Committee on Emergency Medicine, Intensive Care and Trauma Management of the German Trauma Society (DGU)

AUC - Academy for Trauma Surgery

Annual Report 2020

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TraumaRegister DGU®

General Annual Report

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Annual Report 2020 - TraumaRegister DGU®

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Any publication or other publicistic use of data from TraumaRegister DGU® requires the prior approval by the Committee on Emergency Medicine, Intensive Care and Trauma Management (Sektion NIS) of the German Trauma Society (DGU) - working group TraumaRegister via an application to the AUC (e-mail: support-tr@auc-online.de).

Publication of data from the own hospital are excluded from approval. Data from this annual report can also be used without further notification, but with reference to the data origin.

For scientific publications with data from TraumaRegister DGU®, the publication guideline of TraumaRegister DGU® is valid. The current version of the guideline is available on the homepage www.traumaregister-dgu.de. **TraumaRegister DGU®** is a protected term.

Content

Preface

Dear readers,

we are pleased to send you the general **2020 annual report** of the TraumaRegister DGU®.

This issue includes – as usual – the data analysis for the seriously injured in 2019 (basic group), which were documented by the participating hospitals until the end of May 2020. This basic group, in the sense of the TraumaRegister DGU® definition of a seriously injured person, counted 29,345 cases in 2019. Compared to last year, a 12 % decrease in this cohort was observed. The lack of familiarity with the General Data Protection Regulation (GDPR) operating from May 2018 is assumed to be the main reason for this decrease. Because of the extensive obligation to inform, it is sometimes difficult to obtain a patient's consent. In response to this problem, the board of the German Trauma Society in cooperation with the AUC – Academy of Trauma Surgery is working for a political solution. Additionally, the feasibility of organisational approaches within the TNW to defuse the complicated consent situation for transferred patients is discussed in the appropriate committees of the German Trauma Society.

The documentation of a total of 36,699 patients also includes patients with less severe injuries (e.g. simple concussion). Thus, about 20 % of the cases entered in the registry are not included in either the scientific analysis or the annual report for reasons of better comparability. Here, a certain relief can surely be achieved within the hospitals regarding the documentation effort. The AUC – Academy for Trauma Surgery provides information and advice on how to optimise the input effort.

At the end of 2019, a total of 665 hospitals have participated in the TraumaRegister DGU®. In addition to the 608 hospitals from Germany, there are hospitals from eight other countries participating in the registry. Of these, 22 hospitals come from Austria, 14 from Belgium and 11 from Switzerland.

What is new in the 2020 annual report?

In response to the increasing number of patients with a volition, these were excluded from the analysis in chapter 2 and 6.2 if they died within the first week. This was done to give a correct presentation of the treatment quality in a hospital. These analysis focus on a direct comparison of the observed mortality with their prognosis. Furthermore, this special cohort is examined in more detail in chapter 11.2.

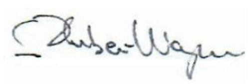
In chapter 13, data from the work of the review board in 2019 are presented. Also, in this year we would like to thank the reviewers – for the first time by name – for their great engagement. Their work contributes substantially to the quality and thus to the reputation of the publications from the TraumaRegister DGU®.

We very much hope that the general annual report – in terms of healthcare research - will provide findings that can help to further improve the treatment of seriously injured patients.

Yours sincerely,


Dan Bieler


Christine Höfer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1 Number of cases

Admission via the emergency room and need for intensive care are the official inclusion criteria for documenting a patient in the TraumaRegister DGU® (TR-DGU). Patients who died before ICU admission should also be included. This pragmatic criterion was chosen to avoid complicated score calculations in the emergency room and to limit the documentation to patients with relevant injuries.

However, the number of patients with only minor injuries continuously increased in recent years. On the one hand, this means a higher workload, but more important it diminishes also the comparability of findings, both between hospitals and over time. Therefore, a **basic group** has been defined in 2015 and nearly all analyses presented in this report refer to this patient group only (and not to all documented patients).

The severity of an injury is determined by the Abbreviated Injury Scale (**AIS**) which indicates a severity grade from 1 (minor) to 6 (maximal) points to each injury. Using these severity grades, more sophisticated measures like the maximum AIS (**MAIS**), the Injury Severity Score (**ISS**) or the New ISS (**NISS**) could be derived.The **basic group** of the TR-DGU is defined as:

All patients with MAIS ≥ 3 are included as well as MAIS 2 patients who have died or were treated on the intensive care unit.

The following flowchart gives an overview of the composition of the basic group.

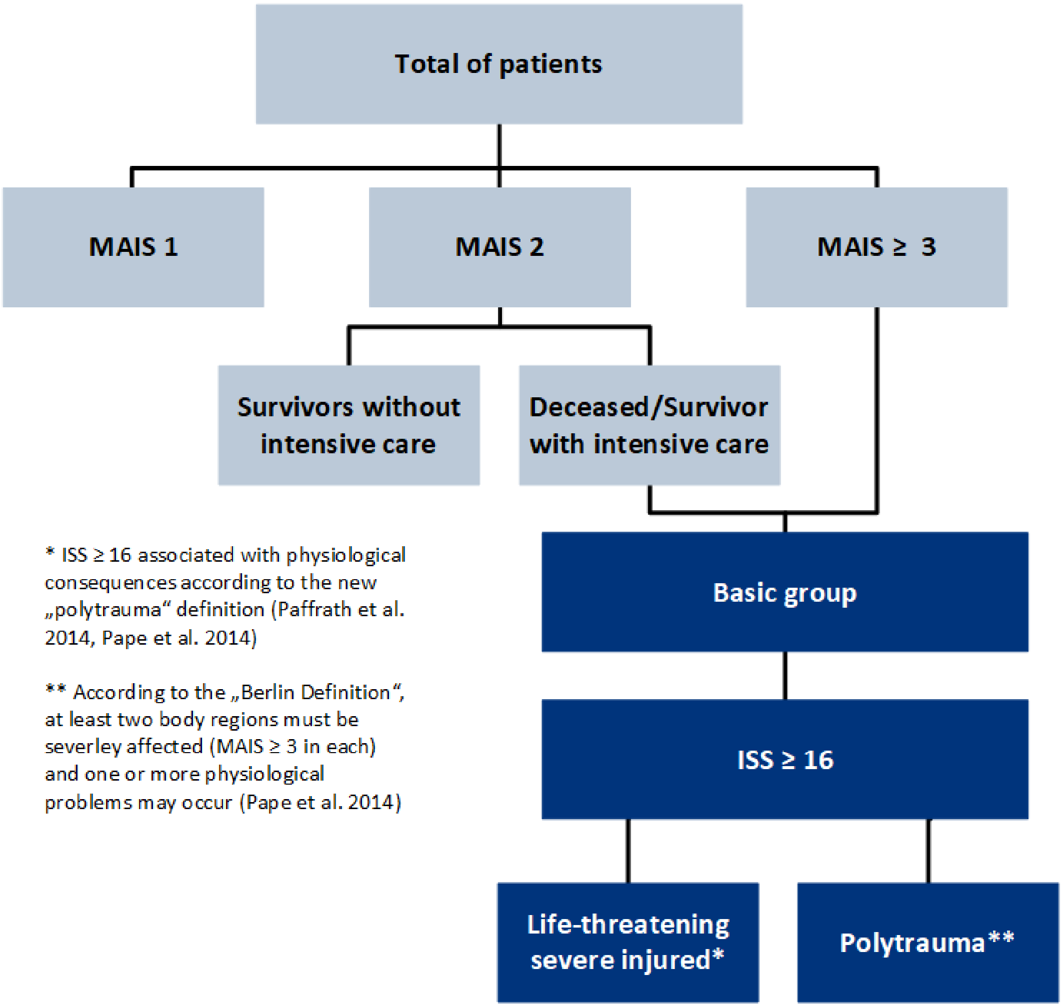


Figure 1: Flowchart to the composition of the basic group

The following table shows the data of groups as defined in figure 1. The table is broken down by the MAIS criteria as well as the basic group and selected subgroups.

Table 1: Number of cases in 2019 from the TR-DGU

	TR-DGU 2019	Primary admitted	Transfer in	Early transfer out
Total number Of documented patients.	**36,699**	31,448	2,862	2,389
MAIS 1 The most severe injury of these patients was of AIS grade 1 (MAIS = 1). Thus, they were not severely injured. Furthermore, the RISC II prognostic score has not been validated for these cases and they were excluded from further analysis (except chapter 5.3).	**4,688** (13 %)	4,507	58	123
MAIS 2 survivors without intensive care The worst injury was of AIS grade 2. All patients survived and did not receive any intensive care.	**2,584** (7 %)	4,949	251	191
MAIS 2 deceased or survivors with intensive care The worst injury was of AIS grade 2. The patients are dead or survived with intensive care.	**5,506** (15 %)	23,951	2,499	954
MAIS ≥ 3 The worst injury was of AIS grade 3 or more (MAIS 3+) which recently was defined as a „*serious injury*” by the EU when looking for an internationally agreed definition for road traffic research.	**23,839** (65 %)	19,606	2,490	1,743
Non-basic group Patients with MAIS 1 as well as patients with MAIS 2 that survived without intensive care.	**7,354** (20 %)	6,786	113	455
Up to here all absolute numbers and percentages refer to the basic group				
Basic group This definition includes all MAIS ≥ 3 patients and MAIS 2 patients who died or were treated on the intensive care unit with valid age data.	**29,345**	**24,662**	**2,749**	**1,934**
Intensive care Patients who required intensive care due to their injuries (admission to ICU).	**25,273** (86 %)	21,919	2,455	899
Deceased Patients who died in the acute care hospital.	**3,260** (11 %)	2,942	318	0
ISS 16+ The definition ISS ≥ 16 (or > 15) is used in many scientific papers to define a serious injury.	**15,651** (53 %)	12,568	1,870	1,213
Life-threatening severe injury Injury severity of ISS ≥ 16 in conjunction with phys. effects according to the new „polytrauma” definition (Paffrath et al. 2014, Pape et al. 2014).	**8,971** (31 %)	7,433	909	629
Polytrauma According to the „Berlin Definition”, two body regions need to be severly affected and one or more phys. problems are present (Pape et al. 2014).	**4,221** (14 %)	3,639	339	243

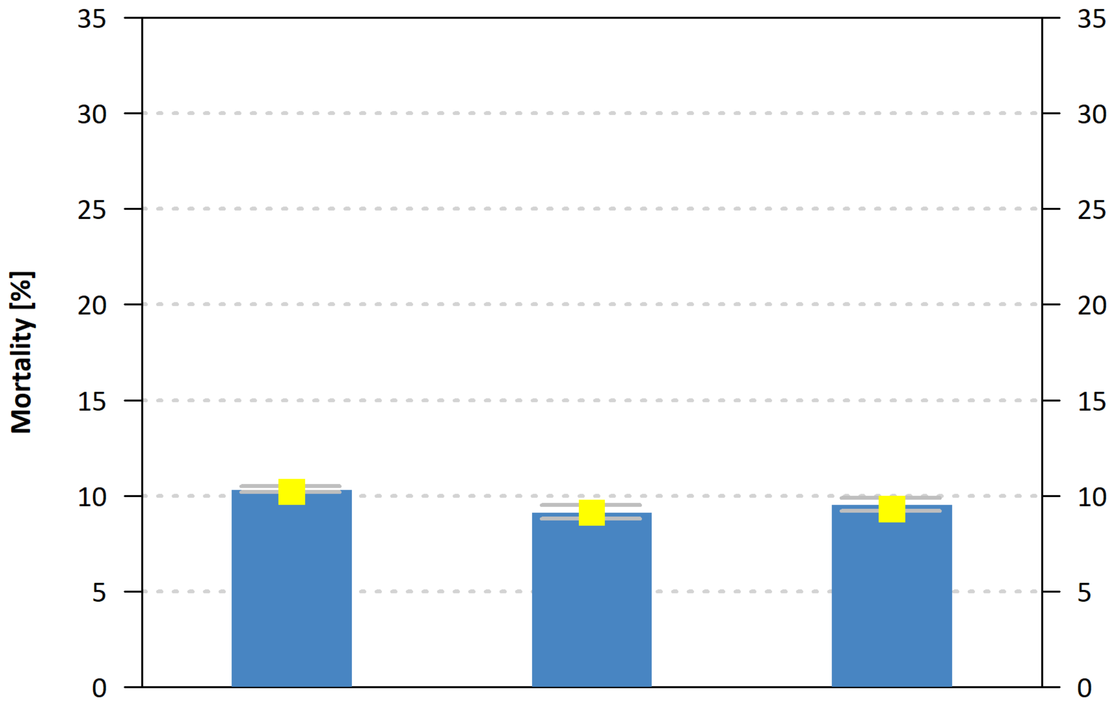
2 Observed mortality and prognosis

Comparing the observed **mortality** of severely injured trauma patients with their **prognosis** is a central element of quality assessment in the TraumaRegister DGU®. Here, the risk of death prognosis is derived from the **RISC II** prognostic score (Revised Injury Severity Classification; Lefering et al. 2014). This score can be calculated for all primary admitted patients. The analysis in chapter 2 is confined to the **basic group** as defined on page 5.

No. of patients of TR-DGU (basic group) documented in the last 10 years (2010-2019)	n = **288,929**
- among them, documented last year (2019)	n = **29,345**
- among them, primary admitted cases (no transfer in; no early transfer out; no patients deceased within the first week with a patient's volition)	n = **24,012**

Comparisons of mortality and risk of death prognosis will be performed for **primary admitted patients** only (Figure 2). For patients **transferred in** from another hospital (n = 2,749 in 2019), the initial status from primary admission is missing; for patients **transferred out early** (within 48 hours after admission; n = 1,934 in 2019), no final outcome is documented. Additionally, patients deceased within the first week with a patient's volition (n = 650 in 2019) are excluded from this analysis to ensure a correct presentation of the quality of treatment in a hospital.

The mean age of the remaining 24,012 patients is 52.6 years and 69 % are males. The mean ISS was 17.6 points. Of these patients 2,292 died in hospital, which is **9.5 %** (95 % CI: 9.2 - 9.9). The risk of death prognosis based on RISC II is **9.3 %**. You find these values for the TR-DGU in figure 2.



	TR-DGU 10 years	TR-DGU 2018	TR-DGU 2019
No. of pat. (n):	240,089	27,549	24,012
Mortality [%]:	10.3	9.1	9.5
RISC II [%]:	10.2	9.1	9.3

Figure 2: Observed mortality and risk of death prognosis (RISC II)

Legend to the figure:

The bars represent the observed mortality rate; percentages are given at the bottom of each bar. The predicted mortality rate based on RISC II is given as a yellow vertical **bar**. This bar turns to green or red in case that the observed mortality is significantly lower (= better) or higher (= worse) than expected, respectively. For the interpretation of the results, it should be considered that these findings depend on statistical uncertainty. Therefore, the 95 % confidence interval (CI) for the observed mortality rate is given as well (vertical line). The 95 %-CI describes a range of values which covers the „true" value with a high probability (95 %). The more patients a value is based on, the narrower the CI. If the observed mortality rate is based on less than 5 cases, the large CI will not be presented.

Data quality for the risk of death prognosis

The validity of a prognosis depends on the quality and the completeness of the variables required for its calculation. In the TR-DGU two different documentation types are used, the standard and the QM dataset. The standard dataset includes all parameters that are recorded by the registry. The QM dataset is a reduced version of the standard dataset. The risk of death prognosis **RISC II score**, developed for the TraumaRegister DGU®, is based on 13 different variables. Since the revision of the dataset in 2015, all 13 required informations are recorded by both datasets. The only mandatory components are age and injury severity. However, every additional information about the patient increases the accuracy of the outcome prediction.

Therefore, additional information on the data quality of the variables used for the prognosis is provided here. If all data required for calculation of the RISC II score were recorded, or if only one value was missing, then this patient was considered as a **„well documented"** case. The percentage of well documented patients (per hospital) is then used to quantify the data quality of outcome prediction. The following applies:

- (green) means: **more than 95 %** of cases were well documented,
- (yellow) means: **80 - 94 %** of cases were well documented,
- (red) means: **less than 80 %** of cases were well documented.

Table 2: Data quality for the calculation of the RISC II score

	TR-DGU 10 years	TR-DGU 2018	TR-DGU 2019
Total no. of cases (n)	240,089	27,549	24,012
„Well documented" (n)	188,415	22,461	19,695
„Well documented" (%)	78	82	82
Data quality colour code	(red)	(yellow)	(yellow)
Average no. of missing values per patient for the calculation of the RISC II	0.9	0.8	0.8

Mortality *vs.* risk of death prognosis

TR-DGU 2019:	Patients in the basic group:	**24,012**	primary admitted cases
	Deviation between mortality and prognosis:	**+0.2 %**	

Figure 3 compares the **observed mortality** of each hospital with their respective **RISC II prognosis for all the hospitals participating in the TR-DGU in 2019**. The **deviation** of the observed mortality from the expected prognosis is plotted against the number of patients. Negative values correspond to mortality rates lower than expected. The grey lines represent the 95 % confidence interval. Hospitals with **less than 5 patients** are not included due to the large statistical uncertainty.

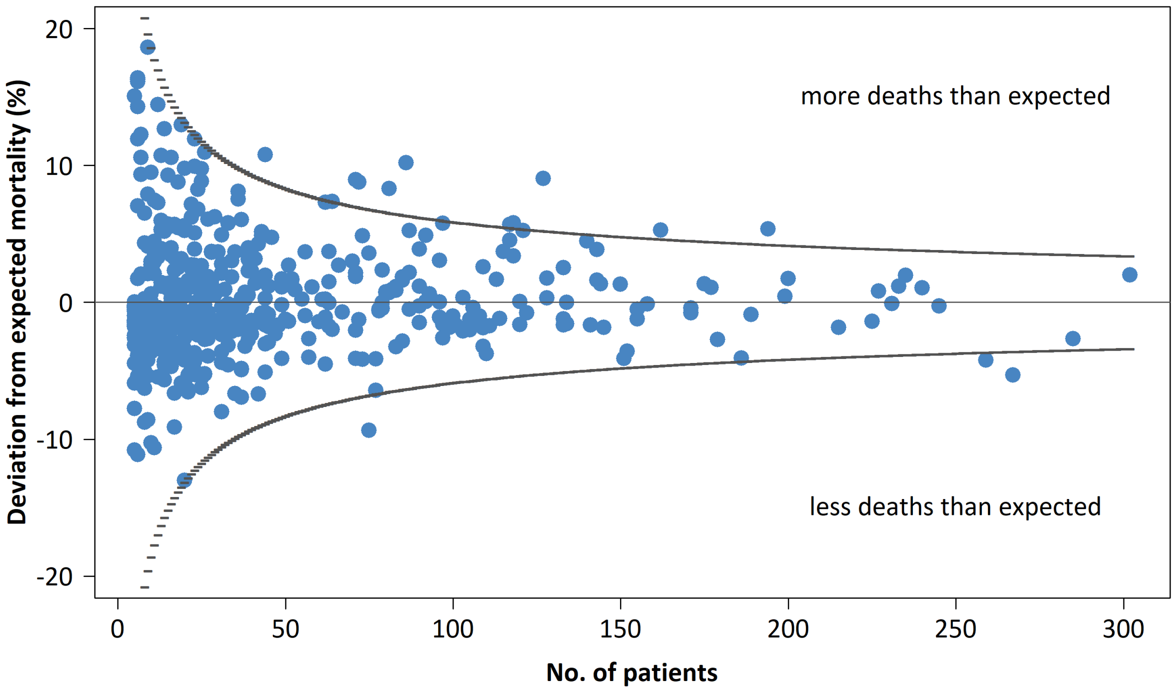


Figure 3: Deviation between the observed mortality and the risk of death prognosis (RISC II) of every hospital participating in the TR-DGU with more than 5 cases in the year 2019

3 Basic data from the last 3 years

The results in table 3 refer to the **basic group** only excluding patients with minor injuries and survivors without intensive care treatment. Attention: Results have to be interpreted with caution when the number of patients is < 5!

Table 3: Overview of the data from the TR-DGU in the basic group from the last 3 years

		TR-DGU			
		10 years	2017	2018	**2019**
Total number of patients	(n)	288,929	35,974	33,352	**29,345**
Primary admitted and treated patients	(n)	242,922	30,295	28,273	**24,662**
Patients early transferred out	(n)	19,085	2,361	2,316	**1,934**
All primary admissions	(n)	262,007	32,656	30,589	**26,596**
Patients transferred in	(n)	26,922	3,318	2,763	**2,749**

Table 3 continuation:

		TR-DGU			
		10 years	2017	2018	**2019**
Demography (patients from the basic group)					
Mean age	[years]	50.9	51.8	52.6	**53.4**
70 years or older	[%]	25.4	26.3	27.3	**28.2**
Amount of men	[%]	70.0	69.8	70.2	**69.2**
Trauma (patients from the basic group)					
Blunt trauma	[%]	95.9	95.9	96.1	**96.2**
Mean ISS	[points]	18.7	18.2	18.3	**18.2**
ISS ≥ 16	[%]	55.3	53.9	54.1	**53.3**
TBI (AIS head ≥ 3)	[%]	37.2	36.3	36.0	**35.7**
Prehospital care (only primary admissions)					
Intubation by emergency physician	[%]	23.3	20.7	20.1	**20.2**
Unconscious (GCS ≤ 8)	[%]	17.4	16.1	15.8	**15.7**
Shock (RR ≤ 90 mmHg)	[%]	9.6	8.1	8.3	**8.2**
Average amount of volume	[ml]	682	635	634	**616**
Emergency room care (only primary admissions)					
Whole-body CT	[%]	77.0	79.0	79.4	**78.8**
X-ray of thorax	[%]	35.2	30.5	26.6	**24.4**
Patients with blood transfusion	[%]	8.1	7.1	6.8	**6.8**
Treatment in hospital (patients from the basic group)					
Patients with surgery [1)]	[%]	67.1	66.3	65.3	**66.4**
if yes, no. of pat. with surgery [2)]	(n)	3.4	3.3	3.4	**3.3**
Patients treated on ICU	[%]	86.9	87.6	86.6	**86.1**
Length of stay on ICU [3)]	[days]	6.6	6.2	6.2	**6.1**
Intubated/ventilated patients on ICU [3)]	[%]	40.2	35.8	35.3	**34.8**
Length of intubation [3)]	[days]	7.5	7.4	7.3	**7.3**
Outcome (patients from the basic group)					
Length of stay in hospital [4)]	[days]	16.4	15.5	15.3	**15.3**
Hospital mortality [4)]	[n]	30,843	3,709	3,621	**3,260**
	[%]	11.4	11.0	11.7	**11.9**
Multiple organ failure [2) 4)]	[%]	20.5	19.0	19.0	**17.8**
Discharge to other hospital	[%]	17.5	17.7	17.9	**18.1**

[1)] years with less than 20 % patients with surgery are excluded

[2)] not available in the reduced QM dataset

[3)] only ICU patients

[4)] without patients transferred out early

4 Indicators of process quality

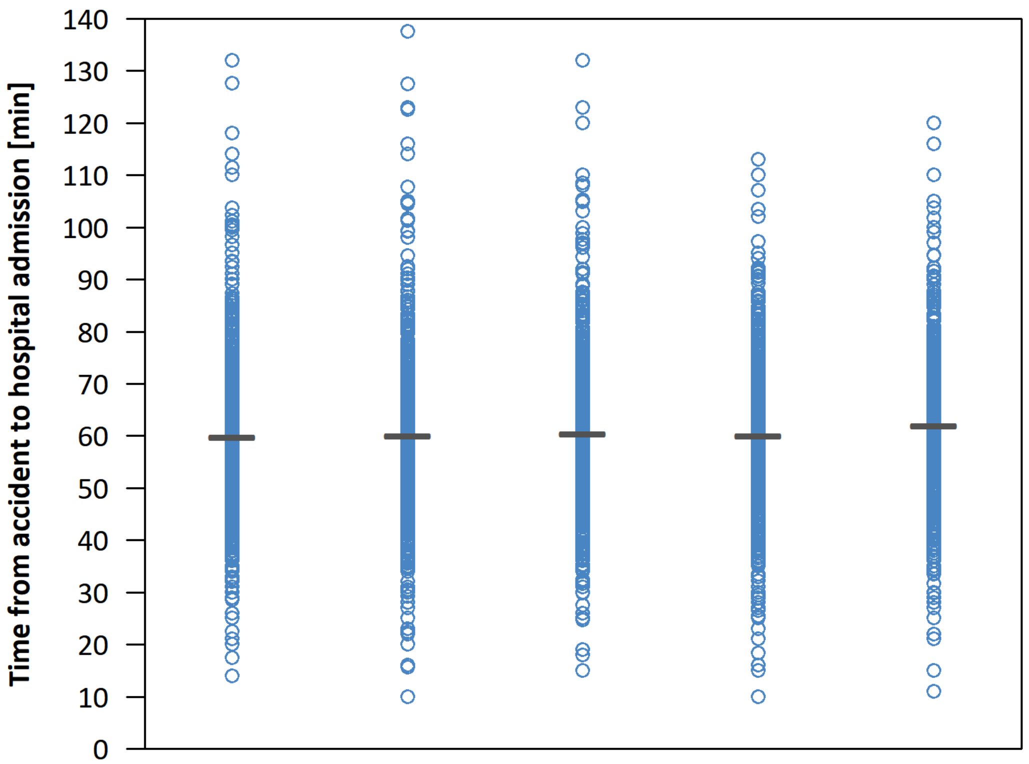
Quality indicators are measurements which are presumed to be associated with the quality of care and outcome. All results presented here are based on **primary admitted cases only from the basic group in 2019** with valid data or respective subgroups thereof. This includes early transfer out cases.

