase. There is no relevant difference in this respect between the former East and West German states. A study of various emergency medical systems confirmed the connection between the type of emergency rescue vehicle, its manning, the treatment standard (BLS or ALS), and the duration of the preclinical phase, and a more detailed analysis showed that patients whose preclinical treatment involved an emergency physician had lower mortality despite the greater investment of time (13, 14).

Transport by helicopter, equally frequent in the former East and West German states, can also lead to a longer preclinical phase, for example because more different treatment measures are carried out (15). A study in Great Britain demonstrated that helicopter transfer

TABLE 4

Causes of accidents*

Cause		Former East German states	Former West German states	Total	p-value
Road accident	Automobile	44.7% (1160)	31.6% (7250)	32.9% (8410)	<0.001
	Two-wheeled vehicle	20.0% (520)	21.0% (4819)	20.9% (5339)	0.25
	Pedestrian	7.4% (191)	8.2% (1892)	8.1% (2083)	0.12
Fall from height >3 m		14.6% (380)	16.0% (3670)	15.8% (4050)	0.075
Other		13.3% (346)	23.2% (5335)	22.2% (5681)	<0.001
Total		100% (2597)	100% (22 966)	100% (25 563)	

* Proportions and absolute numbers (in parentheses)

was associated with lower mortality than transport by road—accompanied by paramedics—only in extremely severely injured patients (16). Other studies show no advantage for patients transported by helicopter, at least not in urban areas (17–20). According to a literature review published in 2003, probably only a small, ill-defined subgroup of patients benefit from helicopter transfer to hospital (21). These are very likely the patients with particularly severe injuries (15, 16).

Time certainly also plays a role in shock-room treatment. Thus the time that elapses before the first emergency intervention correlates with mortality, as does low systolic blood pressure (22). In the case of severe abdominal injury, for example, the patient's likelihood of dying increases by 1% every 3 minutes before laparotomy (23). In contrast to the preclinical phase, the duration of shock-room treatment is on average 7 minutes less in the former East German states.

Various authors have stated their opinion that whole-body CT, in comparison with the standard diagnostic work-up, can decisively shorten the patient's stay in the shock room and provide a better chance of survival (24–28). CT is used much more frequently in the former East German than in the former West German states (86.5% versus 80.4%). With regard to processing times, Wutzler et al. identified particular room for improvement after completion of the diagnostic work-up (29).

Policies regarding administration of fluids and of blood products such as pRBC and FFP vary greatly among German hospitals. The recently published interdisciplinary S3 guideline (30, 31) recommends a pRBC:FFP ratio in the range of 2:1 to 1:1. A study by Maegle et al. revealed that mortality decreased with an

TABLE 5

Mortality, RISC prognosis, and SMR in patients with sufficient data for calculation of the RISC prognosis*

	Number of cases with RISC prognosis	Deaths	RISC prognosis	SMR	95% confidence interval
Former East German states	2452	15.5% (n = 379)	17.4%	0.89	0.81–0.97
Former West German states	21 027	15.6% (n = 3 284)	17.7%	0.88	0.86–0.91
Total	23 479	15.6% (n = 3 663)	17.7%	0.88	0.86–0.91

*The difference between the former East German and former West German states is not statistically significant ($p = 0.89$).
RISC, Revised Injury Severity Classification; SMR, standardized mortality rate

TABLE 6

Subgroup analysis of cases in the periods 1993–2001 and 2002–2008

	Former East German states		Former West German states		Total	
	1993–2001 (n = 507)	2002–2008 (n = 2090)	1993–2001 (n = 6531)	2002–2008 (n = 16 435)	1993–2001 (n = 7038)	2002–2008 (n = 18 525)
Traffic accidents	79.3% (402)	70.3% (1469)	64.9% (4239)	59.2% (9722)	65.9% (4641)	60.4% (11 191)
Automobile accidents	55.2% (280)	42.1% (880)	36.9% (2412)	29.4% (4838)	38.2% (2692)	30.9% (5718)
Computed tomography	62.5% (317)	92.3% (1929)	65.1% (4250)	86.5% (14 218)	64.9% (4567)	87.2% (16 147)
Time from accident to arrival of emergency physician (min)	19.0 (12.3)	18.8 (13.1)	16.4 (12.3)	17.6 (12.7)	16.6 (12.3)	17.8 (12.7)
Time from accident to hospital admission (min)	78.2 (34.3)	75.5 (35.4)	67.3 (31.7)	69.0 (35.9)	68.1 (32.0)	69.8 (35.9)
Age (years)	35.2 (18.1)	41.9 (19.8)	39.6 (19.7)	43.5 (21.0)	39.3 (19.6)	43.3 (20.9)

For categorical variables the percentage and the number of cases (in parentheses) are given, for constant variables the mean and standard deviation (in parentheses)

increasing proportion of FFP in relationship to pRBC (32). The figures in the present study show that the ratio of pRBC to FFP is almost the same in the former East and West German states and that slightly more blood products are administered in the former East German states.