For each indicator, the distribution of the values of all participating hospitals is presented graphically over time. The light blue circles present the single hospital value. The grey horizontal line presents the mean of all hospital values per year.

4.1 Prehospital indicators

4.1.1 Prehospital time

The sooner a patient reaches a trauma centre, the earlier life-saving interventions can be performed. Only patients with ISS ≥ 16 are included here. The time period from accident until hospital admission is presented as an average value in minutes. Implausible time values < 5 minutes and > 4 hours were excluded.

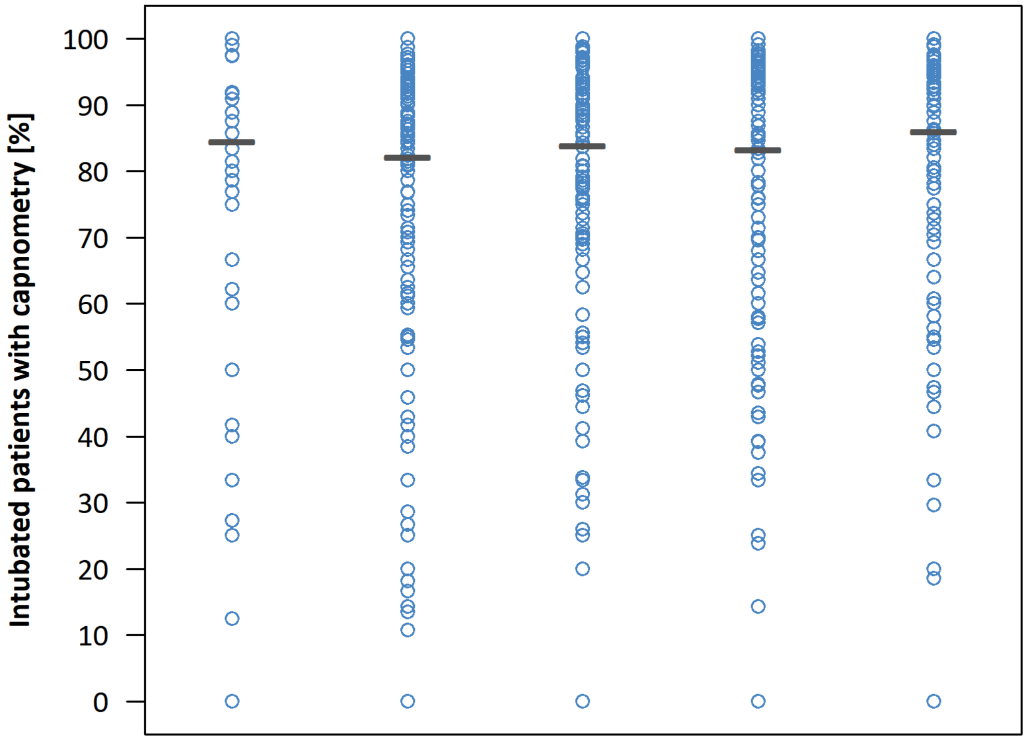


Year:	2015	2016	2017	2018	2019
TR-DGU:	60 [min]	60 [min]	60 [min]	60 [min]	62 [min]
n:	12,339	12,585	12,946	12,257	10,632
Min-Max:	5-240 [min]	5-240 [min]	5-240 [min]	5-240 [min]	5-240 [min]

Figure 4: Distribution of the mean duration from accident until hospital admission of patients with mit ISS ≥ 16 over all hospitals, 2015-2019, — TR-DGU, o single hospital value

4.1.2 Capnometry in intubated patients

A capnometry in intubated patients allows to detect a malpositioning of the tubus. Only patients with a prehospital endotracheal intubation with valid data for capnometry are considered here (since dataset revision 2015). Intubated patients without data to the capnometry cannot be analysed (n = 1,472).

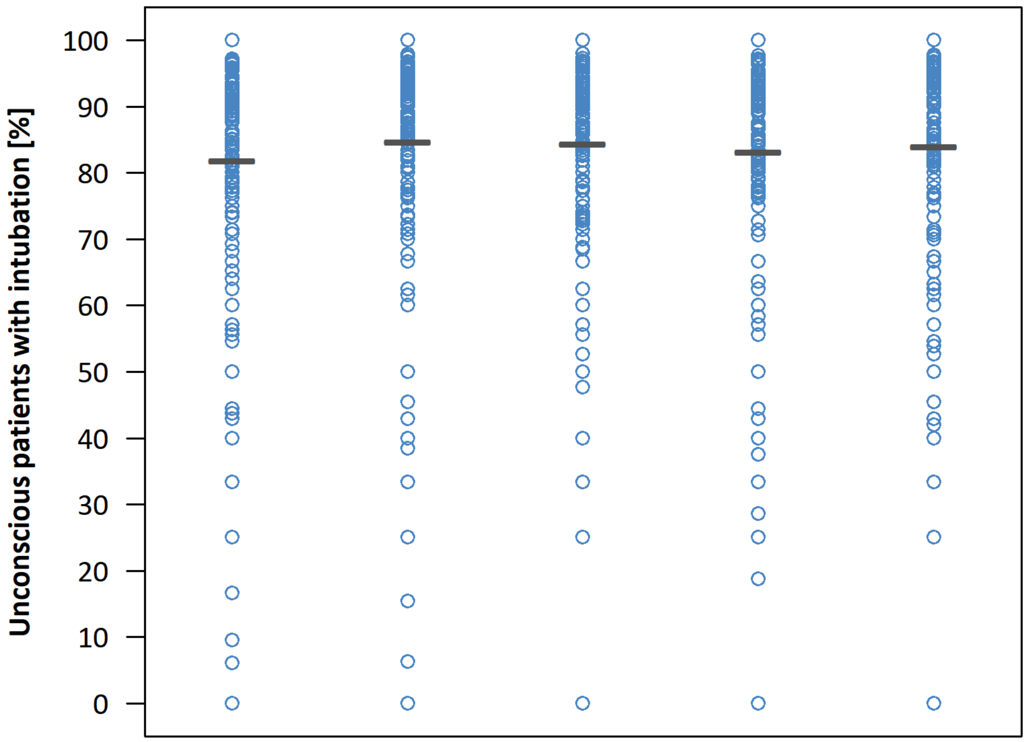


Year:	2015	2016	2017	2018	2019
TR-DGU:	84 %	82 %	84 %	83 %	86 %
Capnometry (n):	876	3,390	3,676	3,392	3,158
Intubated (N):	1,037	4,127	4,380	4,075	3,671

Figure 5: Distribution of the capnometry rate in prehospital intubated patients over all hospitals, 2015-2019, — TR-DGU, o single hospital value

4.1.3 Intubation of unconscious patients

The prehospital intubation of unconscious patients grants the oxygen supply until the hospital is reached. Only patients with a prehospital documented GCS ≤ 8 are considered here, regardless of the injury severity. A missing information on intubation is considered as „no intubation", but an alternative airway counts as „intubation".

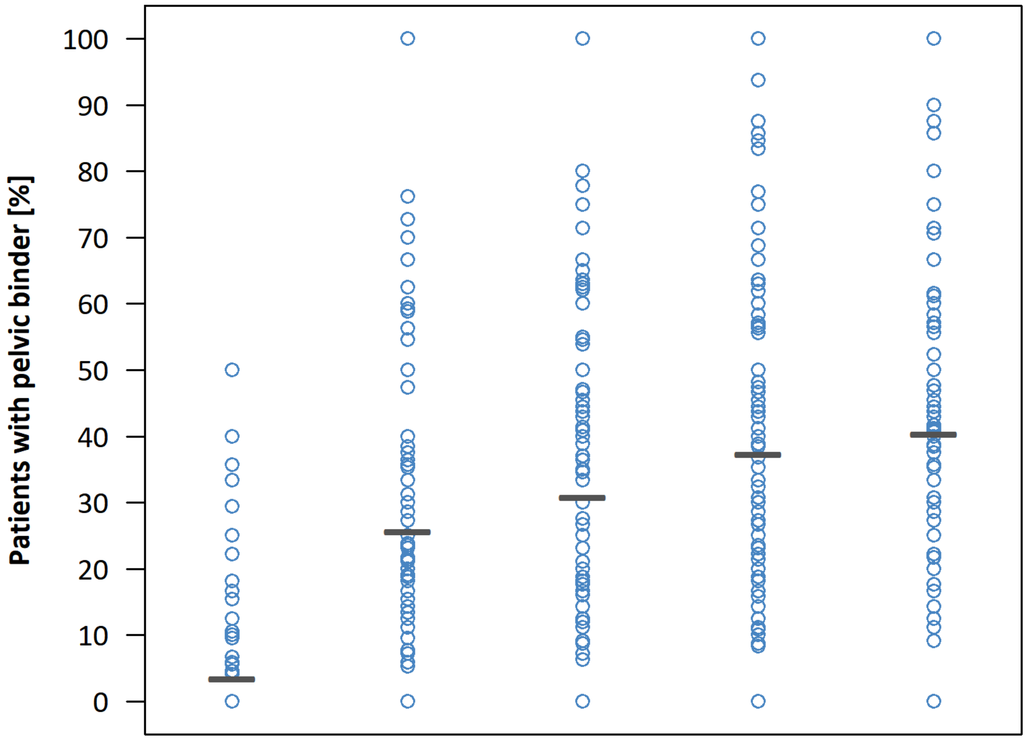


Year:	2015	2016	2017	2018	2019
TR-DGU:	82 %	85 %	84 %	83 %	84 %
Intubated (n):	3,939	4,228	4,074	3,727	3,261
Unconscious (N):	4,812	4,991	4,828	4,482	3,885

Figure 6: Distribution of the intubation rate in unconscious patients over all hospitals, 2015-2019, — TR-DGU, o single hospital value

4.1.4 Pelvic binder in pelvic fracture

The stabilisation of an instable pelvic fracture can help to improve the hemodynamic status of the patient. Only cases with a pelvic fracture (AIS severity 3 to 5) are considered here. The pelvic binder is documented in the standard dataset only (since the dataset revision 2020).



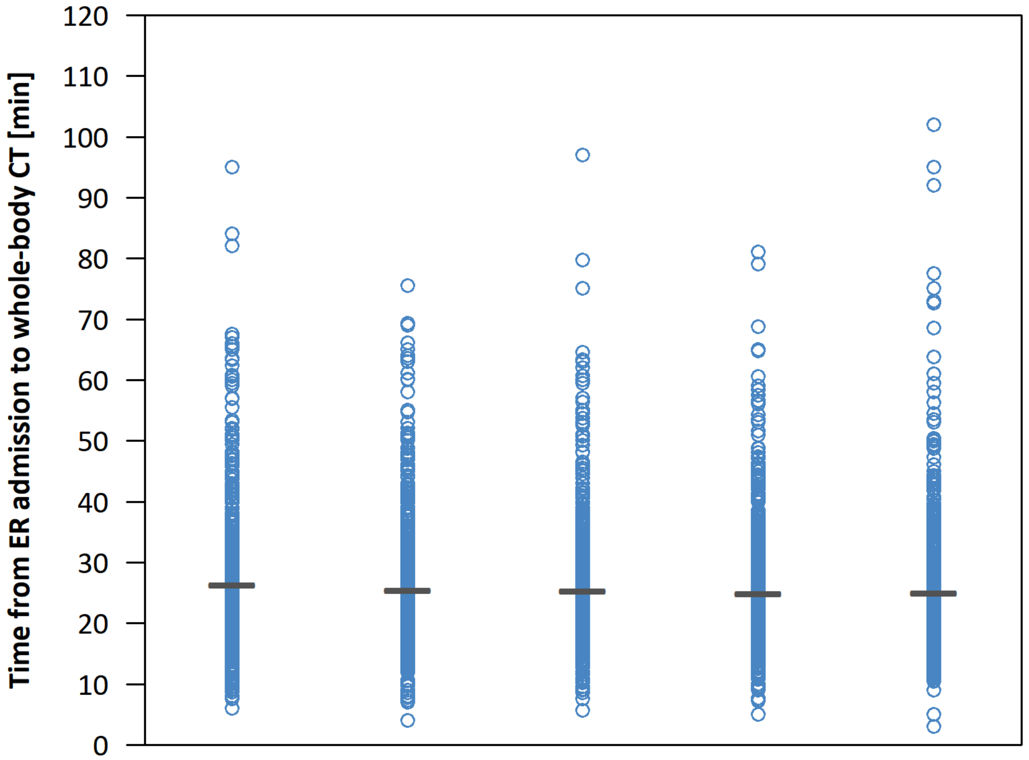
Year:	2015	2016	2017	2018	2019
TR-DGU:	3 %	26 %	31 %	37 %	40 %
Pelvic binder (n):	46	364	467	513	499
Pelvic fracture (N):	1,329	1,422	1,515	1,376	1,236

Figure 7: Distribution of the pelvic binder rate in patients with an instable pelvic fracture over all hospitals, 2015-2019, — TR-DGU, o single hospital value

4.2 Process times in the emergency room

4.2.1 Duration until whole-body CT

If a whole-body CT is indicated, it should be performed immediately after admission to the ER in order to initiate subsequent interventions without loss of time. Time periods > 120 minutes are excluded from the following analysis. All patientes who received a whole-body CT are considered here.

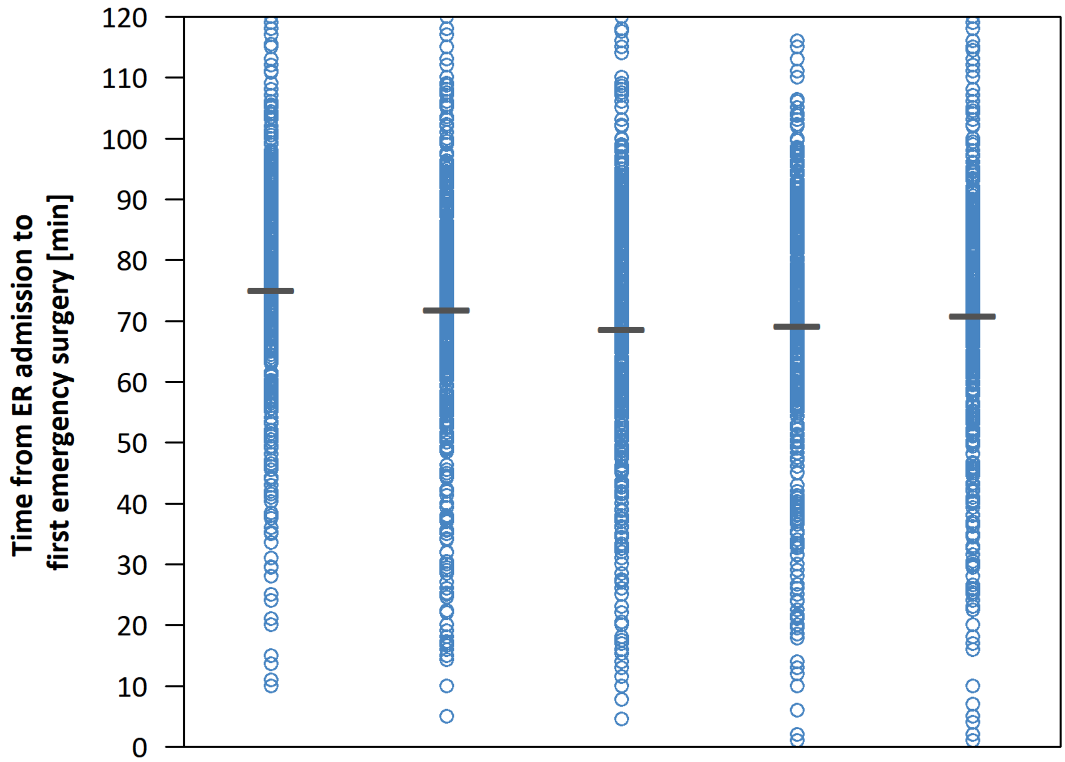


Year:	**2015**	**2016**	**2017**	**2018**	**2019**
TR-DGU:	26 [min]	26 [min]	25 [min]	25 [min]	25 [min]
n:	22,416	23,828	25,086	23,600	20,306
Min-Max:	1-120 [min]	1-120 [min]	1-120 [min]	1-120 [min]	1-120 [min]

Figure 8: Distribution of the mean duration from admission to the ER until whole-body CT over all hospitals, 2015-2019, — TR-DGU, o single hospital value

4.2.2 Duration until first emergency surgery

Eight different emergency interventions are documented in TR-DGU (surgical liquor drain or brain decompression, laminectomy, thoracotomy, laparotomy, revascularisation, embolisation, and stabilisation of pelvis or extremities). All patients with at least one of these interventions are considered here. Time periods between admission to the ER and emergency surgery > 120 minutes are excluded.

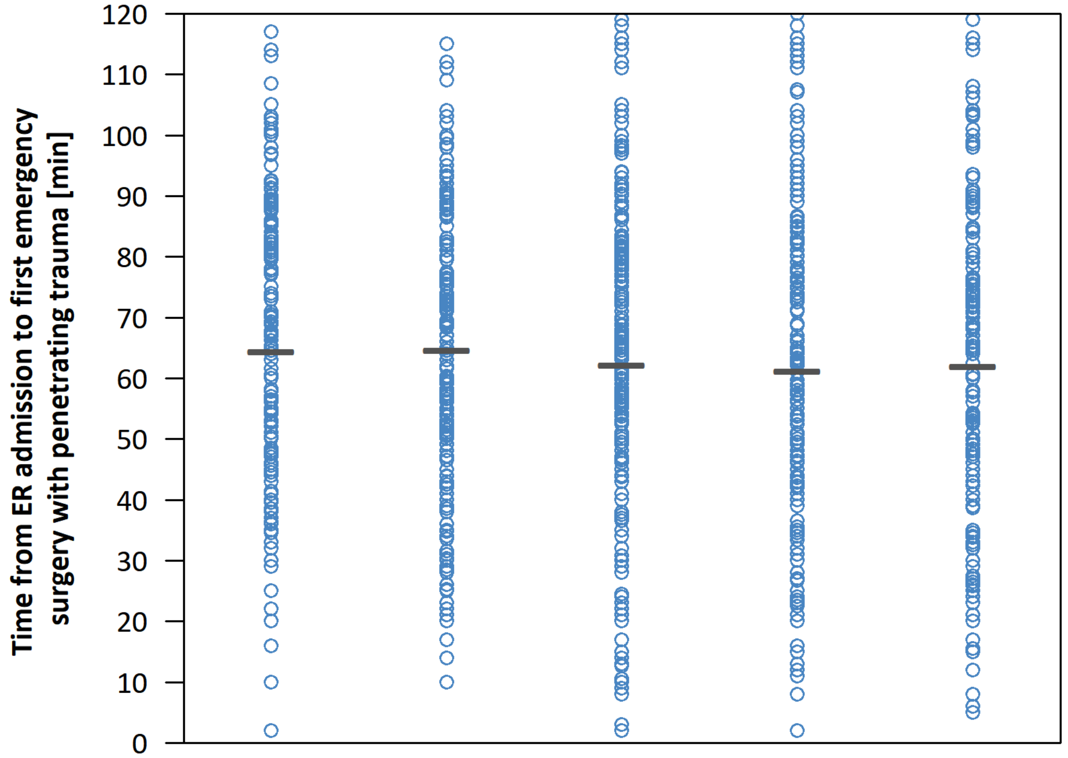


Year:	2015	2016	2017	2018	2019
TR-DGU:	75 [min]	72 [min]	69 [min]	69 [min]	71 [min]
n:	3,834	4,977	5,196	4,545	3,952
Min-Max:	1-120 [min]	1-120 [min]	1-120 [min]	1-120 [min]	1-120 [min]

Figure 9: Distribution of the mean duration from admission to the ER until the first emergency surgery over all hospitals, 2015-2019, — TR-DGU, o single hospital value

4.2.3 Duration from admission to the ER until surgery in penetrating trauma

Time period between admission to the ER and the first surgical intervention (list of procedures see 4.2.2) in patients with penetrating injuries (stabbing, gunshot, etc.). Time periods over 120 hours are excluded from this analysis.

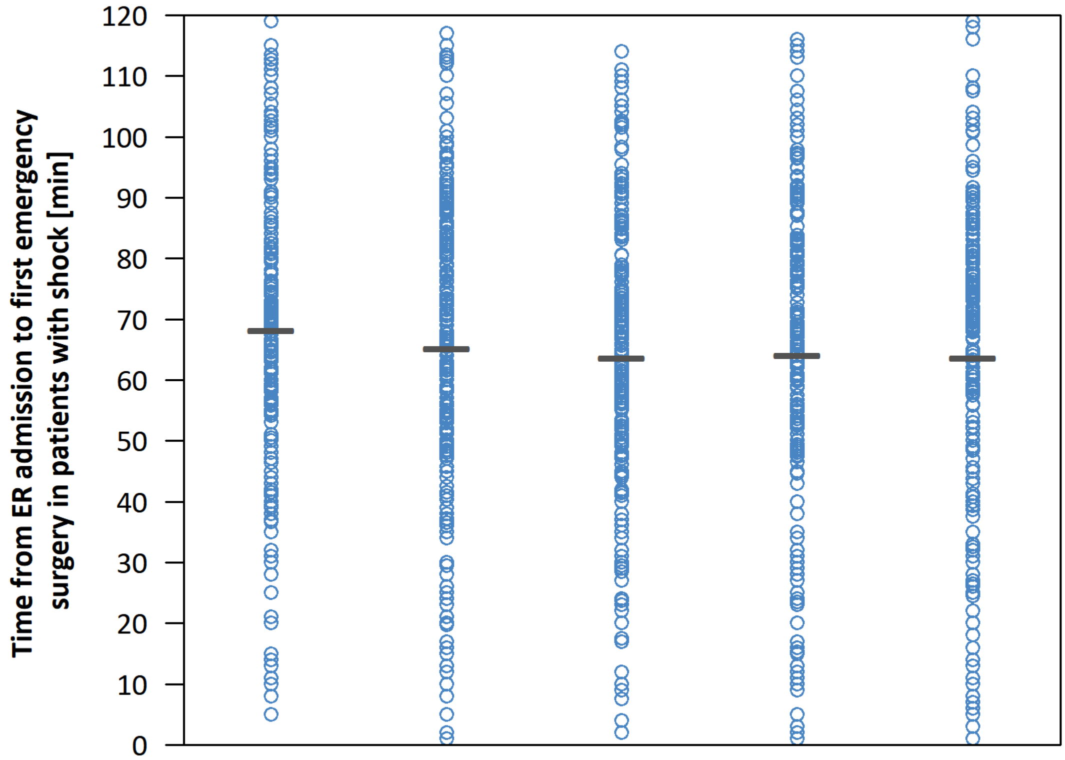


Year:	2015	2016	2017	2018	2019
TR-DGU:	64 [min]	65 [min]	62 [min]	61 [min]	62 [min]
n:	396	464	514	417	391
Min-Max:	1-120 [min]	1-120 [min]	1-120 [min]	1-120 [min]	2-119 [min]

Figure 10: Distribution of the mean duration from admission to the ER until surgery in patients with penetrating trauma over all hospitals, 2015-2019, — TR-DGU, o single hospital value

4.2.4 Duration until surgery in patients with shock

Time period from admission to the ER until first surgical intervention (list of procedures see 4.2.2) in patients with shock (systolic blood pressure ≤ 90 mmHg). Time periods over 120 minutes are excluded from this analysis.

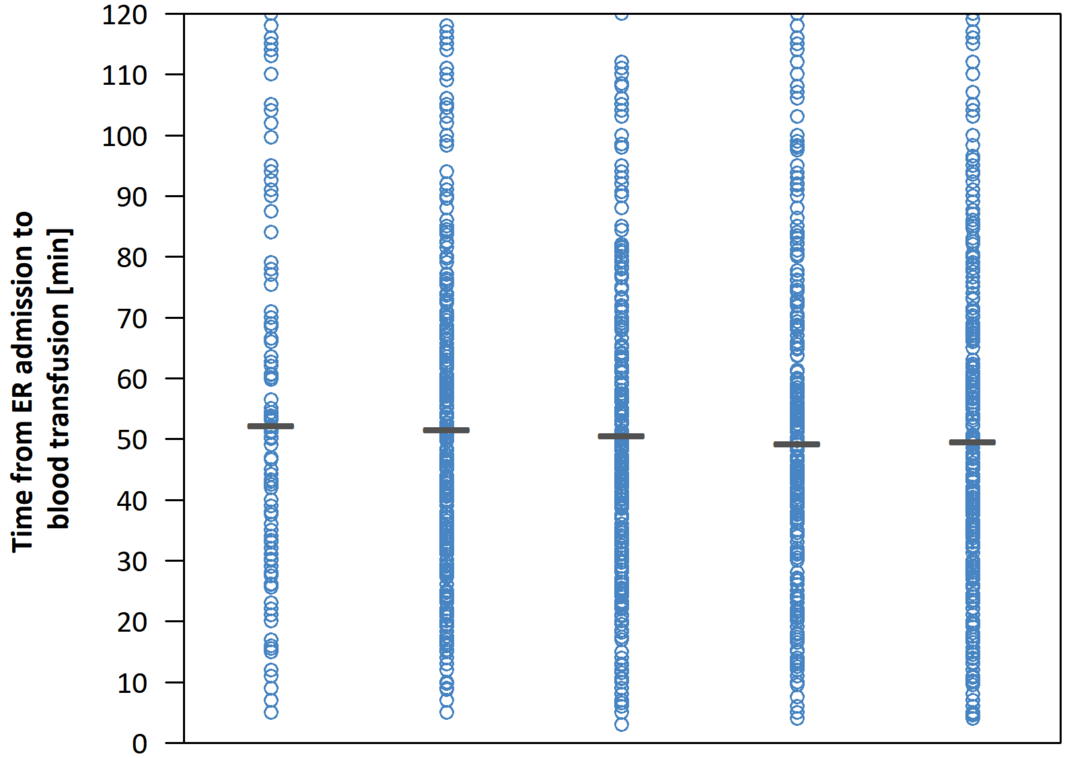


Year:	2015	2016	2017	2018	2019
TR-DGU:	68 [min]	65 [min]	64 [min]	64 [min]	64 [min]
n:	602	724	758	695	587
Min-Max:	1-120 [min]	1-120 [min]	1-120 [min]	1-120 [min]	1-120 [min]

Figure 11: Distribution of the mean duration from admission to the ER until surgery in patients with shock over all hospitals, 2015-2019, — TR-DGU, o single hospital value

4.2.5 Duration until start of blood transfusion

If blood substitution is required, this should be done as early as possible. All patients with a valid time to blood transfusion (pRBC) are considered here. Time periods between admission to the ER and time of blood transfusion over 120 hours are excluded from this analysis.

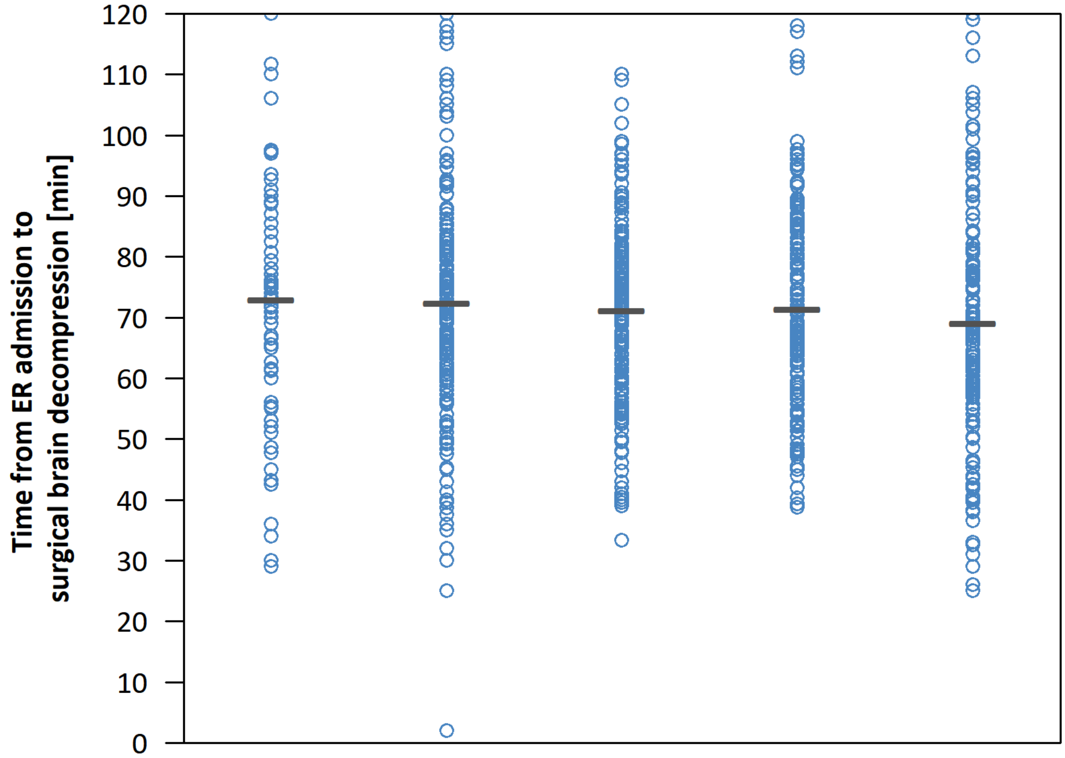


Year:	2015	2016	2017	2018	2019
TR-DGU:	52 [min]	52 [min]	51 [min]	49 [min]	50 [min]
n:	352	1,499	1,487	1,365	1,192
Min-Max:	3-120 [min]	1-120 [min]	1-120 [min]	1-120 [min]	1-120 [min]

Figure 12: Distribution of the mean duration from admission to the ER until start of the transfusion over all hospitals, 2015-2019, — TR-DGU, o single hospital value

4.2.6 Surgical brain decompression

In patients with intracranial bleeding after severe traumatic brain injury (TBI, AIS severity = 5) a surgical brain decompression is indicated. Only surgery patients with a valid time to surgery (max. 120 minutes) and AIS severity degree of 5 are considered in this analysis.



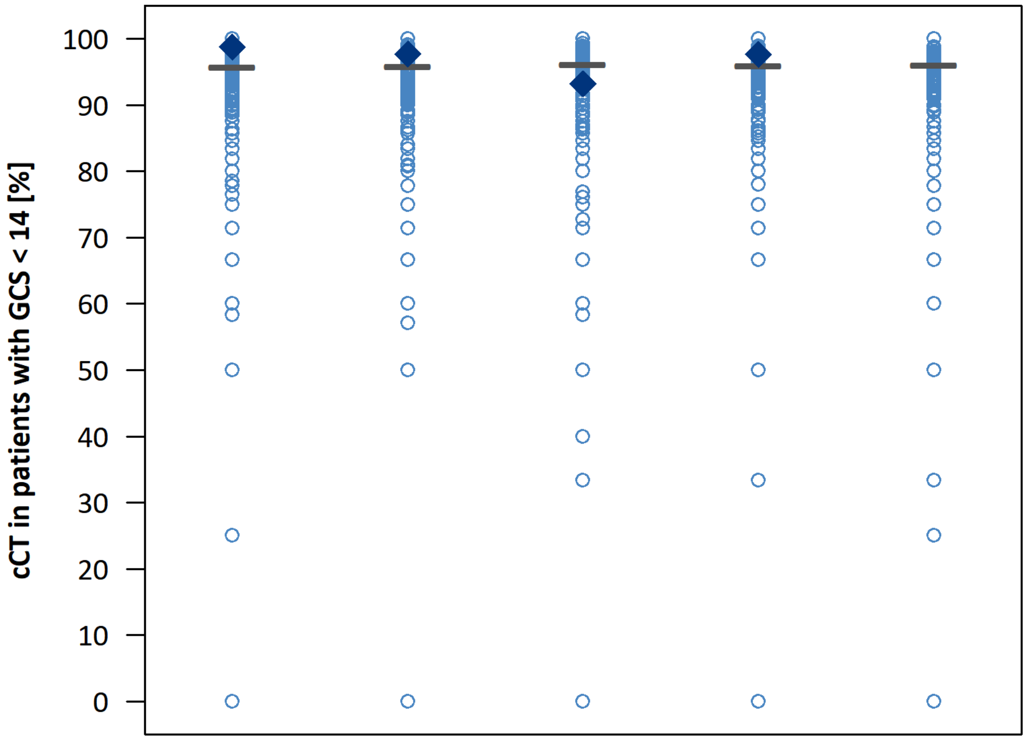
Year:	2015	2016	2017	2018	2019
TR-DGU:	73 [min]	72 [min]	71 [min]	71 [min]	69 [min]
n:	192	796	790	711	619
Min-Max:	20-120 [min]	2-120 [min]	1-120 [min]	1-120 [min]	5-120 [min]

Figure 13: Distribution of the mean duration from admission to the ER until surgical brain decompression over all hospitals, 2015-2019, — TR-DGU, o single hospital value

4.3 Diagnostics and interventions

4.3.1 Cranial CT (cCT) with GCS < 14

A reduced consciousness could be indicative for a TBI and should be investigated with a cranial CT (cCT) or whole-body CT. All patients with a GCS < 14 are included, either prehospital or on admission (if not intubated). Patients who died within the first 30 minutes after admission are excluded, because a cCT / whole-body CT is here often no longer possible. A missing value regarding cCT / whole-body CT is considered as „not performed".

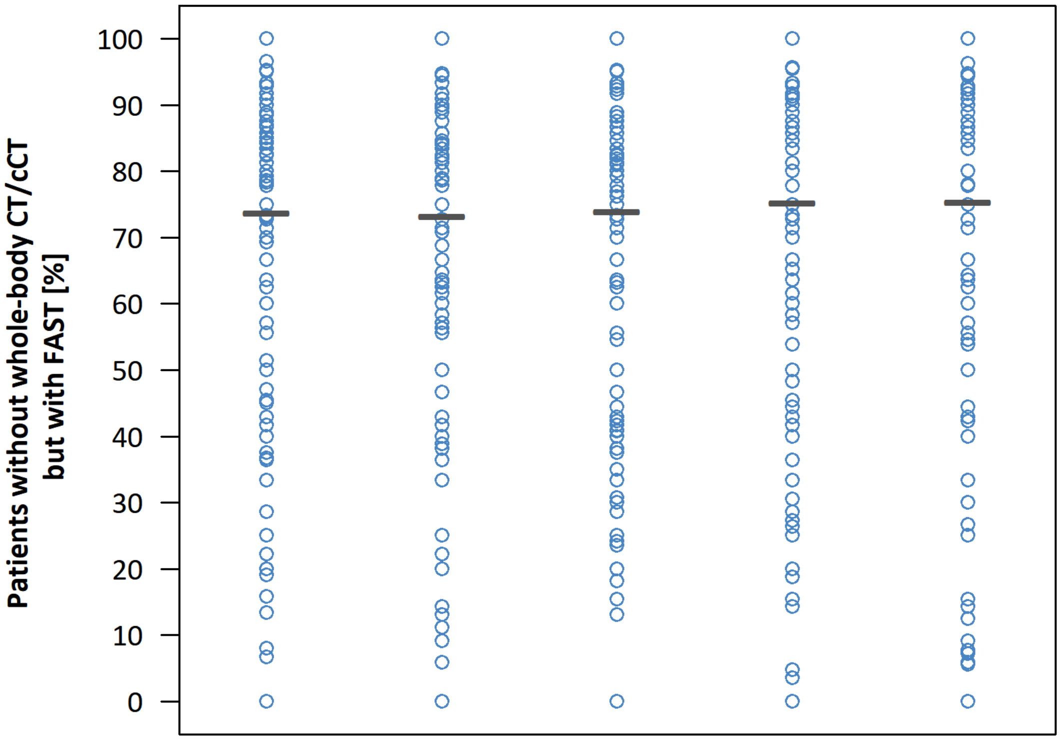


Year:	2015	2016	2017	2018	2019
TR-DGU:	96 %	96 %	96 %	96 %	96 %
cCT (n):	9,338	9,647	9,664	8,739	7,401
GCS < 14 (N):	9,753	10,064	10,046	9,112	7,705

Figure 14: Distribution of the cCT rate in patients with GCS < 14 over all hospitals, 2015-2019, — TR-DGU, o single hospital value

4.3.2 Sonography in patients without CT

If no whole-body CT / cCT has been performed, abdominal sonography (FAST = Focused Assessment with Sonography for Trauma) should be part of the diagnostic work-up. All patients with no documented whole-body CT / cCT are included in this analysis. A missing value regarding the FAST is considered as „not performed".

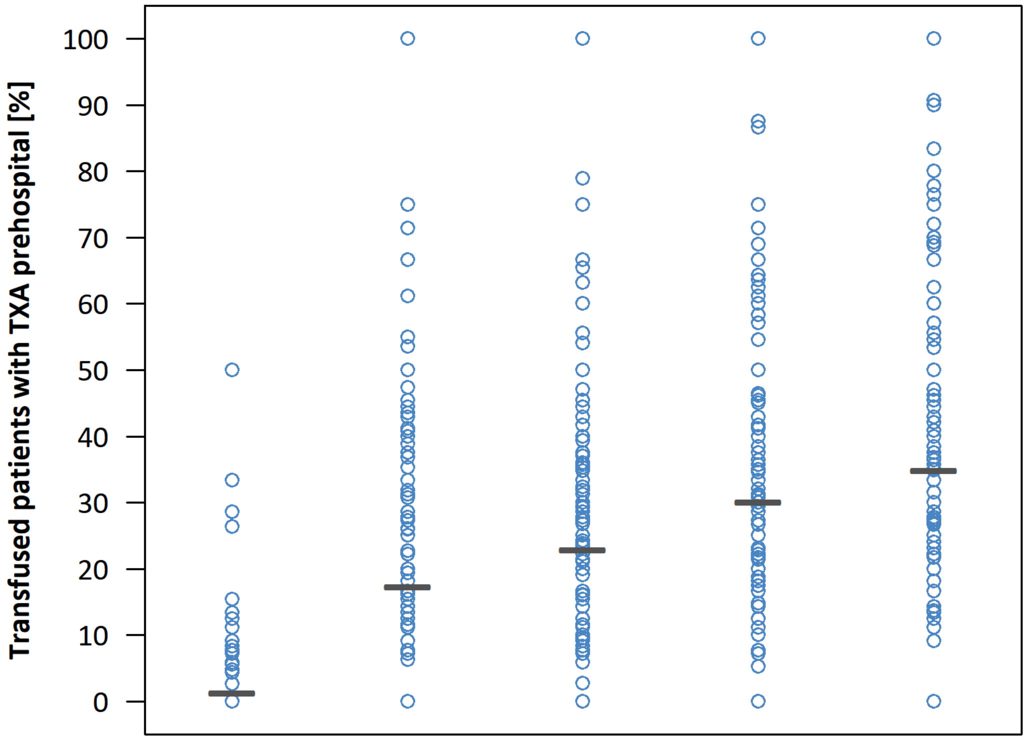


Year:	2015	2016	2017	2018	2019
TR-DGU:	74 %	73 %	74 %	75 %	75 %
FAST (n):	2,119	2,045	2,086	1,964	1,724
No WBCT/cCT (N):	2,875	2,791	2,821	2,609	2,287

Figure 15: Distribution of the sonography rate in patients without whole-body CT / ccT over all hospitals, 2015-2019, — TR-DGU, o single hospital value

4.3.3 Prehospital tranexamic acid in patients with blood transfusion

Based on a randomized trial, tranexamic acid (TXA) is assumed to reduce the amount or even avoid the blood transfusion or the transfused volume. Therefore, patients who require a blood transfusion should have been given TXA perviously. All patients with documented blood transfusion (received pRBCs in the ER up to ICU admission) are included here. A missing value regarding prehospital TXA administration is considered as „no TXA given".

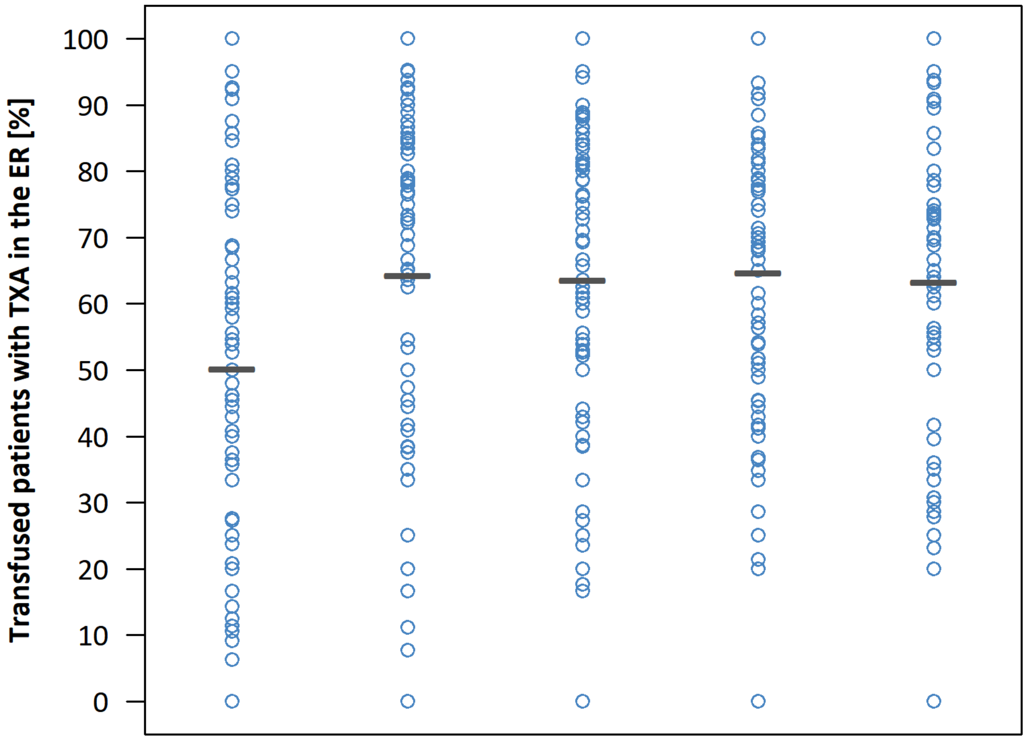


Year:	2015	2016	2017	2018	2019
TR-DGU:	1 %	17 %	23 %	30 %	35 %
TXA prehosp. (n):	29	381	509	618	624
Transfused (N):	2,218	2,202	2,226	2,053	1,789

Figure 16: Distribution of the prehospital tranexamic acid rate in the ER or surgery phase transfused patients over all hospitals, 2015-2019, — TR-DGU, o single hospital value

4.3.4 Tranexamic acid in the ER in patients with blood transfusion

Actually, tranexamic acid in the ER is recorded only in the standard dataset. All patients with documented blood transfusion (received pRBCs in the ER up to ICU admission) are included here. A missing value regarding TXA administration in the ER is considered as „no TXA given".



Year:	2015	2016	2017	2018	2019
TR-DGU:	50 %	64 %	64 %	65 %	63 %
TXA in ER (n):	635	952	996	920	775
Transfused (N):	1,266	1,481	1,567	1,422	1,225

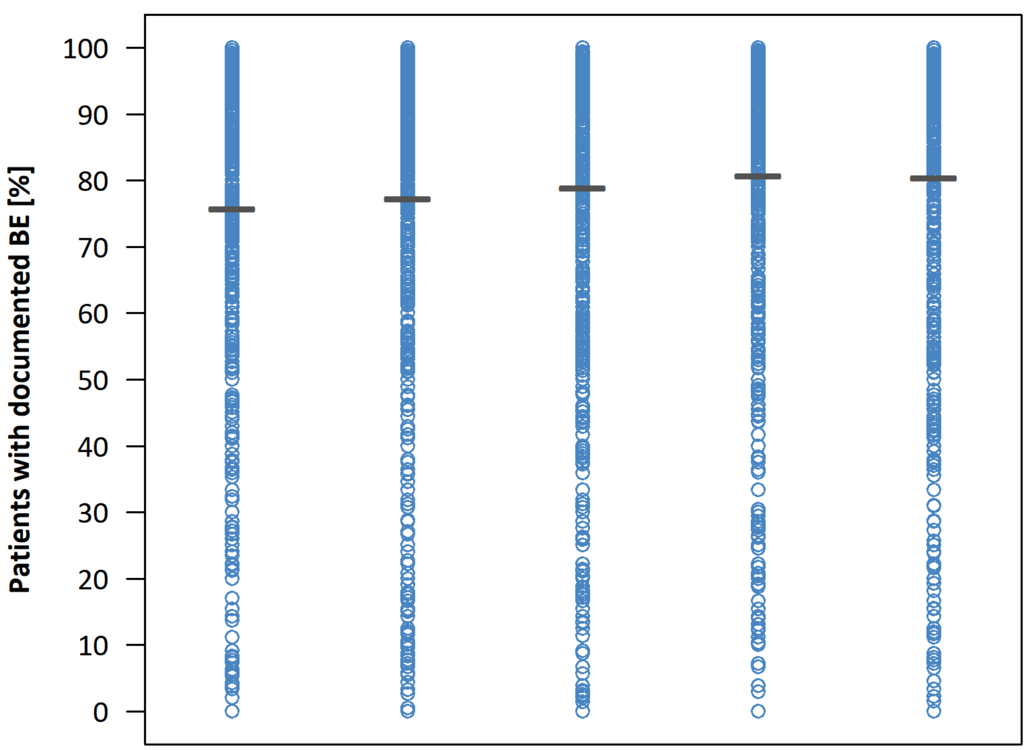
Figure 17: Distribution of the TXA admission rate in the ER in patients transfused between ER and intensive therapy over all hospitals, 2015-2019, — TR-DGU, o single hospital value

4.4 Data quality

4.4.1 Blood gas analysis performed / Base excess documented

A blood gas analysis (BGA) provides important and timely information about the condition of a trauma patient. But often these measurements are not documented in the TR-DGU. Specifically the base excess (BE) is an important outcome predictor that is used in the RISC II prognostic score. Detailed results regarding the completeness of data are presented in chapter 10. As an example, the completeness of BE data is presented here in the same way as the process indicators above.

All primary admitted patients are considered in this analysis and the amount of valid BE values is calculated. BE values less than -50 mmol/l or greater than 20 mmol/l are excluded.



Year:	2015	2016	2017	2018	2019
TR-DGU:	76 %	77 %	79 %	81 %	80 %
Document. BE (n):	22,859	24,256	25,772	24,707	21,385
Patients (N):	30,153	31,368	32,656	30,589	26,596

Figure 18: Distribution of the patient rate with documented base excess (BE) over all hospitals, 2015-2019, — TR-DGU, o single hospital value

5 Comparisons of the hospitals in the TraumaNetzwerk DGU®

In chapter 5, the hospitals in the TraumaNetzwerk DGU® are displayed corresponding to their trauma level. The classification into local, regional, supra-regional TraumaZentrum DGU® results from the certification requirements of the Whitebook Medical Care of the Severly Injured from the German Trauma Society. Hospitals that are not certified are not considered in the data.