The intensive care treatment of a severely injured patient is a complex topic that obviously extends far beyond the parameters discussed here such as ventilation time and duration of treatment in the intensive care unit (33, 34). However, one can see that these key aspects of intensive therapy do not differ to any relevant extent between the former East and West German states.

There is also no crucial difference in mortality between the two groups of states. Because the Trauma Registry documentation ends with hospital discharge, no statement can be made regarding long-term survival.

Limitations

The fact that contribution of data to the Trauma Registry of the German Trauma Society is voluntary may imply selection of hospitals with a special interest in the treatment of the severely injured. Strictly speaking, therefore, the findings reported here should not be viewed as epidemiological results. Moreover, the considerable effort that was until recently involved in documentation of each case may have discouraged some institutions, in particular smaller hospitals, from taking part.

A further limitation may be that the documented data go all the way back to 1993, since when there have been considerable developments in the preclinical and clinical management of severely injured patients. The decision to include all data collected since the establishment of the Trauma Registry was taken so as to include as many cases as possible, and even after

structural improvement of the hospitals in the states of the former East Germany there are clear differences in the traffic accident statistics.

Summary

The data presented here show no relevant difference between the states of the former West Germany and those of the former East Germany; therefore, the East–West gradient implied in the traffic statistics is not confirmed by the Trauma Registry data. There are various possible reasons for this. On the one hand not all hospitals contribute data to the Trauma Registry, and on the other hand the Trauma Registry documents only those patients who reach hospital alive. Thus the higher rate of deaths in the official statistics for the former East German states may be attributable to poorer infrastructure (hospital density, road network) or to more deaths before transfer to hospital can be accomplished. It seems improbable that the cause lies in the quality of emergency services, because the patients who reach hospital have received comparable preclinical treatment and have the same prognosis.

Altogether, treatment of the severely injured is comparably good in the former East German and the former West German states, with a minimally better SMR in the latter. There are statistically significant differences in some individual parameters, but no relevant differences in the overall quality of care. Whether this re-

flects the true situation in Germany, however, will be revealed by epidemiological data from the Trauma Registry in the near future.

Conflict of interest statement

Dr. Mand has received reimbursement of travel costs from AUC GmbH (responsible for the Trauma Registry).

Prof. Lefering has received reimbursement of travel costs from AUC GmbH (responsible for the Trauma Registry).

Prof. Ruchholtz is spokesman for the Trauma Network of the German Trauma Society (AKUT) and has received from this body fees for consultancy, reimbursement of travel costs, and study support (third-party funding).

Prof. Kühne has received reimbursement of travel costs and of expenses arising from his work in the office of the Trauma Network of the German Trauma Society (AKUT) from AUC GmbH (responsible for the Trauma Registry).

Dr. Müller declares that no conflict of interest exists.

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KEY MESSAGES

- Despite the constant decrease in road deaths, there is still a clear difference in mortality between the former East German and the former West German states 20 years after reunification.
- Automobile accidents predominate in the former East German states. The rates of accidents involving two-wheeled vehicles, pedestrian accidents, and falls from height are similar. The proportion of suicide attempts is somewhat higher in the former West German than in the former East German states.
- In the former East German states the time from accident to arrival of emergency physician is 2 minutes longer and the time from accident to hospital admission is 7 minutes longer. The number of different measures carried out by the emergency physician shows no essential difference between the two groups of states, and air rescue is equally frequent.
- Shock-room treatment takes 6 minutes longer in the former West German states than in the former East German states, where the diagnostic work-up more frequently includes CT. The durations of ventilation, intensive care, and hospital stay show no essential difference.
- Both mortality and predicted mortality are comparable between the former East German and the former West German states. The ratio of predicted to actual mortality is also almost identical.

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