5.1 Documented patients of the TR-DGU in the last 10 years

Figure 19 presents the number of documented trauma patients in the last ten years. Only cases from the **basic group** are considered here (see page 5 for definition). From the TR-DGU **288,929 patients** were documented in the last 10 years, among them **29,345 patients from 2019**.

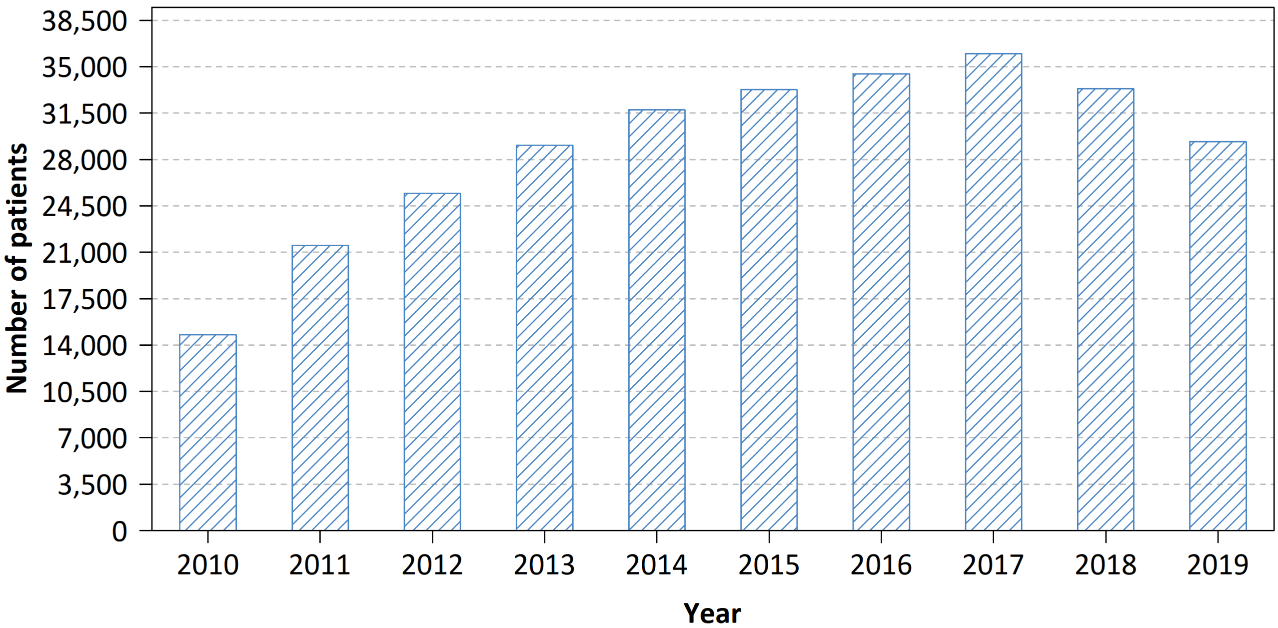


Figure 19: Documented number of patients of the TR-DGU basic group from 2010-2019 (bars)

5.2 Number of patients within the trauma level

In 2019, the TR-DGU documented **29,345 patients** in the basic group. The values in figure 20 represent the median (vertical line), the interquartile range (grey box) and the minimum/maximum (horizontal line). Hospitals without a TraumaNetzwerk DGU® certification are excluded here.

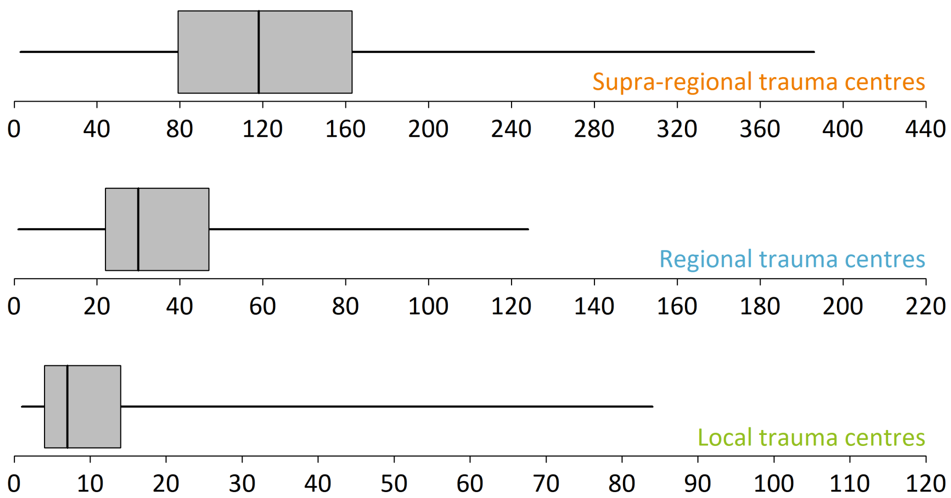


Figure 20: Median number of cases of the in the TR-DGU participating trauma centres separated by the trauma level in 2019

5.3 Comparison of the basic data between the trauma level

Table 4 allows a comparison of the hospitals in the TraumaNetzwerk DGU® with the same trauma level. The total values of all certified trauma centres from the TR-DGU are presented as well.

Again, only cases from the **basic group** are considered here. In order to reduce the statistical uncertainty, all patients from the **last three years** are pooled and analysed together.

Table 4: Basic data from the total data from the TR-DGU trauma centres over the past three years

		Trauma centre DGU			
Characteristics		**local**	**regional**	**supra-regional**	**TR-DGU**
Number of hospitals		289	225	121	635
Amount of patients in the TR-DGU		11 %	31 %	58 %	100 %
Patients per year and hospital (mean)	n	**11** / year	**42** / year	**143** / year	**47** / year
Patients (3 years, cumulated)	n	9,715	28,148	51,862	89,725
Primary admitted and treated	n (%)	7,562 (78 %)	23,731 (84 %)	44,681 (86 %)	75,974 (85 %)
Primary admitted and early (< 48 h) transferred out	n (%)	1,990 (20 %)	3,446 (12 %)	826 (2 %)	6,262 (7 %)
Transferred in from another hospital	n (%)	163 (2 %)	971 (3 %)	6,355 (12 %)	7,489 (8 %)

Table 4 continuation:

		Trauma centre			
Characteristics		**local**	**regional**	**supra-regional**	**TR-DGU**
Patients					
Average age [years]	M	55.6	54.7	51.6	53.0
Patients aged 70 years and older	%	31 %	30 %	26 %	28 %
Males	%	67 %	68 %	71 %	70 %
ASA 3-4	%	19 %	22 %	17 %	19 %
Injuries					
Injury Severity Score (ISS) [points]	M	13.7	16.3	19.7	18.0
Ratio with ISS ≥ 16	%	35 %	47 %	59 %	53 %
Ratio of polytrauma *	%	7 %	11 %	17 %	%
Ratio of life-threatening severe injury **	%	18 %	26 %	35 %	30 %
Patients with TBI, AIS ≥ 3	%	20 %	29 %	42 %	35 %
Patients with thoracic injury, AIS ≥ 3	%	34 %	37 %	38 %	37 %
Patients with abdominal injury, AIS ≥ 3	%	8 %	9 %	10 %	10 %
Prehospital care (primary admissions only)					
Rescue time (accident to hospital) [min]	M	56.4	59.9	68.1	63.8
Prehospital volume administration [ml]	M	472	583	698	634
Prehospital intubation	%	4 %	11 %	29 %	20 %
Unconsciousness (GCS ≤ 8)	%	4 %	9 %	20 %	14 %
Emergency room (primary admissions only)					
Blood transfusion	%	3 %	4 %	9 %	6 %
Whole-body CT	%	67 %	76 %	84 %	79 %
Cardio-pulmonary resuscitation	%	2 %	2 %	4 %	3 %
Shock / hypotension	%	4 %	5 %	9 %	7 %
Coagulopathy	%	8 %	9 %	12 %	10 %
Length of stay (without early transfers out)					
Length of intubation on the intensiv care unit [days]	M	2.3	4.8	6.8	6.2
Length of stay on the intensiv care unit [days]	M	2.7	4.3	6.7	5.6
Length of stay in the hospital [days]	M	10.6	13.1	16.9	15.2
Outcome and prognosis (without transfers in and early transfers out and patients deceased within the first week with a patient's volition)					
Patients	n	7,562	23,731	44,681	75,974
Non-survivors	n	310	1,621	4,654	6,585
Hospital mortality	%	4.2 %	7.0 %	10.7 %	8.9 %
RISC II prognosis	%	4.6 %	7.0 %	10.8 %	9.0 %

GCS = Glasgow Coma Scale; AIS = Abbreviated Injury Scale; M = Mean

* Polytrauma: see „Berlin-Definition" (Pape et al. 2014)

** Life-threatening severe injury: ISS ≥ 16 in conjunction with phys. effects (Paffrath et al. 2014)

5.4 State of transfer within the trauma levels

The percentage distribution of the transfer status of all patients in the TraumaNetzwerk DGU® is displayed in the following figure, classified according to the trauma level for the year 2019. As expected, the rate of patients that are transferred out from a local trauma centre as well as the rate of patients that are transferred in a supra-regional trauma centre is the highest.

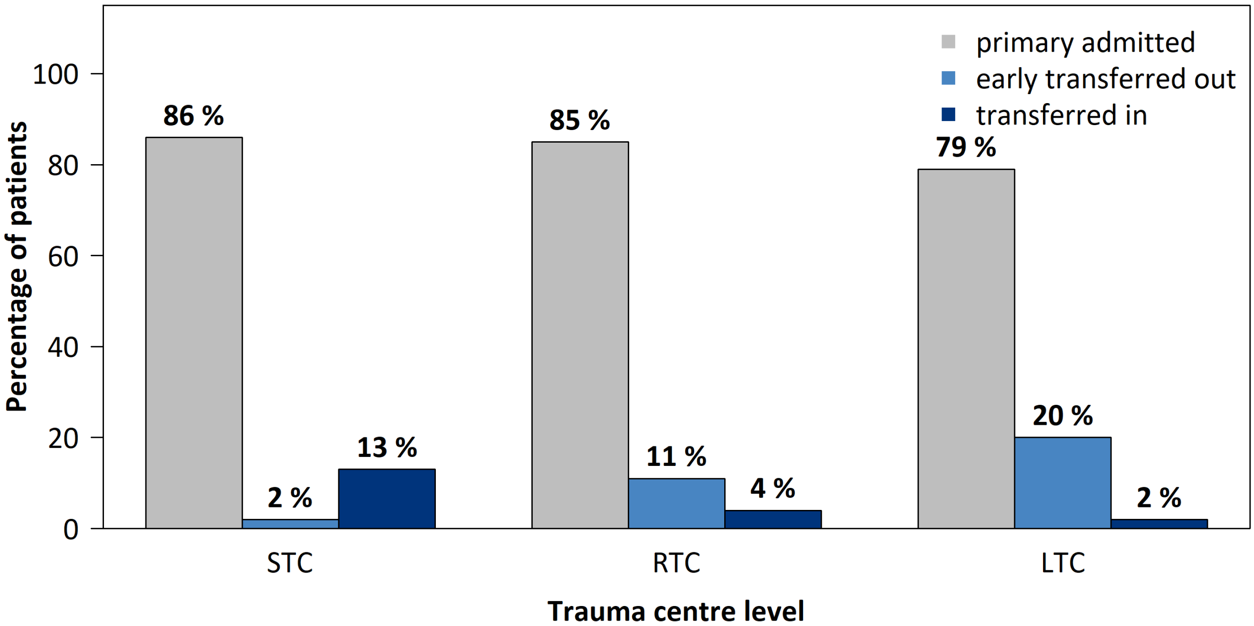


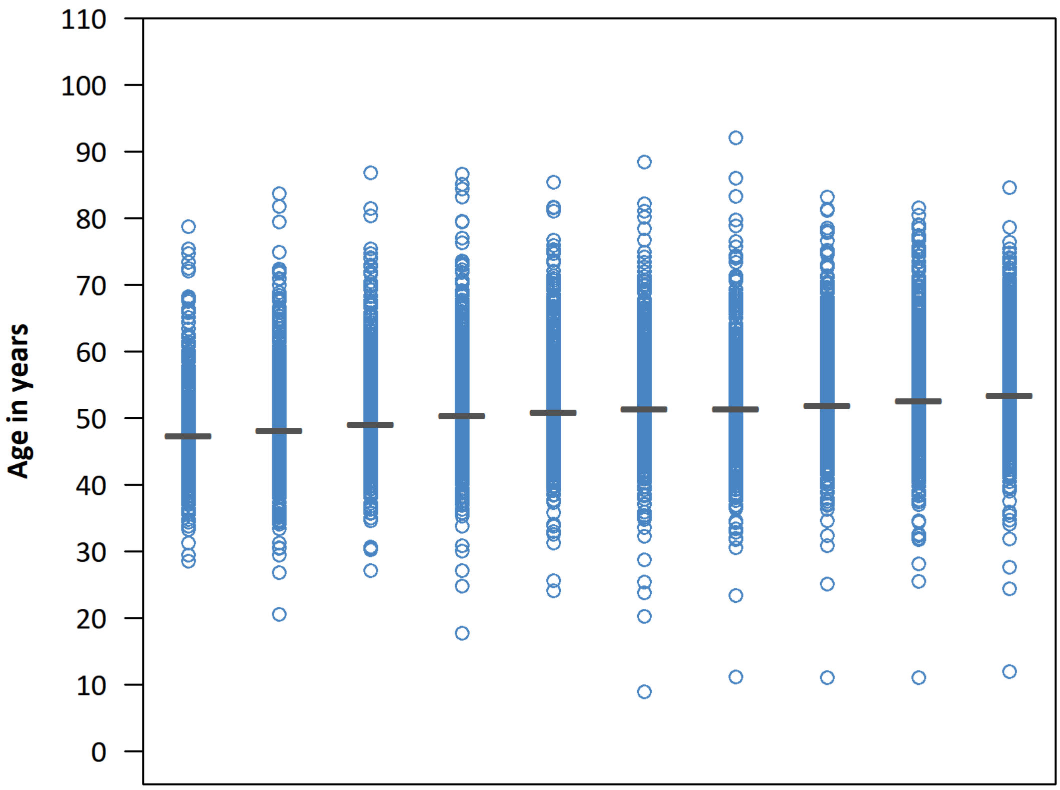
Figure 21: Transfer status classified according to the trauma level in 2019

6 Graphical comparisons with other hospitals

Below, selected information about the patients from the years **2010-2019** from the hospitals in the TraumaRegister DGU® are displayed. Only cases from the **basic group** are considered (see page 5). Different from the values in chapter 3, only hospitals are analysed, where **at least 3 patients** were available. The hospitals from the TR-DGU are indicated as light blue circles. The horizontal grey line is the mean value over all hospitals per year.

6.1 Distribution of age in the past 10 years

The lower figure shows the distribution of mean age of the patients from the TR-DGU over the past ten years **with at least 3 patients**).

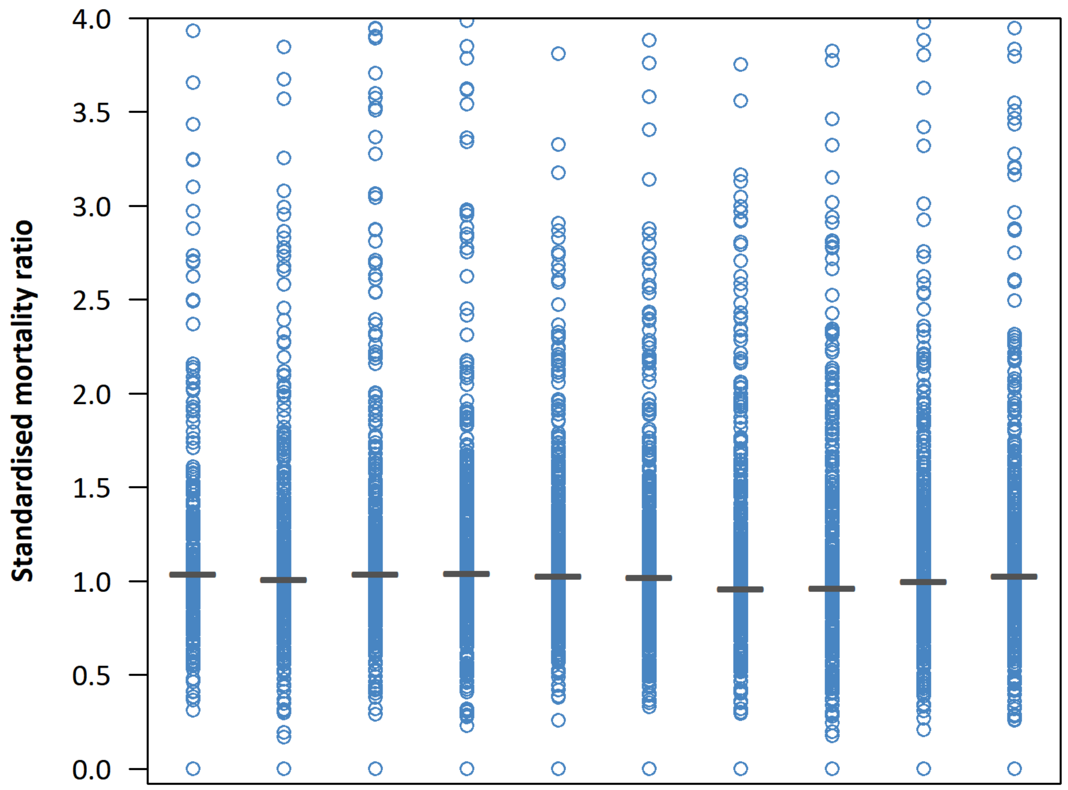


Year:	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
TR-DGU:	47.4	48.1	49.1	50.4	50.9	51.4	51.4	51.9	52.6	53.4

Figure 22: Mean patient's age in the — TR-DGU compared to the o single hospital values in the TR-DGU for the years 2010-2019

6.2 Distribution of the standardised mortality ratio (SMR) over the past ten years

Only primary admitted patients per year are displayed here (with at least 3 cases). Early transfers out (< 48 h) are excluded. Also, patients deceased within one week after admission **with a patient's volition** are excluded from this analysis to ensure a correct presentation of the quality of treatment in a hospital, as in chapter 2. The standardised mortality ratio is shown for each hospital as well as for the TR-DGU over the past ten years. The standardised mortality ratio is defined as the quotient of the observed mortality and the risk of death prognosis (RISC II) for each hospital. A SMR value > 1 means, that the observed mortality is higher as expected. A SMR value < 1 indicates that the observed mortality is lower than expected. Figure 23 shows a slight increase in SMR for the TR-DGU compared to the four previous years.



Year:	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
TR-DGU:	1.04	1.01	1.04	1.04	1.03	1.02	0.96	0.96	1.00	1.03

Figure 23: Standardised mortality ratio of the — TR-DGU compared to the o single hospital values in the TR-DGU for the years 2010-2019

6.3 Length of stay and injury severity

The length of stay of the patients is very variable and depends on diverse factors. Figure 24 describes the relationship between the average length of stay (LOS) in hospital and injury severity (ISS). The mean value is calculated for survivors from the basic group. Patients transferred to another hospital (n= 4,715) are excluded here. Hospitals with **less than 3 patients** are **not** displayed in the figure due to their statistical uncertainty.

TR-DGU 2019:

The value is based on:
21,370 patients

Mean length of stay:
16.4 days

Mean ISS:
15.9 points

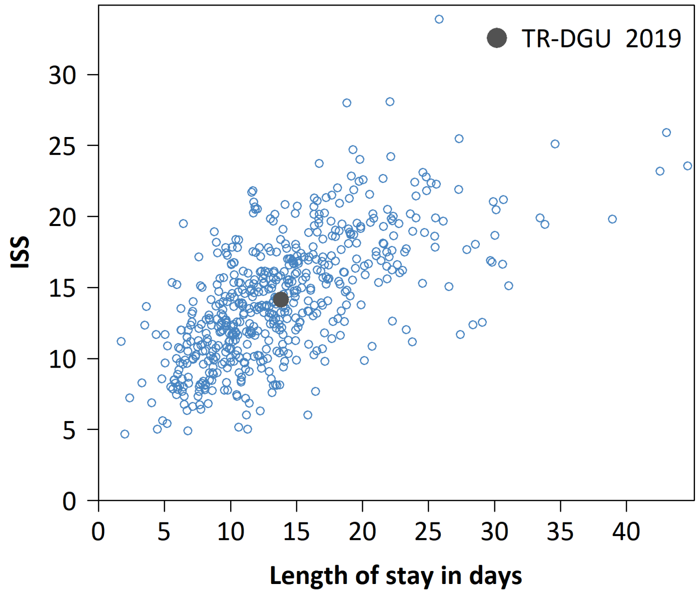


Figure 24: Relationship between length of stay and injury severity over all hospitals in 2019

6.4 Length of stay of the deceased patients

The following figure shows the distribution of length of stay of the deceased patients (N = 3,259) within the first 30 days (n = 3,114) in the TR-DGU in 2019.

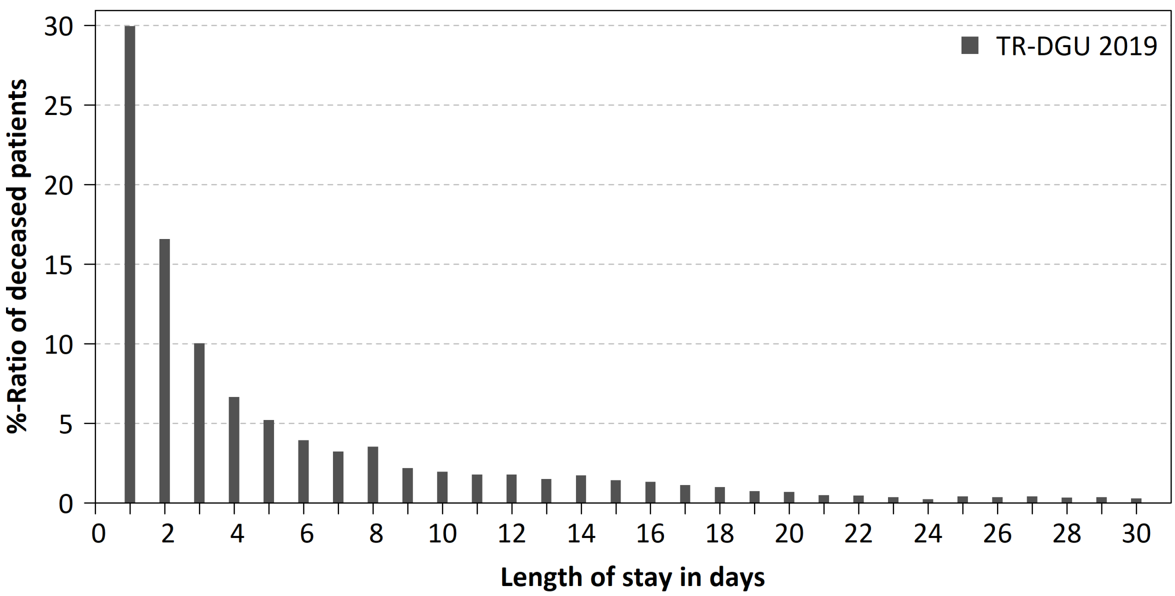


Figure 25: Time point of death of the patients from the TR-DGU [length of stay in days] in 2019

7 Basic data of trauma care

The following pages present basic data from the trauma care of the actual year 2019. The data refer to patients from the **basic group** (see page 5). Comparison group to the data from the TraumaRegister DGU® basic group of the same year (**TR-DGU 2019**) are the registry data of the last 10 years 2010-2019 (**TR-DGU 10 years**).

Table 5: Data from the TR-DGU on the patients and accident type

(S) Patient and accident	TR-DGU 2019		TR-DGU 10 years	
Patients of the **basic group** (n)	29,345		288,929	
Primary admissions / transfers	%	n	%	n
Primary admitted	**90.6 %**	26,596	**90.7 %**	262,007
Among these transferred out within 48 h	**6.6 %**	1,934	**6.6 %**	19,085
Transferred in within 24 h after accident	**8.5 %**	2,482	**8.4 %**	24,166
Transferred in after 24 h	**00.9 %**	267	**1.0 %**	2,756
Patient characteristics	**M** ± SD*/%	n	**M** ± SD*/%	n
Age [years]	**53.4** ± 22.6	29,345	**50.9** ± 22.6	288,929
Children under 16 years	**3.8 %**	1,112	**4.2 %**	12,137
Elderly over 70 years	**28.2 %**	8,263	**25.4 %**	73,353
Males	**69.2 %**	20,299	**70.0 %**	202,121
ASA 3-4 prior to trauma (since 2009)	**18.7 %**	5,109	**16.9 %**	42,855
Mechanism of injury	%	n	%	n
Blunt	**96.2 %**	26,853	**95.9 %**	263,294
Penetrating	**3.8 %**	1,055	**4.1 %**	11,238
Type and cause of accident	%	n	%	n
Traffic: Car	**19.3 %**	5,625	**20.8 %**	58,843
Traffic: Motor bike	**11.8 %**	3,433	**12.3 %**	34,860
Traffic: Bicycle	**10.5 %**	3,062	**9.3 %**	26,281
Traffic: Pedestrian	**5.2 %**	1,521	**6.2 %**	17,519
High fall (> 3m)	**14.4 %**	4,192	**15.5 %**	43,828
Low fall (≤ 3m)	**27.2 %**	7,904	**24.6 %**	69,522
Suicide (suspected)	**4.2 %**	1,211	**4.4 %**	12,366
Assault (suspected)	**2.3 %**	670	**2.5 %**	6,989

* M = Mean; SD = Standard deviation

Table 6: Data from the TR-DGU on findings at the accident scene. Information for primary admitted patients

Time point A: Findings at the accident scene	TR-DGU 2019		TR-DGU 10 years	
Primary admitted patients (n) (%-ratio of the basic group)	26,596 (91 %)		262,007 (91 %)	
Vital signs	**M** ± SD*	n	**M** ± SD*	n
Systolic blood pressure [mmHg]	**134.4** ± 33.2	23,126	**131.8** ± 33.3	227,933
Respiratory rate [1/min]	**15.9** ± 5.9	17,702	**15.7** ± 5.9	162,833
Glasgow Coma Scale (GCS) [points]	**12.8** ± 3.9	24,711	**12.5** ± 4.0	242,730
Findings	%	n	%	n
Shock (systolic blood pressure ≤ 90 mmHg)	**8.2 %**	1,905	**9.6 %**	21,864
Unconsciousness (GCS ≤ 8)	**15.7 %**	3,885	**17.4 %**	42,247
Therapy	%	n	%	n
Cardio-pulmonary resuscitation	**3.2 %**	808	**3.0 %**	7,510
Endotracheal intubation	**20.2 %**	5,143	**23.3 %**	59,070
Alternative airway	**1.2 %**	310	**.8 %**	1,917
Analgo-sedation **	**60.0 %**	7,896	**61.3 %**	77,834
Chest drain **	**3.9 %**	512	**3.1 %**	3,917
Catecholamines **	**9.5 %**	1,252	**8.2 %**	10,388
Pelvic binder **	**15.9 %**	2,089	**5.2 %**	6,620
Tranexamic acid	**11.3 %**	2,879	**3.7 %**	9,327
Volume administration	**M** ± SD*/%	n	**M** ± SD*/%	n
Patients without volume administration	**18.3 %**	4,508	**16.6 %**	40,651
with volume administration	**81.7 %**	20,141	**83.4 %**	203,576
with colloids	**2.0 %**	481	**8.0 %**	18,780
Average amount in patients with volume administration [ml]	**616** ± 521	24,649	**682** ± 576	244,227
Average amount in patients with and without volume administration [ml]	Median **500**		Median **500**	

* M = Mean; SD = Standard deviation

** Not available in the reduced QM dataset

Table 7: Data from the TR-DGU on emergency room and surgery. Information for primary admitted patients

Time point B: Emergency room / surgery	TR-DGU 2019		TR-DGU 10 years	
Primary admitted patients (n) (%-ratio of the basic group)	26,596 (91 %)		262,007 (91 %)	
Transportation to the hospital	%	n	%	n
With helicopter	**18.7 %**	4,973	**19.3 %**	50,675
Glasgow Coma Scale (GCS)	**MW** ± SA*	n	**MW** ± SA*	n
Prehospital intubated patients	**3.3** ± 1.6	3,255	**3.2** ± 1.4	34,065
Patients not prehospital intubated	**14.0** ± 2.3	9,257	**13.8** ± 2.5	85,398
Initial diagnostics	%	n	%	n
Sonography of the abdomen	**81.9 %**	21,635	**81.6 %**	211,174
X-ray of the thorax	**24.5 %**	6,482	**35.6 %**	92,219
cCT (isolated or whole-body)	**90.7 %**	24,124	**89.3 %**	233,936
Whole-body CT	**78.8 %**	20,808	**77.0 %**	199,262
Time period in the emergency room	**M** ± SD*/%	n	**M** ± SD*/%	n
Transfer to the operating theatre	**24.1 %**	6,171	**23.9 %**	29,382
If so: Duration from admission to the ER* until surgery [min]	**77.8** ± 61.8	5,677	**76.1** ± 61.2	26,289
Transfer to intensive care unit	**63.4 %**	16,252	**64.0 %**	78,547
If so: Duration from admission to the ER* until ICU* [min]	**87.4** ± 73.8	14,395	**85.5** ± 74.0	67,285
Bleeding and transfusion	**M** ± SD*/%	n	**M** ± SD*/%	n
Pre-existing coagulopathy	**20.0 %**	4,452	**19.4 %**	19,741
Systolic blood pressure ≤ 90 mmHg	**7.3 %**	1,814	**8.1 %**	19,763
Hemostasis therapy**	**20.8 %**	2,569	**16.6 %**	19,180
Administration of tranexamic acid**	**16.6 %**	2,059	**15.7 %**	7,790
ROTEM / thrombelastography**	**10.7 %**	1,214	**10.4 %**	9,718
Patients with blood transfusion	**6.8 %**	1,820	**8.1 %**	21,221
Number of pRBC, if transfused	**4.7** ± 4.9	1,820	**5.4** ± 6.6	21,221
Number of FFP, if transfused	**2.7** ± 4.7	1,820	**3.3** ± 6.0	21,221
Treatment in the ER	%	n	%	n
Cardio-pulmonary resuscitation **	**2.4 %**	310	**2.6 %**	3,318
Chest drain**	**10.0 %**	1,316	**10.9 %**	13,702
Endotracheal intubation**	**11.0 %**	1,429	**15.7 %**	19,373
Initial laboratory values	**M** * ± SD	n	**M** * ± SD	n
Base excess [mmol/l]	**-1.6** ± 4.6	21,395	**-1.8** ± 4.7	191,942
Hemoglobine [g/dl]	**13.1** ± 2.2	25,987	**13.1** ± 2.3	249,575
INR	**1.1** ± 00.5	25,189	**1.2** ± 00.5	239,673
Quick's value [%]	**89.6** ± 21.5	24,545	**87.0** ± 21.6	234,065
Temperature [C°]**	**36.2** ± 1.1	8,193	**36.2** ± 1.1	68,960

* ICU = Intensiv care unit; ER = Emergency room; M = Mean; SD = Standard deviation
** Not available in the reduced QM dataset

Table 8: Data from the TR-DGU on intensive care unit

Time point C: Intensive care unit	TR-DGU 2019		TR-DGU 10 years	
Patients with **intensive care therapy** (n) (%-ratio of the basic group)	25,273 (86 %)		251,178 (87 %)	
Treatment	%	n	%	n
Hemostasis therapy **	**13.4 %**	1,771	**15.1 %**	18,637
Dialysis / hemofiltration **	**1.9 %**	250	**2.3 %**	2,830
Blood transfusion ** (within the first 48 h after admission to ICU)	**22.8 %**	2,389	**27.3 %**	28,261
Mechanical ventilation / intubated	**34.8 %**	8,787	**40.2 %**	101,048
Complications on ICU	%	n	%	n
Organ failure **	**31.4 %**	4,201	**34.6 %**	43,577
Multiple organ failure (MOF) **	**17.8 %**	2,339	**20.5 %**	25,540
Sepsis **	**5.3 %**	13,085	**5.9 %**	0
Length of stay and ventilation	**M** ± SD*	n	**M** ± SD*	n
Length of intubation [days]	**7.3** ± 10.1	8,698	**7.5** ± 10.5	99,883
	Median **3**		Median **3**	
Length of stay on ICU* [days]	**6.1** ± 10.1	25,273	**6.6** ± 10.4	251,178
	Median **2**		Median **2**	

* ICU = Intensiv care unit; ER = Emergency room; M = Mean; SD = Standard deviation
** Not available in the reduced QM dataset

Table 9: Data from the TR-DGU on discharge and outcome

Time point D: Discharge / outcome	TR-DGU 2019		TR-DGU 10 years	
Patients from the basic group	29,345		288,929	
Diagnoses	**M** ± SD*/%	n	**M** ± SD*/%	n
Number of injuries / diagnoses per patient	**4.5** ± 3.1		**4.5** ± 2.9	
Patients with only **one** injury	**10.5 %**	3,087	**10.0 %**	28,902
Surgeries	**M** ± SD*/ %	n	**M** ± SD*/ %	n
Patients with surgery	**66.4 %**	10,639	**67.1 %**	97,987
Number of surgeries per patient, if undergone surgery**	**3.3** ± 3.7		**3.4** ± 4.1	
Thrombo-embolic events (MI; pulmonary embolism; DVT; stroke; etc.)	%	n	%	n
Patients with at least one event **	**2.7 %**	386	**2.7 %**	3,724

* M = Mean; SD = Standard deviation
** Not available in the reduced QM dataset

Table 9 continuation:

Time point D: Discharge / outcome	**TR-DGU 2019**		**TR-DGU 10 years**	
Patients from the basic group	29,345		288,929	
Outcome (without early transfers out)	%	n	%	n
Survivors	**88.1 %**	24,151	**88.6 %**	239,001
Hospital mortality	**11.9 %**	3,260	**11.4 %**	30,843
Died within 30 days	**11.4 %**	3,114	**11.0 %**	29,551
Died within 24 hours	**4.5 %**	1,223	**4.5 %**	12,240
Died in the ER (without ICU)	**1.5 %**	419	**1.6 %**	4,307
Transfer / discharge (all survivors)	%	n	%	n
Survivors who were discharged and …	**100.0 %**	26,085	**100.0 %**	258,086
transferred into another hospital	**18.1 %**	4,715	**17.5 %**	45,262
... among them early discharges (< 48 h)	**7.4 %**	1,934	**7.4 %**	19,085
transferred into a rehabilitation center	**15.1 %**	3,946	**18.5 %**	47,854
other destination	**3.4 %**	890	**3.6 %**	9,202
sent home	**63.4 %**	16,534	**60.4 %**	155,768
Condition at the time of discharge (according to the parameter „outcome"; without early transfers out)	%	n	%	n
Patients with a valid value		27,051		261,337
of these surviving patients	**100 %**	23,791	**100 %**	230,494
- good recovery	**63.7 %**	15,154	**65.6 %**	151,143
- moderate disability	**26.5 %**	6,300	**24.5 %**	56,486
- severe disability	**8.6 %**	2,046	**8.5 %**	19,544
- persistant vegetative state	**1.2 %**	291	**1.4 %**	3,321
Length of stay in hospital [days] (all patients from the basic group)	**M** ± SD*	n	**M** ± SD*	n
All patients	**14.4** ± 17.3	29,344	**15.4** ± 17.7	288,888
Median	Median **10**		Median 11	
Only survivors	**15.2** ± 17.5	26,085	**16.4** ± 17.9	258,050
Median survivors	10		**12**	
Only non-survivors	**7.7** ± 14.6	3,259	**7.3** ± 12.5	30,838
Median non-survivors	3		3	
LOS when transferred to a rehabilitation centre	**28.4** ± 22.5	3,946	**29.2** ± 22.2	47,849
when transferred to another hospital	**10.0** ± 14.0	4,715	**10.2** ± 14.7	45,258
when sent home	**13.3** ± 14.8	16,534	**14.0** ± 14.8	155,743
Costs of treatment *** (without early transfers out)	€	n	€	n
Average costs in € per patient				
... all patients	**21,630**	10,438	**22,627**	115,542
... only non-survivors	**13,253**	2,354	**12,553**	24,123
... only survivors	**24,070**	8,084	**25,286**	91,419
... only patients with ISS ≥ 16	**24,876**	7,562	**25,575**	85,944
Sum of all costs	225,779,120 €		2,614,401,921 €	
Sum of all days in hospital	212,344 days		2,442,017 days	
Average costs per day per patient	1063.3 €		1070.6 €	

* M = Mean; SD = Standard deviation; LOS = Length of stay
** Not available in the reduced QM dataset
***** Treatment costs:** The estimated treatment costs are based on data from 1,002 German TR-DGU patients treated in 2007/08. For these patients a detailed cost analysis is available (Lefering et al., Unfallchirurg, 2017). Assuming a cost increase of 2 % per year the costs today would be 25 % higher.

8 Subgroup analyses

Specific subgroups are presented on these pages. Besides descriptive data on the patients and the process of care, also the outcome (hospital mortality) and prognosis are presented here for each subgroup. In order to reduce the statistical uncertainty occurring in subgroup analyses, patients from the last three years (2017-2019) are pooled together. Again, only patients from the **basic group** are considered here.

8.1 Subgroups within the TR-DGU

All results in table 10 refer to **primary admitted cases** from the basic group. Patients transferred in as well as those transferred out early (within 48 h) are not considered here. There is a total of **83,230 patients** from the TR-DGU in the last three years.

Table 10: Basic data from the TR-DGU on selected subgroups. The percentage frequency refers to the number of patients from the respective subgroup in the basic group

		Primary patients 2017-2019	Subgroups					
			No TBI	**Combined trauma**	**Isolated TBI**	**Shock**	**Severe injuries**	**Elderly**
Definition of the subgroups		All	AIS head ≤ 1	AIS head and body each ≥ 2	AIS head ≥ 3 and AIS elsewhere ≤ 1	sBP ≤ 90 mmHg on admission	ISS ≥ 16 and at least 1 phys. problem*	Age 70 years or more
Number of basic group patients	n	75,974	42,405	30,526	10,299	5,801	24,938	22,134
	%	100 %	50.9 %	36.7 %	12.4 %	7.0 %	30.0 %	26.6 %
Patients								
Age [years]	M	52.3	49.4	53.4	61.0	52.0	61.4	80.3
Males	%	69.6 %	71.3 %	68.9 %	64.6 %	68.9 %	66.0 %	55.6 %
ASA 3-4	%	17.6 %	13.6 %	18.7 %	31.7 %	21.3 %	29.9 %	46.5 %
Injuries								
ISS [points]	M	17.9	14.3	22.7	18.3	30.0	28.5	18.7
Head injury (AIS ≥ 3)	%	33.1 %		56.5 %	100.0 %	46.0 %	63.8 %	45.2 %
Thoracic injury (AIS ≥ 3)	%	38.2 %	44.5 %	42.4 %		55.7 %	51.4 %	35.5 %
Abdominal injury (AIS ≥ 3)	%	9.6 %	13.3 %	7.7 %		23.8 %	14.2 %	5.1 %
Prehospital care								
Duration from accident to hospital [min]	M	64	63	66	67	70	70	66
Intubation	%	20.9 %	10.6 %	31.2 %	32.8 %	61.8 %	47.3 %	20.1 %
Volume [ml]	M	634.7	638.7	670.9	507.8	983.1	763.2	538.8
Emergency room								
Blood transfusion	%	7.1 %	6.8 %	8.9 %	2.9 %	36.1 %	17.5 %	5.9 %
Whole-body CT	%	79.8 %	81.7 %	84.3 %	58.5 %	80.4 %	81.2 %	72.4 %
Cardio-pulmonary resuscitation	%	2.4 %	2.1 %	3.1 %	1.6 %	14.1 %	6.4 %	2.5 %
Physiological problems *								
Age ≥ 70 years	%	26.6 %	20.2 %	29.0 %	45.9 %	27.2 %	50.6 %	100.0 %
Shock (sBP ≤ 90 mmHg)	%	11.7 %	10.4 %	14.2 %	9.2 %	100.0 %	29.8 %	11.4 %
Acidosis (BE < -6)	%	11.6 %	9.1 %	14.8 %	11.8 %	42.7 %	28.5 %	11.5 %
Coagulopathy	%	11.2 %	8.5 %	13.7 %	14.7 %	33.9 %	26.5 %	20.4 %
Unconsciousness (GCS ≤ 8)	%	16.1 %	4.3 %	25.9 %	35.7 %	46.8 %	44.2 %	18.7 %

* According to the definition of patients with severe life-threatening injuries from Paffrath et al. (2014); phys. problems are defined according to Pape et al. (2014).

Table 10 continuation:

		Primary patients 2017-2019	Subgroups					
			No TBI	Combined trauma	Isolated TBI	Shock	Severe injuries	Elderly
Length of stay								
Patients with intensiv care therapy	n	74,634	36,908	28,403	9,323	4,936	22,552	19,569
- Intubation on intensiv care unit [days]	M	7.4	5.7	8.6	6.9	8.8	8.8	7.2
- Intensiv care unit [days]	M	6.1	4.7	7.8	6.8	12.0	10.8	6.4
Days in hospital, all patients	M	15.1	15.1	16.0	12.7	19.8	19.1	14.8
Mortality and prognosis (without patients deceased within the first week with a patient's volition)								
Non-survivors	n	7,433	1,754	3,682	1,997	1,875	6,199	3,819
Mortality	%	9.2 %	4.2 %	12.4 %	21.2 %	34.2 %	26.7 %	18.7 %
Risk of death prognosis (RISC II)	%	9.2 %	4.0 %	13.1 %	20.4 %	36.6 %	27.1 %	18.4 %

8.2 Graphical comparison of the length of stay between subgroups

To graphically illustrate the deviations between the different subgroups regarding their length of stay, the following figures are given. As in chapter 6, the hospitals from the TR-DGU are indicated as light blue circles. The horizontal grey line is the mean value over all hospitals per group.

Figure 26 shows the **length of stay on intensive care unit** in days for 2017-2019 between the subgroups defined in table 10 for all primary admitted and treated patients of the TR-DGU in the basic group (patients ≥ 3).

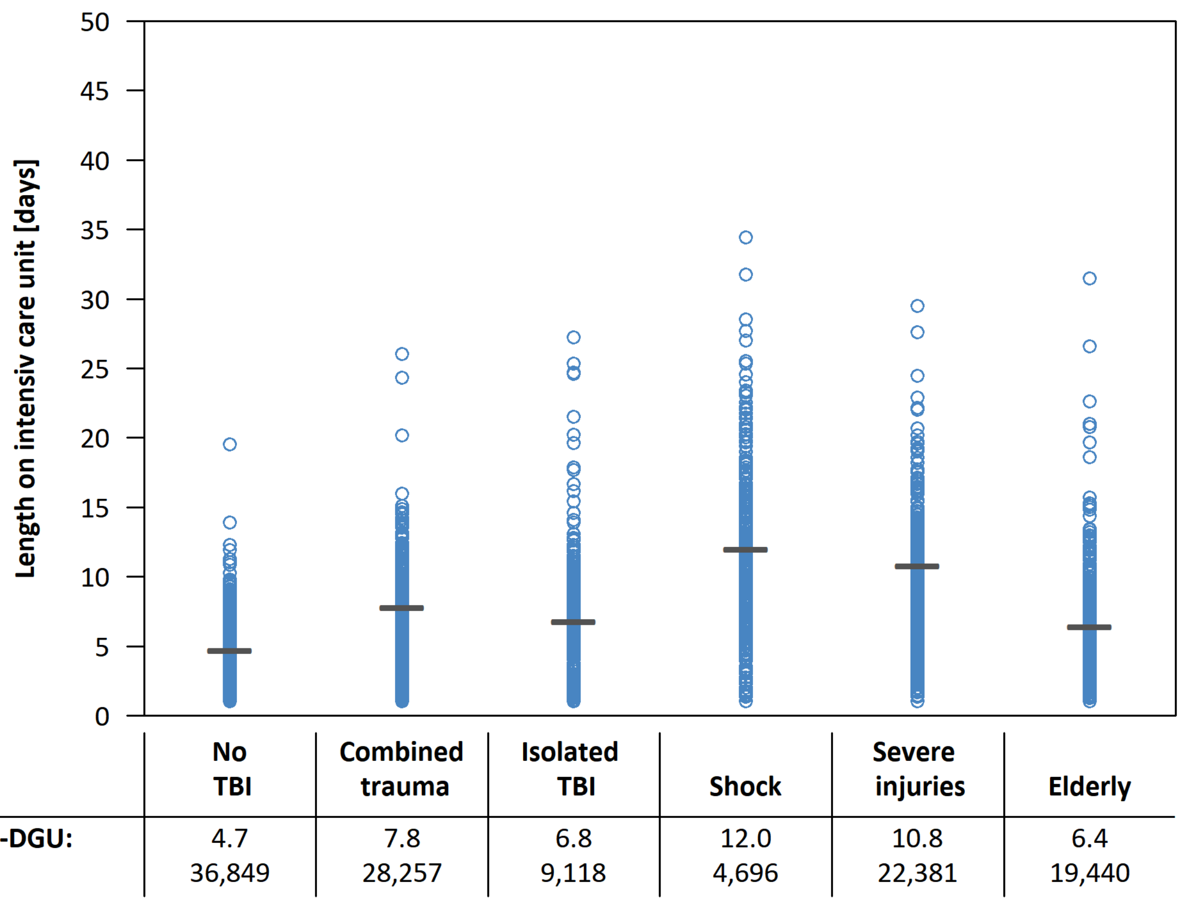
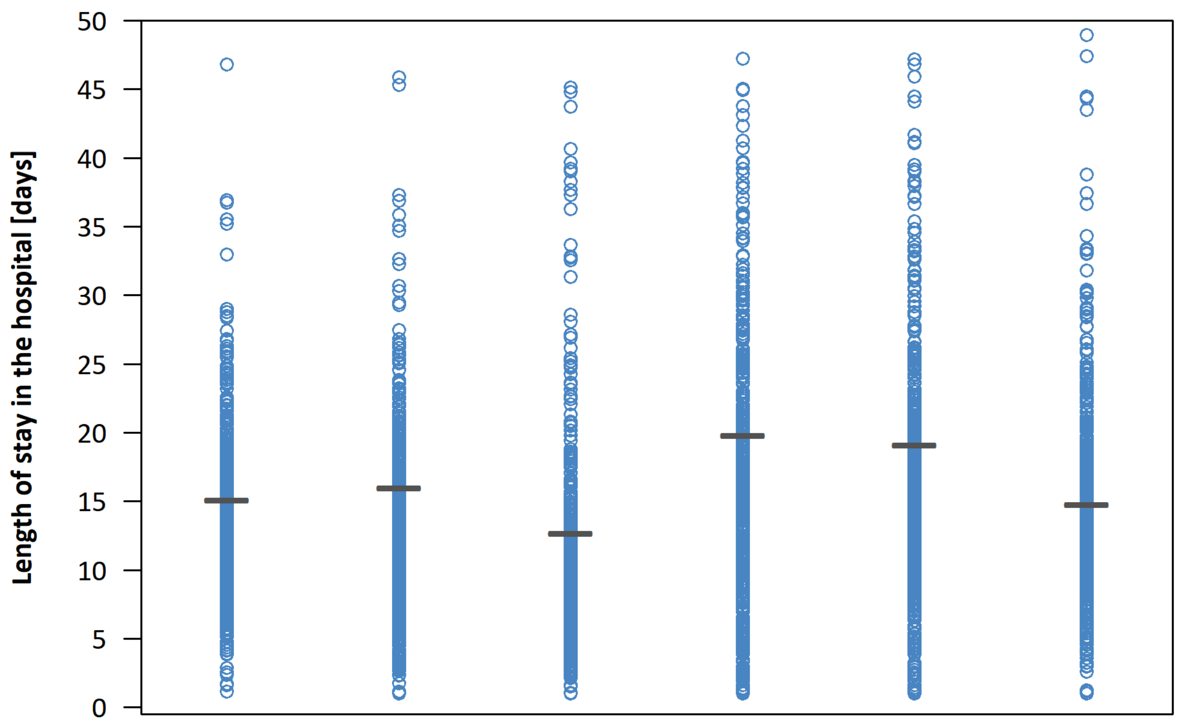


Figure 26: Length of stay on intensive care unit [days] and number of patients divided into subgroups, for definition see tab. 10, patients 2017-2019, — TR-DGU, o single hospital value

Figure 27 compares the **length of stay in hospital** in days for 2017-2019 between the subgroups defined in table 10 for all primary admitted and treated patients of the TR-DGU in the basic group.



	No TBI	Combined trauma	Isolated TBI	Shock	Severe injuries	Elderly
TR-DGU:	15.1	16.0	12.7	19.8	19.1	14.8
n:	42,405	30,526	10,299	5,801	24,938	22,134

Figure 27: Length of stay in hospital [days] and number of patients divided into subgroups, for definition see tab. 10, patients 2017-2019, — TR-DGU, o single hospital value

9 Data quality and completeness

9.1 Completeness of selected variables

Registries and audit reports can only be as good as the data they are based on. If a lot of patients have missing data in important variables, then the results might be biased or even wrong. Table 12 describes the **completeness rates („ % ”)** of several important variables, together with **the number of patients with missing data („ {} ”)**. The list of variables only contains the prognostic variables needed for the RISC II.

As on the previous pages, only cases from the **basic group** are considered here. The completeness rates of the **TR-DGU in 2019** are compared with the data from the previous years (**since 2010**). Cases with implausible data are classified as missing.

Table 11: Evaluation criteria for data quality in the TR-DGU

Coding	Evaluation	Data completeness in general	Data completeness based on the surgery rate
green	Good	> 95 %	≥ 70 %
yellow	Moderate	90 %-95 %	50 %-69 %
red	Insufficient	< 90 %	< 50 %

Table 12: Completeness rates [%], number of missing values {} for selected parameters as well as time to case documentation in the TR-DGU [months]

Variable	Explanation	TR-DGU 2019		TR-DGU 2010-2018	
Prehospital data (A)		%	{}	%	{}
Only primary admitted patients, who have not admitted themselves / were not admitted privately		n = 26,008		n = 230,936	
GCS	RISC II requires the motor component; quality indicators use the GCS for the definition of cases	**94 %**	1,484	**94 %**	14,801
Blood pressure	Initial blood pressure is important for validating the volume therapy and for the definition of shock	**89 %**	2,951	**88 %**	26,955
Pupils *	Pupil size and reactivity are relevant for prognosis (RISC II)	**91 %**	91	**64 %**	82,707
CPR	Cardio-pulmonary resuscitation is seldom but highly predictive for outcome; required for RISC II	**91 %**	2,245	**92 %**	17,410
Emergency room (B)					
Only primary admitted patients		n = 26,596		n = 235,411	
Time of admission	Required to calculate the diagnostic time periods (quality indicators)	**99 %**	244	**99 %**	2,528
Blood pressure	Blood pressure on admission is used by RISC II as a prognostic variable and to define shock	**94 %**	1,582	**92 %**	17,864
Base excess	The initial base excess is part of the RISC II and an important prognostic factor	**80 %**	5,211	**72 %**	65,018
Coagulation	The INR (or Quick's value) is needed for the RISC II as coagulation marker	**95 %**	1,407	**91 %**	20,927
Hemoglobine	Prognostic factor; is part of the RISC II prognosis	**98 %**	609	**95 %**	11,823
Patients and outcome					
All patients from the basic group		n = 29,345		n = 259,584	
ASA	Prior diseases are relevant for outcome prediction (RISC II)	**93 %**	2,049	**87 %**	32,708
Surgical treatment *	A low rate of surgical patients could be based on incomplete documentation	**61 %**		**44 %**	
Outcome	The levels according to the parameter „outcome" describe the patient's condition at discharge or transfer	**97 %**	897	**95 %**	12,545
Process data - Period of time until documentation					
All patients from the basic group		n = 29,345		n = 259,584	
Period of time accident to case creation in the TR-DGU**	A **prompt documentation** of patients increases the data quality of a case in the TR-DGU. Therefore, the time period from accident to the start of documentation is given here	**4.3 months**		**4.5 months**	
Period of time discharge to case completion in the TR-DGU**	Time from discharge of a patient to **completion** of documentation in the registry	**5.4 months**		**5.5 months**	

* Up from the dataset revision 2015 the parameter is also part of the QM dataset

** Not to be interpreted for imported data, because only the import date is recorded and not the date of creation and completion of a case

9.2 Comparison of data quality among hospitals

Detailed completeness rates for different variables are presented in chapter 9.1. In order to compare data quality among hospitals, a combined **quality score** is generated here.

The calculation of this quality score is based on the following ten variables:
Prehospital phase: GCS, blood pressure, cardio-pulmonary resuscitation
Emergency room phase: Time of admission, blood pressure, base excess, coagulation (Quick's value or INR), hemoglobine
Patient information: Previous health status (pre-injury ASA), outcome (according to the parameter „outcome").
All these variables are part of both, the standard and the reduced QM dataset.

The number of missing data from all **primary admitted patients in the basic group** is summarised. This leads to the calculation of an average completeness rate.

Table 13: Data completeness of the TR-DGU in 2019 and comparison over the time

Data quality: Completeness	TR-DGU 2019	TR-DGU 2010-2018
Primary admitted patients from the basic group	n = 26,596	n = 235,411
Sum over all recorded values	n = 265,960	n = 2,354,110
Sum of the missing values	{} 19,668	{} 226,548
Average completeness rate (%) based on the 10 specified parameters	**92.6 %**	**90.4 %**

9.2.1 Graphical comparison with other hospitals

Figure 28 summarises the average completeness value from all 657 hospitals that entered cases **in 2019**. It follows the idea of a box plot in which the light blue box ranging from 88.1 % to 96.7 % covers half of all hospital values. The black vertical line within the box is the median average completeness value 93.1 %.

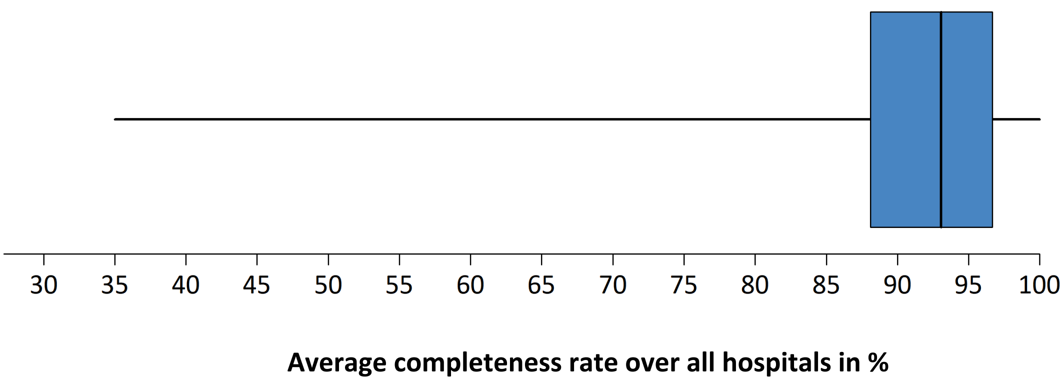


Figure 28: Distribution of the data completeness rate in 2019 over all hospitals

9.2.2 Development over time

Figure 29 shows the development of data completeness over the last ten years since 2010. For each documentation form (standard/QM dataset) a separate line is given. It can be seen that the data completeness rate of the QM dataset is slightly increased since 2012. The data completeness of the standard dataset has approached to the line of the QM dataset since 2013, so that the data completeness in 2019 is similar between the two datasets with a notable value over 90 %.

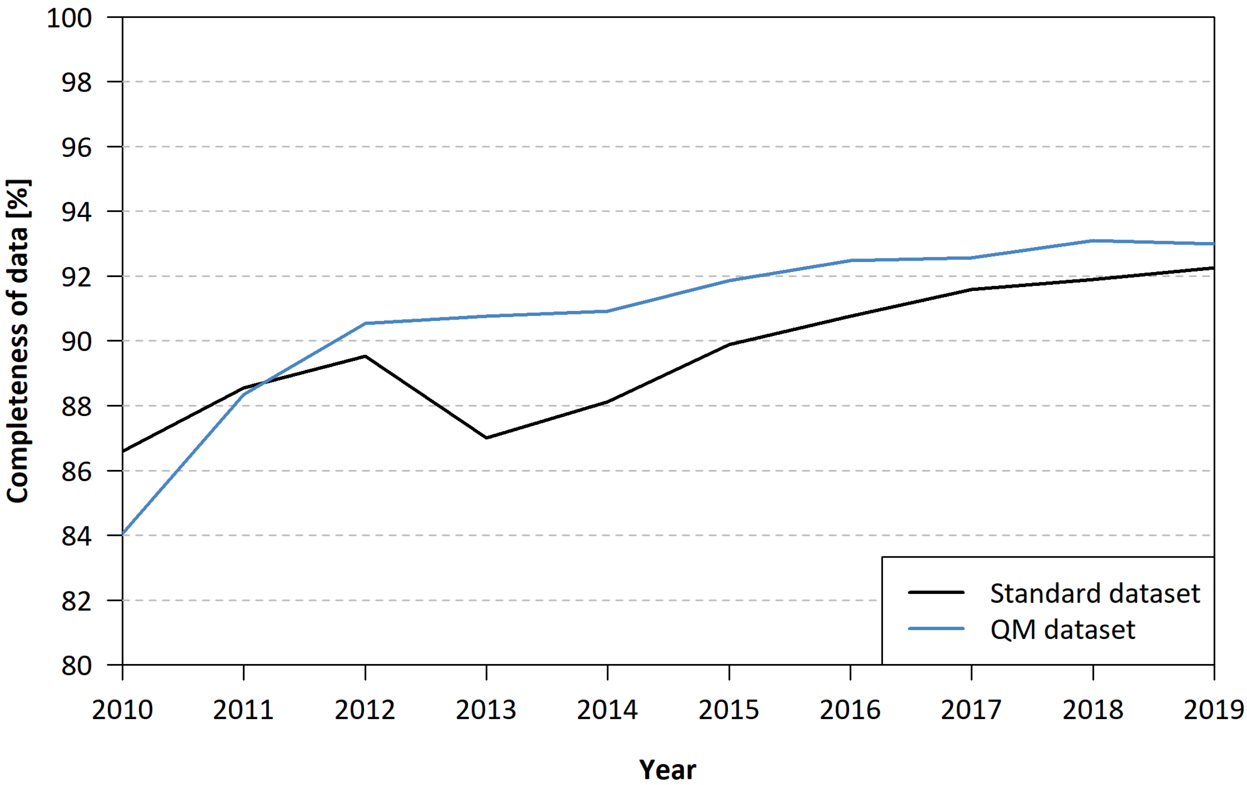


Figure 29: Development over time of the documentation quality: completeness rate in the TR-DGU 2010-2019

10 Injury pattern

In table 14, the average injury pattern ofthe TraumaRegister DGU® patients is presented. Only cases from the **basic group** are considered. In order to reduce the statistical uncertainty, all patients from the **last three years (2017-2019)** are pooled. Data are presented for each of the nine body regions according to the **Abbreviated Injury Scale (AIS)**. The rates refer to injuries with an injury **severity of at least two points** (including radius fractures, spine fractures, lung contusions, etc.).

Figure 30 shows in colour the injury pattern over the the body regions that were documented in the TR-DGU in 2019.

Table 14: Distribution of the injuries from all recorded patients (basic group) for the years 2017-2019

	TR-DGU 2017-2019
Patients in the basic group	**100 %** (N = 98,671)
Head	**46.2 %** (n = 45,572)
Face	**11.0 %** (n = 10,861)
Neck	**1.6 %** (n = 1,540)
Thorax	**45.1 %** (n = 44,482)
Abdomen	**14.4 %** (n = 14,173)
Spine	**29.4 %** (n = 29,059)
Arms	**28.8 %** (n = 28,415)
Pelvis	**15.1 %** (n = 14,902)
Legs	**23.3 %** (n = 23,030)

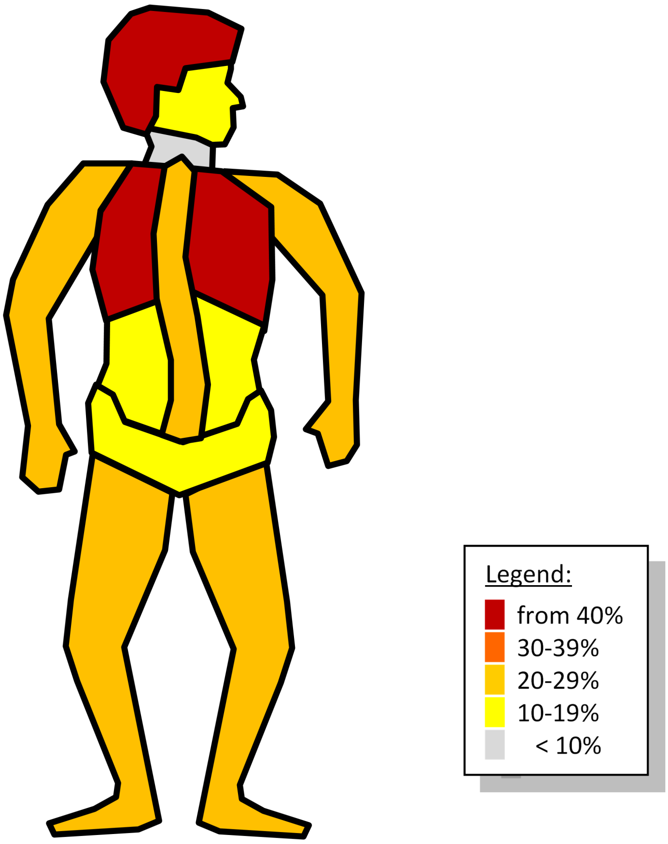


Figure 30: Injury pattern in the TR-DGU for the basic group from 2019

Serious injuries (AIS 3+)

Injuries with a severity of 3 points or more (AIS) are considered as „serious". The prevalence of serious injuries in the four most important body regions (head, thorax, abdomen, extremities) is given in table 15. The body regions considered here refer to the respective regions of the **Injury Severity Score** (ISS). So spine injuries are assigned to the respective regions head, thorax or abdomen.

Different from table 14 only patients with at least one relevant injury (MAIS 3+, see chapter 1) are considered here.

Table 15: Ratio of serious injured patients (AIS ≥ 3) per body region for the years 2017-2019 (basic group)

	TR-DGU 2017-2019
Serious injury (AIS ≥ 3)	**80.9 %** (N = 79,863)
... of the **head**	**44.5 %** (n = 35,540)
... of the **thorax**	**45.9 %** (n = 36,635)
... of the **abdomen**	**12.1 %** (n = 9,651)
... of the **extremities**	**28.2 %** (n = 22,525)
Patients with **more than one** seriously injured body region	**29.4 %** (n = 23,507)

11 General results

Some results of the actual data analysis from the TraumaRegister DGU® are of general interest. They are presented here without reference to individual hospitals' results.

Hospitals

In 2019, 36,699 patients were registered from 665 hospitals that documented cases in the TraumaRegister DGU®. The **basic group** that this report is based on comprises **29,345 patients** from 657 hospitals (details on the definition see chapter 1). There are already **175,729 patients** that have been documented with the in 2015 updated dataset.

There were 15,651 patients with ISS ≥ 16 from 616 hospitals in the basic group. The distribution of the number of ISS ≥ 16 patients per hospital is shown in figure 31.

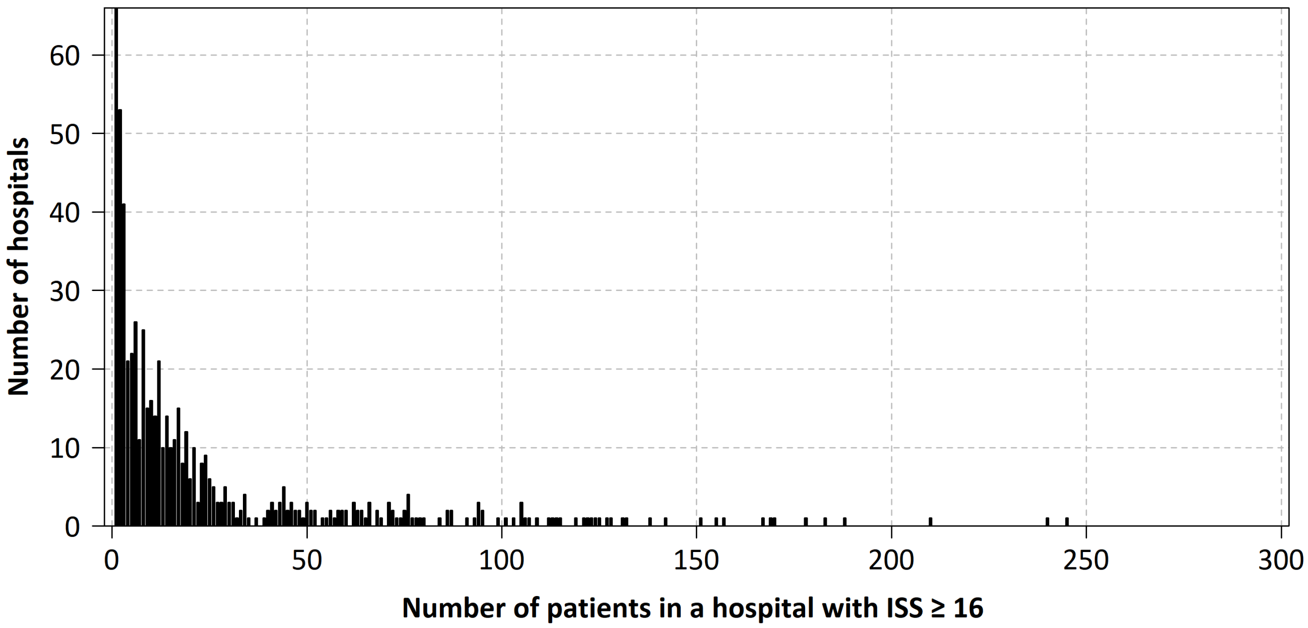


Figure 31: Frequency distribution of ISS ≥ 16 patients numbers per hospital in the TR-DGU 2019

Patients

Figure 32 demonstrates the continuous increase of registered patients over time since 2002. In 2019, 7,354 recorded patients did not fulfil the criteria of the basic group and were not seriously injured per TR-DGU definition. There were 49.3 % German patients in the basic group that were documented by the standard dataset (S) in 2019.

In 2019, there were **657 hospitals** that documented patients in the basic group, 57 hospitals were from foreign countries (8.7 %), namely Belgium, Finland, Luxembourg, The Netherlands, Austria, Switzerland, Slovenia and the United Arab Emirates and 600 hospitals from Germany.

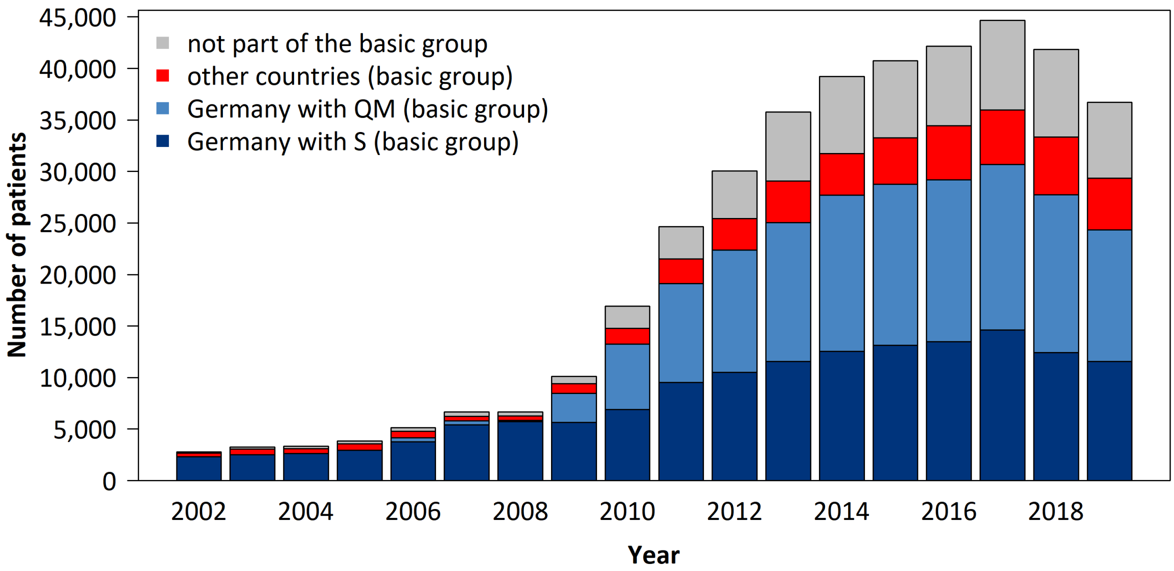


Figure 32: Number of cases in the TR-DGU 2002-2019, S: standard dataset, QM: QM dataset

11.2 Patients with a documented patient's volition

With the revision of the data set in 2015, the new parameter "Patient's volition" was added for a more precise documentation the treatment quality. This allows to consider patients more accurately that were against life-sustaining treatments. However, without the limitation to document this parameter for deceased patients, only. With the new data revision 2020 this limitation was added. In the analysis and the respective chapters, that compare the actual mortality with the risk of death prognosis, deceased within the first week with a patient's volition were excluded. This was done in order to better assess the quality of treatment in each hospital.

The following analysis will provide a deeper insight into this special cohort. Table 16 shows the deceased of the basic group, separated according to patient's volition available or not available.

Table 16: Number of deceased patients with a documented patient's volition for the years 2015-2019

Year	2015	2016	2017	2018	2019
Number of deceased	3,497	3,610	3,709	3,621	3,260
Number of deceased **without** a patient's volition	438	1,754	1,749	1,674	1,038
Number of deceased **with** a patient's volition	272	1,140	1,239	1,321	1,128
...among them deceased within the first 7 days	166	707	759	811	722
Proportion of deceased **with a patient's volition**	38 %	39 %	41 %	44 %	52 %

The analysis of the age of the deceased shows (Table 17) that their mean age in the past 5 years was over 65. Furthermore, it is displayed that deceased with a patient's volition were in average approximately 15 years older compared to deceased without a patient's volition.

Table 17: Mean age of the deceased separated by availability of a patient's volition in the years 2015-2019

Year	2015	2016	2017	2018	2019
Mean age of the deceased [years]	65.7	66.0	66.7	67.7	67.3
Mean age of the deceased **with** a patient's volition [years]	77.5	76.8	77.5	76.9	76.5
Mean age of the deceased **without** a patient's volition [years]	62.2	60.0	60.5	61.2	59.7

12 Publications from the TraumaRegister DGU®

An extended list of publications from the TraumaRegister DGU® since 1997 is available on **www.traumaregister-dgu.de**.

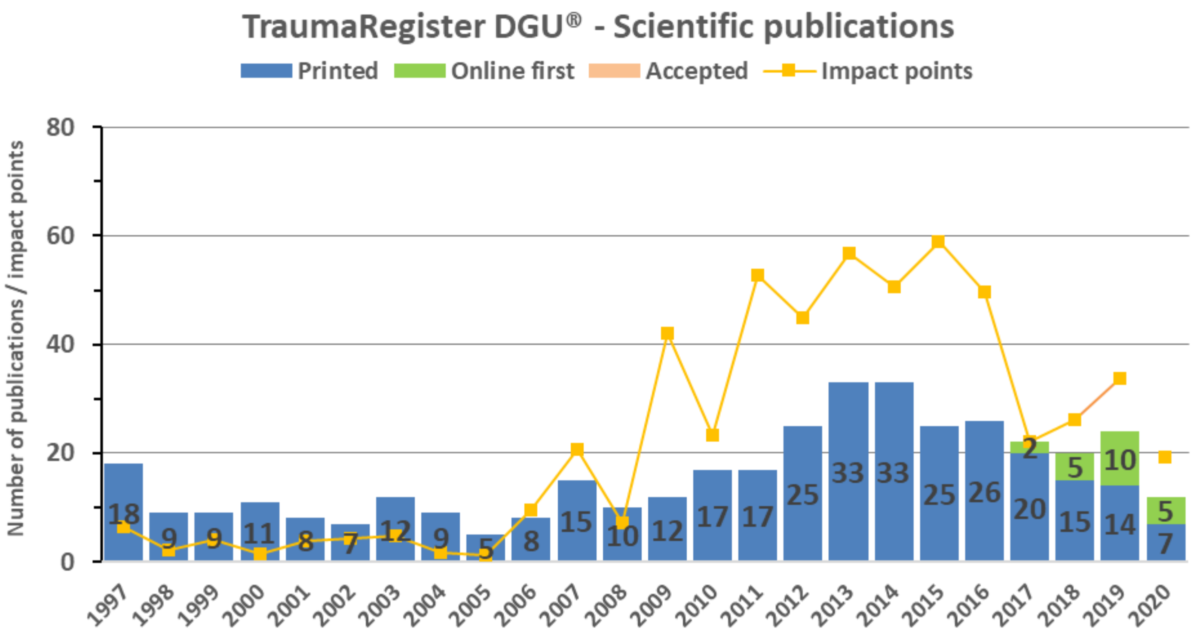


Figure 33: Number of publications from the TraumaRegister DGU® and their impact points since 1997

12.1 Facts from the Reviewboard in 2019

The Reviewboard meets every 4-6 weeks to discuss incoming applications and manuscripts from the TraumaRegister DGU® and to initiate the review process. The Reviewboard consists of four members of the NIS, that meet in a quarterly rotation system with Prof. Lefering, Dr. Höfer and Mrs. Nienaber. The administrative management is performed by Mrs. Isserstedt. Table 18 is given an overview over the work of the TraumaRegister DGU® Reviewboard in the year 2019.

Table 18: Facts from the Reviewboard 2019

	2019
Number of discussed applications	55
Number of approved manuscripts for publication	17
Number of reviewd applications	72
Number of reviewed manuscripts	36
Number of reviewers	62

12.2 Publications from the TR-DGU 2018-07/2020

2020

Bieler D, Paffrath T, Schmidt A, Völlmecke M, Lefering R, Kulla M, Kollig E, Franke A, Sektion NIS of the German Trauma Society. Why do some trauma patients die while others survive? A matched-pair analysis based on data from Trauma Register DGU®. Chinese Journal of Traumatology 2020 [Epub ahead of print].

Briese T, Theisen C, Schliemann B, Raschke MJ, Lefering R, Weimann A. Shoulder injuries in polytraumatized patients: an analysis of the TraumaRegister DGU®. Eur J Trauma Emerg Surg. 2020 [Epub ahead of print].

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12.3 Abstracts 08/2019 - 07/2020

Chin J Traumatol. 2020 May 15. doi: 10.1016/j.cjtee.2020.05.001. [Epub ahead of print]

Why do some trauma patients die while others survive? A matched-pair analysis based on data from Trauma Register DGU®.

Bieler D, Paffrath T, Schmidt A, Völlmecke M, Lefering R, Kulla M, Kollig E, Franke A, Sektion NIS of the German Trauma Society.

PURPOSE: The mortality rate for severely injured patients with the injury severity score (ISS) ≥16 has decreased in Germany. There is robust evidence that mortality is influenced not only by the acute trauma itself but also by physical health, age and sex. The aim of this study was to identify other possible influences on the mortality of severely injured patients.

METHODS: In a matched-pair analysis of data from Trauma Register DGU®, non-surviving patients from Germany between 2009 and 2014 with an ISS≥16 were compared with surviving matching partners. Matching was performed on the basis of age, sex, physical health, injury pattern, trauma mechanism, conscious state at the scene of the accident based on the Glasgow coma scale, and the presence of shock on arrival at the emergency room.

RESULTS: We matched two homogeneous groups, each of which consisted of 657 patients (535 male, average age 37 years). There was no significant difference in the vital parameters at the scene of the accident, the length of the pre-hospital phase, the type of transport (ground or air), pre-hospital fluid management and amounts, ISS, initial care level, the length of the emergency room stay, the care received at night or from on-call personnel during the weekend, the use of abdominal sonographic imaging, the type of X-ray imaging used, and the percentage of patients who developed sepsis. We found a significant difference in the new injury severity score, the frequency of multi-organ failure, hemoglobine at admission, base excess and international normalized ratio in the emergency room, the type of accident (fall or road traffic accident), the pre-hospital intubation rate, reanimation, in-hospital fluid management, the frequency of transfusion, tomography (whole-body computed tomography), and the necessity of emergency intervention.

CONCLUSION: Previously postulated factors such as the level of care and the length of the emergency room stay did not appear to have a significant influence in this study. Further studies should be conducted to analyse the identified factors with a view to optimising the treatment of severely injured patients. Our study shows that there are significant factors that can predict or influence the mortality of severely injured patients.

Eur J Trauma Emerg Surg. 2020 Mar 27. doi: 10.1007/s00068-020-01340-1. [Epub ahead of print]

Shoulder injuries in polytraumatized patients: an analysis of the TraumaRegister DGU®.

Briese T, Theisen C, Schliemann B, Raschke MJ, Lefering R, Weimann A.

BACKGROUND: The aim of the present study was to analyze the prevalence, epidemiology and relevance of shoulder injuries in polytraumatized patients in a large national trauma database. We hypothesize a high prevalence of shoulder injuries in traffic accidents and a high prevalence of concomitant injuries of the thorax leading to an aggravated clinical course and higher Injury Severity Score (ISS). Furthermore, we hypothesize an increased rate of surgical treatment with the severity of the injury.

MATERIALS AND METHODS: The retrospective analysis is based on the database (2002-2013) of the TraumaRegister DGU® and includes statistical data from 608 hospitals. The severity of injuries and trauma were scaled using the Abbreviated Injury Scale (AIS), and the Injury Severity Score (ISS), respectively. Patients with an ISS ≥ 16 were included in the study, and injuries were subdivided according to their anatomical involvement and analyzed with respect to the trauma mechanism and the resulting injuries.

RESULTS: In this study, 54,076 cases of patients with an ISS ≥ 16 were analyzed. Shoulder injuries occurred in 15,115 patients (27.9 %). Of these, 68.5 % were caused by traffic accidents, especially in motorbike, bicycle, and pedestrian accidents. We found more shoulder injuries in blunt trauma mechanisms. Moreover, patients with shoulder injuries spent on average 1.7 more days on the intensive care unit (ICU), or intermediate care unit (IMCU), according to the severity of the injury, and had longer overall hospital stays (26.2 vs. 24.1 days) than patients without shoulder injuries. The overall ISS was increased in patients with shoulder injuries, whereas an increase of mortality could not be identified. Concomitant thoracic injuries occurred significantly more often in patients with shoulder injuries (82.9 % vs. 69.6 %). Injuries of the abdomen, pelvis, and lower extremity showed no correlation with shoulder injuries, whereas head and spine injuries showed a significant correlation.

CONCLUSION: Shoulder injuries are very common in polytraumatized patients. Together with their distinctive concomitant injuries, they have an aggravating impact on the clinical progress. Our data confirm the correlation with thoracic injuries. Furthermore, we identified an increased risk of shoulder injuries in motorbike, bicycle, and pedestrian accidents. An increase in mortality could not be identified.

Injury. 2020 May 8;S0020-1383(20)303 53-3. doi: 10.1016/j.injury.2020.04.022. [Epub ahead of print]

Missed Hand and Forearm Injuries in Multiple Trauma Patients: An Analysis From the TraumaRegister DGU®.

Fitschen-Oestern S, Lippross S, Lefering R, Klüter T, Behrendt P, Weuster M, Seekamp A, TraumaRegister Dgu

PURPOSE: Multiple trauma patients have a high risk of missed injuries. The main point of our study was to provide new epidemiological data on hand and forearm injuries in multiple trauma with a focus on those that were missed. Therefore, we used the database of the TraumaRegister DGU®.

METHODS: In this study, we evaluated anonymous data from 139931 patients aged 1-100 years with multiple trauma in the TraumaRegister DGU® of the German Society for Trauma Surgery from 2007 to 2017. Patients with hand and forearm injuries documented during hospital stay were identified and analyzed. We included fractures, dislocations, tendon injuries, nerve injuries and vessel injuries. Patients with missed hand and forearm injuries were compared with patients with primary diagnosed injuries in view of gender, age, ISS, Abbreviated Injury Score (AIS), Glasgow Coma Scale (GCS), Glasgow Outcome Scale (GOS), trauma mechanism type of injury, hospital stay, RISC II and mortality rate. Missed injuries were defined as injuries that were recently diagnosed and documented in the intensive care unit (ICU).

RESULTS: A total of 50459 multiple trauma patients (36.1 %) had hand or forearm injuries, and 89472 patients (63.9 %) had neither. Patients with hand injuries were younger and were more often involved in car and motorcycle accidents. Severe head trauma was evaluated less frequently, and severe thorax trauma was evaluated more often in patients with hand injuries. The times of diagnosis of hand injuries were documented in 10971 cases. A total of 727 patients (6.6 %) with missed hand injuries were registered. The most commonly missed injuries in multiple trauma were 104 carpal fractures/ dislocations (11.2 %), 195 nerve injuries (25.4 %) and 54 tendon injuries (11.4 %). Predisposing factors for missing injuries were multiple diagnoses, primary care in the first hospital and direct from emergency room transfer to the ICU.

CONCLUSION: In contrast to previous findings, severely injured patients, especially those with head injuries and GCS of ≤8, were not predisposed to have missed hand injuries compared to patients without severe head trauma. Special attention should be paid to younger patients after traffic accidents with multiple diagnoses and direct transfer to the ICU.

Z Orthop Unfall. 2020 May 11. doi: 10.1055/a-1121-7989. [Epub ahead of print]

Spinal Injury Without Neurological Symptoms in Severely Injured Patients: Impact on the Length of Stay?

Fochtmann U, Jungbluth P, Zimmermann W, Lefering R, Lendemans S, Hussmann B.

BACKGROUND: The impact of spinal injuries on clinical outcome in most severely injured patients is currently being controversially discussed. At the same time, most of the studies examine patients with post-traumatic neurological disorders. The aim of this study was therefore to analyse severely injured patients with spinal injuries but without neurological symptoms with regard to their clinical outcome. Here the focus was then on the question, whether spinal injury is an independent risk factor increasing length of stay in the intensive care unit and in the hospital in total.

MATERIAL AND METHODS: Data of the TraumaRegister DGU® were retrospectively analysed. Inclusion criteria were: Injury Severity Score ≥ 16, primary admission, age ≥ 16 years, time interval 2009 - 2016, and a full data set on length of stay in the hospital and the intensive care unit, respectively. Following a univariate analysis in the first step, independent risk factors for the length of stay in the intensive care unit and in the hospital in total were investigated using a multivariate regression analysis.

RESULTS: 98,240 patients met the inclusion criteria. In this population, patients with Abbreviated Injury Scale (AIS) 2 and 3 spinal injuries were significantly younger (up to 60 years), and injuries were significantly more commonly caused by falls from a great height and traffic accidents (age ≤ 60 years: AISSpine 0: 58.4 %, AISSpine 3: 65 %; p < 0.001). Multivariate analysis showed that spinal injury without neurological symptoms is an independent risk factor for increased length of stay in the intensive care unit (odds ratio: + 1.1 d) and in the hospital in total (AIS 3 odds ratio: + 3.4 d).

CONCLUSION: It has been shown for the first time that spinal injury without initial neurological symptoms has a negative impact on the length of stay of most severely injured patients in the intensive care unit and in the hospital in total and thus represents an independent risk factor in this group of patients.

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Possible advantages of early stabilization of spinal fractures in multiply injured patients with leading thoracic trauma - analysis based on the TraumaRegister DGU®.

Hager S, Eberbach H, Lefering R, Hammer TO, Kubosch D, Jäger C, Südkamp NP, Bayer J, TraumaRegister DGU®.

BACKGROUND: Major trauma often comprises fractures of the thoracolumbar spine and these are often accompanied by relevant thoracic trauma. Major complications can be ascribed to substantial simultaneous trauma to the chest and concomitant immobilization due to spinal instability, pain or neurological dysfunction, impairing the respiratory system individually and together. Thus, we proposed that an early stabilization of thoracolumbar spine fractures will result in significant benefits regarding respiratory organ function, multiple organ failure and length of ICU / hospital stay.

METHODS: Patients documented in the TraumaRegister DGU®, aged ≥16 years, ISS ≥ 16, AISThorax ≥ 3 with a concomitant thoracic and / or lumbar spine injury severity (AISSpine) ≥ 3 were analyzed. Penetrating injuries and severe injuries to head, abdomen or extremities (AIS ≥ 3) led to patient exclusion. Groups with fractures of the lumbar (LS) or thoracic spine (TS) were formed according to the severity of spinal trauma (AISspine): AISLS = 3, AISLS = 4–5, AISTS = 3 and AISTS = 4–5, respectively.

RESULTS: 1740 patients remained for analysis, with 1338 (76.9 %) undergoing spinal surgery within their hospital stay. 976 (72.9 %) had spine surgery within the first 72 h, 362 (27.1 %) later on. Patients with injuries to the thoracic spine (AISTS = 3) or lumbar spine (AISLS = 3) significantly benefit from early surgical intervention concerning ventilation time (AISLS = 3 only), ARDS, multiple organ failure, sepsis rate (AISTS = 3 only), length of stay in the intensive care unit and length of hospital stay. In multiple injured patients with at least severe thoracic spine trauma (AISTS ≥ 4) early surgery showed a significantly shorter ventilation time, decreased sepsis rate as well as shorter time spend in the ICU and in hospital.

CONCLUSIONS: Multiply injured patients with at least serious thoracic trauma (AISThorax ≥ 3) and accompanying spine trauma can significantly benefit from early spine stabilization within the first 72 h after hospital admission. Based on the presented data, primary spine surgery within 72 h for fracture stabilization in multiply injured patients with leading thoracic trauma, especially in patients suffering from fractures of the thoracic spine, seems to be beneficial.

Scand J Trauma Resusc Emerg Med. 2020 Mar 2;28(1):15. doi: 10.1186/s13049-020-0712-5.

Damage to the eye and optic nerve in seriously traumatized patients with concomitant head injury: analysis of 84,627 cases from the TraumaRegister DGU® between 2002 and 2015.

Huckhagel T, Regelsberger J, Westphal M, Nüchtern J, Lefering R.

BACKGROUND: To determine the prevalence and characteristics of prechiasmatic visual system injuries (VSI) among seriously injured patients with concomitant head trauma in Europe by means of a multinational trauma registry.

METHODS: The TraumaRegister DGU® was searched for patients suffering from serious trauma with a Maximum Abbreviated Injury Scale (AIS) ≥ 3 between 2002 and 2015 in Europe. After excluding cases without significant head injury defined by an AIS ≥ 2, groups were built regarding the existence of a concomitant damage to the prechiasmatic optic system comprising globe and optic nerve. Group comparisons were performed with respect to demographic, etiological, clinical and outcome characteristics.

RESULTS: 2.2 % (1901/84,627) of seriously injured patients with concomitant head trauma presented with additional VSI. These subjects tended to be younger (mean age 44.7 versus 50.9 years) and were more likely of male gender (74.8 % versus 70.0 %) compared to their counterparts without VSI. The most frequent trauma etiologies were car accidents in VSI patients (28.5 %) and falls in the control group (43.2 %). VSI cases were prone to additional soft tissue trauma of the head, skull and orbit fractures as well as pneumocephalus. Primary treatment duration was significantly longer in the VSI cohort (mean 23.3 versus 20.5 days) along with higher treatment costs and a larger proportion of patients with moderate or severe impairment at hospital discharge despite there being a similar average injury severity at admission in both groups.

CONCLUSIONS: A substantial proportion of patients with head injury suffers from additional VSI. The correlation between VSI and prolonged hospitalization, increased direct treatment expenditures, and having a higher probability of posttraumatic impairment demonstrates the substantial socioeconomic relevance of these types of injuries.

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Pre-hospital trauma care in Switzerland and Germany: do they speak the same language?

Jensen KO, Teuben MPJ, Lefering R, Halvachizadeh S, Mica L, Simmen HP, Pfeifer R, Pape HC, Sprengel K; TraumaRegister DGU.

PURPOSE: Swiss and German (pre-)hospital systems, distribution and organization of trauma centres differ from each other. It is unclear if outcome in trauma patients differs as well. Therefore, this study aims to determine differences in characteristics, therapy and outcome of trauma patients between both German-speaking countries.

METHODS: The TraumaRegister DGU® (TR-DGU) was used. Patients with Injury Severity Score ≥ 9 admitted to a level 1 trauma centre between 01/2009 and 12/2017 were included if they required ICU care or died. Trauma pattern, pre-hospital procedures and outcome were compared between Swiss (CH, n = 4768) and German (DE, n = 66,908) groups.

RESULTS: Swiss patients were older than German patients (53 vs. 50 years). ISS did not differ between groups (CH 23.8 vs. DE 23.0 points). There were more low falls < 3 m (34 % vs. 21 %) at the expense of less traffic accidents (37 % vs. 52 %) in the Swiss population. In Switzerland 30 % of allocations were done without physician involvement, whereas this occurred in 4 % of German cases. Despite a comparable number of patients with a GCS ≤ 8 (CH 29.6 %; DE 26.4 %), differences in pre-hospital intubation rates occurred (CH 31 % vs. DE 40 %). Severe traumatic brain injuries were diagnosed most frequently in Switzerland (CH 62 % vs. DE 49 %). Admission vital signs were similar, and standardized mortality ratios were close to one in both countries.

CONCLUSION: This study demonstrates that patients' age, trauma patterns and pre-hospital care differ between Germany and Switzerland. However, adjusted mortality was almost similar. Further benchmarking studies are indicated to optimize trauma care in both German-speaking countries.

J Intensive Care Med. 2020 Apr;35(4):378-382. doi: 10.1177/0885066617753356. Epub 2018 Mar 19.

Cervical Spinal Cord Injury Shows Markedly Lower than Predicted Mortality (>72 Hours After Multiple Trauma) From Sepsis and Multiple Organ Failure.

Kamp O, Jansen O, Lefering R, Meindl R, Waydhas C, Schildhauer TA, Hamsen U; TraumaRegister DGU.

BACKGROUND: Sepsis and multiple organ failure (MOF) remain one of the main causes of death after multiple trauma. Trauma- and infection-associated immune reactions play an important role in the pathomechanism of MOF, but the exact pathways remain unknown. Spinal cord injury (SCI) may lead to an altered immune response, and some studies suggest a prognostic advantage for such patients having sepsis or multiple trauma. Yet these findings need to be evaluated in larger cohorts of trauma patients.

METHODS: Retrospective, multicenter study, using the data of the TraumaRegister DGU. Patients with and without SCI surviving the initial first 72 hours after trauma were matched according to injury pattern and age. Comparative analysis considered morbidity (sepsis, MOF) and hospital mortality.

RESULTS: The study population included 800 matched pairs. As intended by the matching process, patients with cervical SCI had an otherwise comparable injury pattern but a higher severity of trauma (mean Injury Severity Score: 36 vs 29, mean number of diagnosis: 5.6 vs 4.4). They had a higher rate of sepsis (15.9 % vs 10.9 %, P = .005) and MOF (35.9 % vs 24.1 %, P < .001) while mortality revealed no significant difference (9.5 % vs 9.9 %, P = .866).

CONCLUSIONS: Cervical SCI leads to an increased rate of sepsis and MOF but appears to be favorable with respect to outcome of sepsis and MOF following multiple trauma. Further research should focus on the pathomechanisms and the possible arising therapeutic options.

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Major trauma care in Hong Kong and Germany: a trauma registry data benchmark study.

Lai CY, Maegele M, Yeung JHH, Lefering R, Hung KCK, Chan PSL, Leung M, Wong HT, Wong JKS, Graham CA, Cheng CH, Cheung NK.

BACKGROUND: Trauma remains a leading cause of death and effective trauma management within a well-developed trauma system has been shown to reduce morbidity and mortality. A trauma registry, as an integral part of a mature trauma system, can be used to monitor the quality of trauma care and to provide a means to compare local versus international standards. Hong Kong and Germany both have highly developed health care services. We compared the performance of trauma systems including outcomes among major trauma victims (ISS > 15) over a 3-year period (2013-2015) in both settings using trauma registry data.

METHODS: This study was a retrospective analysis of prospectively collected data from trauma registries in Hong Kong and Germany. Data from 01/2013 to 12/2015 were extracted from the trauma registries of the five trauma centers in Hong Kong and the TraumaRegister DGU® (TR-DGU). The study cohort included adults (≥ 18 years) with major trauma (ISS > 15). Data related to patient characteristics, nature of the injury, prognostic parameters to calculate the RISC II score, outcomes and clinical management were collected and compared.

RESULTS: Datasets from 1,864 Hong Kong and 10,952 German trauma victims were retrieved from respective trauma registries. The unadjusted mortality in Hong Kong (22.4 %) was higher compared to Germany (19.2 %); the difference between observed and expected mortality was higher in Hong Kong (+ 2.7 %) than in Germany (- 0.5 %). The standardized mortality ratio (SMR) in Hong Kong and Germany were 1.138 (95 % CI 1.033-1.252) and 0.974 (95 % CI 0.933-1.016), respectively, and the adjusted death rate in Hong Kong was significantly higher compared to the calculated RISC II data. However, patients in Hong Kong were significantly older, had more pre-trauma co-morbidities, more head injuries, shorter hospital and ICU stays and lower ICU admission rates.

CONCLUSION: Hong Kong had a higher mortality rate and a statistically significantly higher standardized mortality ratio (SMR) after RISC II adjustment. However, multiple differences existed between trauma systems and patient characteristics.

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Cross-validation of two prognostic trauma scores in severely injured patients.

Lefering R, Huber-Wagner S, Bouillon B, Lawrence T, Lecky F, Bouamra O.

INTRODUCTION: Trauma scoring systems are important tools for outcome prediction and severity adjustment that informs trauma quality assessment and research. Discrimination and precision of such systems is tested in validation studies. The German TraumaRegister DGU® (TR-DGU) and the Trauma Audit and Research Network (TARN) from the UK agreed on a cross-validation study to validate their prediction scores (RISC II and PS14, respectively).

METHODS: Severe trauma patients with an Injury Severity Score (ISS) ≥ 9 documented in 2015 and 2016 were selected in both registries (primary admissions only). The predictive scores from each registry were applied to the selected data sets. Observed and predicted mortality were compared to assess precision; area under the receiver operating characteristic curve was used for discrimination. Hosmer-Lemeshow statistic was calculated for calibration. A subgroup analysis including patients treated in intensive care unit (ICU) was also carried out.

RESULTS: From TR-DGU, 40,638 patients were included (mortality 11.7 %). The RISC II predicted mortality was 11.2 %, while PS14 predicted 16.9 % mortality. From TARN, 64,622 patients were included (mortality 9.7 %). PS14 predicted 10.6 % mortality, while RISC II predicted 17.7 %. Despite the identical cutoff of ISS ≥ 9, patient groups from both registries showed considerable difference in need for intensive care (88 % versus 18 %). Subgroup analysis of patients treated on ICU showed nearly identical values for observed and predicted mortality using RISC II.

DISCUSSION: Each score performed well within its respective registry, but when applied to the other registry a decrease in performance was observed. Part of this loss of performance could be explained by different development data sets: the RISC II is mainly based on patients treated in an ICU, while the PS14 includes cases mainly cared for outside ICU with more moderate injury severity. This is according to the respective inclusion criteria of the two registries.

CONCLUSION: External validations of prediction models between registries are needed, but may show that prediction models are not fully transferable to other health-care settings.

Scand J Trauma Resusc Emerg Med. 2020 Mar 12;28(1):21. doi: 10.1186/s13049-020-0708-1.

Impact of blunt chest trauma on outcome after traumatic brain injury- a matched-pair analysis of the TraumaRegister DGU®.

Schieren M, Wappler F, Wafaisade A, Lefering R, Sakka SG, Kaufmann J, Heiroth HJ, Defosse J, Böhmer AB.

BACKGROUND: Traumatic brain injury (TBI) is associated with high rates of long-term disability and mortality. Our aim was to investigate the effects of thoracic trauma on the in-hospital course and outcome of patients with TBI.

METHODS: We performed a matched pair analysis of the multicenter trauma database TraumaRegisterDGU® (TR-DGU) in the 5-year period from 2012 to 2016. We included adult patients (≥18 years of age) with moderate to severe TBI (abbreviated injury scale (AIS)= 3-5). Patients with isolated TBI (group 1) were compared to patients with TBI and varying degrees of additional blunt thoracic trauma (AISThorax= 2-5) (group 2). Matching criteria were gender, age, severity of TBI, initial GCS and presence/absence of shock. The χ2-test was used for comparing categorical variables and the Mann-Whitney-U-test was chosen for continuous parameters. Statistical significance was defined by a p-value < 0.05.

RESULTS: A total of 5414 matched pairs (10,828 patients) were included. The presence of additional thoracic injuries in patients with TBI was associated with a longer duration of mechanical ventilation and a prolonged ICU and hospital length of stay. Additional thoracic trauma was also associated with higher mortality rates. These effects were most pronounced in thoracic AIS subgroups 4 and 5. Additional thoracic trauma, regardless of its severity (AISThorax ≥2) was associated with significantly decreased rates of good neurologic recovery (GOS = 5) after TBI.

CONCLUSIONS: Chest trauma in general, regardless of its initial severity (AISThorax= 2-5), is associated with decreased chance of good neurologic recovery after TBI. Affected patients should be considered "at risk" and vigilance for the maintenance of optimal neuro-protective measures should be high.

J Clin Med. 2020 May 12;9(5). pii: E1437. doi: 10.3390/jcm9051437.

Which Risk Factors Predict Knee Ligament Injuries in Severely Injured Patients?-Results from an International Multicenter Analysis.

Weber CD, Solomon LB, Lefering R, Horst K, Kobbe P, Hildebrand F, Dgu T.

INTRODUCTION: Ligament injuries around the knee joint and knee dislocations are rare but potentially complex injuries associated with high-energy trauma. Concomitant neurovascular injuries further affect their long-term clinical outcomes. In contrast to isolated ligamentous knee injuries, epidemiologic data and knowledge on predicting knee injuries in severely injured patients is still limited.

METHODS: The TraumaRegister DGU® (TR-DGU) was queried (01/2009-12/2016). Inclusion criteria for selection from the database: maximum abbreviated injury severity ≥ 3 points (MAIS 3+). Participating countries: Germany, Austria, and Switzerland. The two main groups included a "control" and a "knee injury" group. The injury severity score (ISS) and new ISS (NISS) were used for injury severity classification, and the abbreviated injury scale (AIS) was used to classify the severity of the knee injury. Logistic regression analysis was performed to evaluate various risk factors for knee injuries.

RESULTS: The study cohort included 139,462 severely injured trauma patients. We identified 4411 individuals (3.2 %) with a ligament injury around the knee joint ("knee injury" group) and 1153 patients with a knee dislocation (0.8 %). The risk for associated injuries of the peroneal nerve and popliteal artery were significantly increased in dislocated knees when compared to controls (peroneal nerve from 0.4 % to 6.7 %, popliteal artery from 0.3 % to 6.9 %, respectively). Among the predictors for knee injuries were specific mechanisms of injury: e.g., pedestrian struck (Odds ratio [OR] 3.2, 95 % confidence interval [CI]: 2.69-3.74 p ≤ 0.001), motorcycle (OR 3.0, 95 % CI: 2.58-3.48, p ≤ 0.001), and motor vehicle accidents (OR 2.2, 95 % CI: 1.86-2.51, p ≤ 0.001) and associated skeletal injuries, e.g., patella (OR 2.3, 95 % CI: 1.99-2.62, p ≤ 0.001), tibia (OR 1.9, 95 % CI: 1.75-2.05, p ≤ 0.001), and femur (OR 1.8, 95 % CI: 1.64-1.89, p ≤ 0.001), but neither male sex nor general injury severity (ISS).

CONCLUSION: Ligament injuries and knee dislocations are associated with high-risk mechanisms and concomitant skeletal injuries of the lower extremity, but are not predicted by general injury severity or sex. Despite comparable ISS, knee injuries prolong the hospital length of stay. Delayed or missed diagnosis of knee injuries can be prevented by comprehensive clinical evaluation after fracture fixation and a high index of suspicion is advised, especially in the presence of the above mentioned risk factors.

Neurosurg Rev. 2019 Aug 14. doi: 10.1007/s10143-019-01159-4. [Epub ahead of print]

Operative versus non-operative treatment of traumatic brain injuries in patients 80 years of age or older

Czorlich P, Mader MM, Emami P, Westphal M, Lefering R, Hoffmann M.

Traumatic brain injury (TBI) in older adults is an increasing issue in modern medicine. Nevertheless, it remains unclear which patients presenting with TBI and 80 years of age or older benefit from an operative treatment. The aim of this study was to explore the effect of an operative treatment in isolated TBI patients ≥ 80 years of age. Data were derived from the TraumaRegister DGU® from 2002 to 2016. Inclusion criteria were ≥ 80 years of age, an Abbreviated Injury ScaleHead (AIS) ≥ 3, and an AISNon-Head ≤ 1. The cohort was split in operatively and non-operatively treated patients, and outcome was assessed at discharge using the Glasgow Outcome Scale (GOS). A favorable outcome was defined as a GOS of 4 or 5. A total of 1.693 patients (431 operatively and 1.262 non-operatively treated patients) were analyzed. Mortality rate was 54.4 % (687 patients) in the non-operative group and 49.4 % in the operative group. Simultaneously, there were more patients discharged with a GOS 2 (persistent vegetative state) in the operative group (7.9 %, 34 patients) than in the non-operative group (1.0 %, 13 patients). An analysis of the operatively treated patients showed an association between a higher mortality risk and brainstem hemorrhage (p = 0.04), fixed pupils (p = 0.001), initial intubation (p = 0.03), and an AISHead of 5/6 (p = 0.03). Patients 80 years of age or older seem to benefit from an operative treatment regarding mortality rate. However, there has been a higher rate of a poor neurological outcome particularly with regard to persistent vegetative state in the operative treatment group at discharge.

Dtsch Arztebl Int. 2019 Jul 8;116(27-28):479-485. doi: 10.3238/arztebl.2019.0479

Increased Mortality Among Critically Injured Motorcyclists Over 65 Years of Age

Eden L, Kühn A, Gilbert F, Meffert RH, Lefering R.

BACKGROUND: Motorcycle accidents account for a large fraction of the patients with polytrauma treated in German hospitals. Clinical experience indicates that an in- creasing number of older motorcyclists are having accidents. We studied whether such individuals are subject to higher mortality and longer hospital stays.

METHODS: We retrospectively evaluated data from the Traumaregister DGU® (TR- DGU) concerning all patients (n = 13 850) who were registered in the TR-DGU as having sustained trauma in a motorcycle accident from 2002 to 2015 and who had an Injury Severity Score (ISS) greater than 8. The patients were divided into four age groups for further study.

RESULTS: Despite a nearly identical severity of anatomical injury according to the ISS, persons sustaining trauma in motorcycle accidents who were over 65 years of age (n = 892) needed longer and more intensive treatment than their younger counter- parts. They were invasively ventilated for a longer time (+ 1.2 days), kept for a longer time on the intensive care unit (+ 1.7 days), and stayed in the hospital three days longer. These older persons injured in motorcycle accidents had a disproportionate mortality in comparison to other polytrauma patients and a significantly elevated mor- tality in comparison to their younger counterparts-15.8 %, compared to 7.2 % among patients aged 45 to 64. Older trauma patients are more likely than younger ones to develop lethal complications in the later course of their hospitalization, while younger trauma patients who die generally do so as a direct result of the traumatic injury.

CONCLUSION: Patients over age 65 who sustain trauma in motorcycle accidents have a higher mortality, a longer duration of ventilation, and longer stays in the intensive care unit and in the hospital overall than their younger counterparts. These patients present a special challenge to the treating medical team.

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Do elderly trauma patients receive the required treatment? Epidemiology and outcome of geriatric trauma patients treated at different levels of trauma care

Fröhlich M, Caspers M, Lefering R, Driessen A, Bouillon B, Maegele M, Wafaisade A; TraumaRegister DGU.

PURPOSE: In an ageing society, geriatric trauma displays an increasing challenge in trauma care. Due to comorbidities and reduced physiologic reserves, these patients might benefit from an immediate specialised care. The current study aims to clarify the prevalence and outcome of geriatric trauma depending on the level of the primary trauma centre.

METHODS: Data sets of 124,641 patients entered in the TR-DGU between 2009 and 2016 were included. Geriatric trauma was defined above 65 years and ISS ≥ 9. Analysing the prevalence, the age structure of all trauma cases registered in 2014 was compared to demographic data of the German Federal Statistical Office. Differences in injury pattern, in-hospital care and outcome between the primary levels of care were analysed.

RESULTS: In comparison to their share of population, geriatric patients are highly overrepresented in the TR-DGU. Despite minor injury mechanisms, severe head injuries are common. A tendency to under-triage can be observed, as level II and III trauma centres receive a higher percentage of older patients. Nevertheless, there is no effect on the mortality. 10 % of these patients require an early transfer to a higher levelled trauma centres mainly due to severe head and spine injuries. Surprisingly, pre-clinical available signs such as GCS or blood pressure were not altered in these patients.

CONCLUSION: Patients above the age of 65 years represent a second group with high risk for traumatic injuries besides younger adults. Despite low-energy trauma mechanisms, these patients are prone to suffer from severe injuries, which require specialised care. Current admission practice appears adequate, as pre-clinical available symptoms did not correlate with injuries that demanded an early inter-hospital transfer. Specialised geriatric triage scores might further improve admission practice.

Eur J Trauma Emerg Surg. 2019 Feb;45(1):115-124. doi: 10.1007/s00068-017-0884-5. Epub 2017 Nov 23.

Trauma-induced coagulopathy upon emergency room arrival: still a significant problem despite increased awareness and management?

Fröhlich M, Mutschler M, Caspers M, Nienaber U, Jäcker V, Driessen A, Bouillon B, Maegele M; TraumaRegister DGU.

PURPOSE: Over the last decade, the pivotal role of trauma-induced coagulopathy has been described and principal drivers have been identified. We hypothesized that the increased knowledge on coagulopathy of trauma would translate into a more cautious treatment, and therefore, into a reduced overall incidence rate of coagulopathy upon ER admission.

PATIENTS AND METHODS: Between 2002 and 2013, 61,212 trauma patients derived from the TraumaRegister DGU® had a full record of coagulation parameters and were assessed for the presence of coagulopathy. Coagulopathy was defined by a Quick's value < 70 % and/or platelet counts < 100,000/µl upon ER admission. For each year, the incidence of coagulopathy, the amount of pre-hospital administered i.v.-fluids and transfusion requirements were assessed.

RESULTS: Coagulopathy upon ER admission was present in 24.5 % of all trauma patients. Within the years 2002-2013, the annual incidence of coagulopathy decreased from 35 to 20 %. Even in most severely injured patients (ISS > 50), the incidence of coagulopathy was reduced by 7 %. Regardless of the injury severity, the amount of pre-hospital i.v.-fluids declined during the observed period by 51 %. Simultaneously, morbidity and mortality of severely injured patients were on the decrease.

CONCLUSION: During the 12 years observed, a substantial decline of coagulopathy has been observed. This was paralleled by a significant decrease of i.v.-fluids administered in the pre-hospital treatment. The reduced presence of coagulopathy translated into decreased transfusion requirements and mortality. Nevertheless, especially in the most severely injured patients, posttraumatic coagulopathy remains a frequent and life-threatening syndrome.

Chirurg. 2019 Oct;90(10):791-794. doi: 10.1007/s00104-019-01019-3.

Polytrauma in old age-Knowledge from the TraumaRegister DGU®

Gather A, Grützner PA, Münzberg M.

The geriatric fracture patient is becoming more and more in the forefront due to the demographic development. It is expected that the number of polytraumatized geriatric patients in the coming years will rise in line with demographic trends. The TraumaRegister DGU® of the German Trauma Society (DGU) provides interesting insights into the age structure and patient outcome. In 2017 in total 26.2 % of the patients included were over 70 years old. Geriatric polytraumatized patients show significant differences in the injury patterns as well as in the treatment strategy compared to younger patients. This is often due to the pre-existing diseases and various drugs that alter the physiology. With respect to the injury patterns an increase in severe head injuries and a decrease in severe abdominal injuries can be seen with increasing age. Hospitals and professional societies are currently dealing with numerous challenges. The implementation of the General Data Protection Regulation leads to conflicts and uncertainties. The further development of the TraumaRegister DGU® is important in order to collect more outcome-relevant data from patients because more than ever the objective should be the survival of an accident with a high quality of life. To measure this, a structured survey of patients is necessary. The TraumaRegister DGU® is one of the most important tools to make treatment comparable and to measure structural changes.

Unfallchirurg. 2019 Jul 16. doi: 10.1007/s00113-019-0699-4. [Epub ahead of print]

Empirical evaluation of quality indicators for severely injured patients in the TraumaRegister DGU®

Hörster AC, Kulla M, Bieler D, Lefering R.

BACKGROUND AND OBJECTIVE: A systematic assessment of the quality of medical treatment by using key indicators has been required in Germany for many years. These quality indicators (QI) have to satisfy many requirements. Besides an expert review an empirical data-based evaluation is also necessary. The TraumaRegister DGU® (TR-DGU) has reported QI in the annual reports from the beginning. The objective of this study was to validate 40 QI for the treatment of severely injured patients reviewed by experts using data from the TR-DGU.

MATERIAL AND METHODS: The association of the 40 QI with hospital mortality was verified using healthcare data from the TR-DGU from a 5-year period (2012-2016). Of these 26 QI consider events while the remaining 14 QI are key indicators, such as time spent in the trauma room. To compensate differences in injury severity, adjusted mortality rates were calculated using the revised injury severity classification (RISC) II score. For this two different approaches were chosen: the hospital-based approach classifies all hospitals into three categories and analyzes the grade of fulfilment of the indicator. The indicator-based approach considers the adjusted mortality depending on the grade of fulfilment of the indicator.

RESULTS: The analysis was based on 111,656 cases documented in the TR-DGU (mean age 50 years; 70 % male). The data analysis showed an obvious correlation with mortality for half of the QI, including only three procedural times. A clear correlation in both approaches was shown for two QI: prehospital capnometry in intubated patients and sonography used for patients without whole body computed tomography (CT) scans. Of the 20 QI with a positive result 15 were also positively rated by the experts. Of the 14 QI reported annually since 2017 in the TR-DGU report, 8 (57 %) showed a clear correlation with mortality.

CONCLUSION: There is no doubt regarding the necessity of scientifically assessing QI. Approximately half of the evaluated QI showed an empirical association with mortality. Interventions and events showed better results than measurements of procedural times; however, many QI may require a refined definition. The interpretation of the results is still challenging due to differences in the patient groups. Secondary endpoints, such as hospital length of stay and quality of life after trauma were not considered here.

Clin Oral Investig. 2020 Jan;24(1):503-513. doi: 10.1007/s00784-019-03024-6. Epub 2019 Aug 3.

Maxillofacial injuries in severely injured patients after road traffic accidents-a retrospective evaluation of the TraumaRegister DGU® 1993-2014

Pietzka S, Kämmerer PW, Pietzka S, Schramm A, Lampl L, Lefering R, Bieler D, Kulla M.

OBJECTIVES: It was the aim of the study to analyse the prevalence of maxillofacial trauma (MFT) in severely injured patients after road traffic accident (RTA) and to investigate associated factors.

MATERIALS AND METHODS: In a retrospective study, data from patients after RTA by the TraumaRegister DGU® from 1993 to 2014 were evaluated for demographical and injury characteristics. The predictor variable was mechanism of injury and the outcome variables were type of injury, severity and hospital resources utilization.

RESULTS: During the investigation period, n = 62,196 patients were enclosed with a prevalence of maxillofacial injuries of 20.3 % (MFT positive). The injury severity score of MFT-positive patients was higher than in the MTF-negative subgroup (27 ± 12.8 vs. 23.0 ± 12.7). If MFT positive, 39.8 % show minor, 37.1 % moderate, 21.5 % serious and 1.6 % severe maxillofacial injuries. Injuries of the midface occurred in 60.3 % of MTF-positive patients. A relevant blood loss (> 20 % of total blood volume) occurred in 1.9 %. MFT-positive patients had a higher coincidence with cervical spine fractures (11.3 % vs. 7.8 %) and traumatic brain injuries (62.6 % vs. 34.8 %) than MFT-negative patients. There was a noticeable decrease in the incidence of facial injuries in car/truck drivers during the study period.

CONCLUSION: Every 5th patient after RTA shows a MFT and the whole trauma team must be aware that this indicates a high prevalence of traumatic brain and cervical spine injuries.

CLINICAL RELEVANCE: Even if sole injuries of the face are seldom life threatening, maxillofacial expertise in interdisciplinary trauma centres is strongly recommended.

Thorac Cardiovasc Surg. 2019 Dec 13. doi: 10.1055/s-0039-1700505. [Epub ahead of print]

Lung Contusion in Polytrauma: An Analysis of the TraumaRegister DGU.

Schulz-Drost S, Finkbeiner R, Lefering R, Grosso M, Krinner S, Langenbach A, Dgu TT.

BACKGROUND: Thorax trauma frequently occurs in which injuries to the bony chest, lung contusions (LCs), and others are diagnosed. The significance of this violation is described very differently and is mostly based on monocentric data.

METHODS: A retrospective analysis of the TraumaRegister DGU® (TR-DGU) dataset (Project 2014-062) was performed between 2009 and 2014 (injury severity score [ISS] ≥ 16, primary admission to a trauma center, no isolated traumatic brain injury). Patients with LC (Abbreviated Injury Scale [AIS] 3 + 4) were compared with the control group, and an analysis of different age groups was performed.

RESULTS: A total of 49,567 patients were included, thereunder 14,521 (29.3 %) without relevant thoracic trauma (TT); 95.9 % blunt traumas. 18,892 patients (38.1 %) had LC and 14,008 (28.3 %) had severe LC with AIS 3 + 4; thereunder 72.7 % males. For severe LC, the average age was the lowest (44.7 ± 19.7 years) and ISS the highest (30.4 ± 12.1 points).Intubation, intensive care, (multi-) organ failure, sepsis, and extrathoracic injuries were most common in severe LC. Shock, chest tubes, further thoracic injuries, and patient death occurred most frequently in TT without LC.Younger patients showed a higher incidence of LC than the older ones; however, high patient age was a highly significant risk factor for the development of complications and poor outcome.

CONCLUSION: Since LC was present in almost 40 % of the severely injured and was related to higher morbidity, LC should be detected and managed at the earliest possible time. Proper follow-ups employing chest X-rays and computed tomography (CT) scans are recommended.

Eur J Trauma Emerg Surg. 2019 Sep 13. doi: 10.1007/s00068-019-01212-3. [Epub ahead of print]

Emergency department thoracotomy of severely injured patients: an analysis of the TraumaRegister DGU®

Schulz-Drost S, Merschin D, Gümbel D, Matthes G, Hennig FF, Ekkernkamp A, Lefering R, Krinner S; TraumaRegister DGU.

AIM OF THE STUDY: Emergency department thoracotomy (EDT) may be the last chance for survival in some severe thoracic trauma. This study investigates a representative collective with the aim to compare the findings in Europe to the international experience. Moreover, the influence of different levels of trauma care is investigated.
METHODS: All emergency thoracotomies in patients with an ISS ≥ 9 from TR-DGU (2009-2014) within the first 60 min after arrival were identified. EDTs were identified separately, and mini thoracotomies and drainage systems were excluded.
RESULTS: 99,013 patients with sufficient data were observed. 1736 (1.8 %) received thoracotomy during their hospital stay. 887 patients had a thoracotomy within the first hour in the emergency department (ED). 52.5 % were treated in supraregional trauma centers (STC), 36.4 % in regional (RTC) and 11.0 % in local trauma centers (LTC). The mortality rates were 39.4 % (STC), 20.9 % (RTC) and 20.8 % (LTC). The overall mortality rate showed no significant differences for blunt (28.2 %) and penetrating trauma (31.3 %). In case of cardiac arrest in the ED, a survival rate of 4.8 % for blunt trauma and 20.7 % for penetrating trauma was determined if EDT was carried out. Those patients showed a higher rate in severe thoracic organ injuries due to penetrating trauma but less extrathoracic injuries.
CONCLUSION: Just over half of EDTs were performed in STC. Emergency room resuscitation followed by EDT had survival rates of 4.8 % and 20.7 % for blunt and penetrating trauma patients, respectively.

Eur J Trauma Emerg Surg. 2019 Sep 13. doi: 10.1007/s00068-019-01229-8. [Epub ahead of print]

It is time for a change in the management of elderly severely injured patients! An analysis of 126,015 patients from the TraumaRegister DGU®

Spering C, Lefering R, Bouillon B, Lehmann W, von Eckardstein K, Dresing K, Sehmisch S.

BACKGROUND: The number of elderly patients among the severely injured has been increasing continuously. It has been suggested that an increased life expectancy and a higher level of activity and mobility in older ages could explain this observation. Elderly trauma patients have relevant higher mortality rates and poorer functional outcomes. The reasons remain unclear. The aim of this study was to look for differences in the management of severely injured elderly patients compared to younger age groups and to evaluate their potential impact on outcome.
METHODS: The TraumaRegister DGU® is a multicenter database that documents de-identified data of severely injured patients since 1993. Trauma cases documented between 2009 and 2016 with an ISS ≥ 9 were divided in four age groups. The groups were compared with respect to mechanism of injury, pattern of injury, severity of injury, management and outcome.
RESULTS: The analysis of 126,015 severely injured patients showed that 37.5 % of the population were elderly patients (≥ 60 years). Their rate actually increased every year by 1.7 %. The elderly trauma patients experience different mechanisms of injury (more low energy trauma) and different pattern of injuries (more brain trauma, less abdominal and extremity injuries). Evaluating the management of patients showed that elderly patients have lower intubation rates and less volume replacement in the prehospital setting. Diagnostic interventions like CT scans in the emergency room were performed more restrictively. Elderly trauma patients also received fewer surgical interventions for brain injuries, pelvic fractures and femur fractures. Their hospital mortality rates were higher.
CONCLUSION: Severely injured elderly patients are treated with a more "wait and see approach" resulting in higher mortality rates. We suggest that this population needs a more "aggressive management" to improve their outcome, if the wish to perform complete treatment including surgical procedures and intensive care medicine has not been excluded by the patients or their legal guardian.

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The influence of alcohol on the outcome of trauma patients: a matched-pair analysis of the TraumaRegister DGU®

Wagner N, Relja B, Lustenberger T, Leiblein M, Wutzler S, Lefering R, Marzi I; TraumaRegister DGU.

BACKGROUND AND PURPOSE: In the diagnosis and treatment of trauma patients, numerous individual and trauma-related factors must be considered, all of which may influence the outcome. Although alcohol exposure is a major risk factor for an accident, its influence on the outcome is unclear. This matched-pair analysis investigates the hypothesis that alcohol has no negative impact on the outcome of trauma patients.

MATERIALS AND METHODS: In a retrospective matched-pair analysis of the multi-centre database of the TraumaRegister DGU® patients with a maximum Abbreviated Injury Scale (MAIS) of 3 or greater from the years 2015 and 2016 with an alcohol level ≥ 0.5‰ were compared to patients with a measured alcohol level of 0.0‰. The patients were matched according to age, gender, AIS body regions (head, thorax, abdomen, pelvis/extremities) and survival presumption (Revised Injury Severity Classification Score (RISC) II the TraumaRegister ervals).

RESULTS: After matching, a total of 834 patients were enrolled, with 417 patients in group with positive blood alcohol levels (BAL +) with a median alcohol level of 1.82‰ and 417 patients in the negative-alcohol group (BAL -). As a mechanism of injury, the BAL + group showed more often penetrating injuries, pedestrian accidents and low energy falls compared to car and motorcycle accidents in the BAL - group. BAL + patients were significantly less sedated (BAL -: 66.7 % vs. BAL + : 56.2 %, p = 0.002), less frequently transported by rescue helicopter, were more frequently hypotensive (BAL -: 42 patients (10.3 %) vs. BAL + : 61 patients (15.2 %), p = 0.045, Table 2) and exhibited lower base excess levels associated with an acidotic metabolic status compared to sober patients (acidosis: BAL -: 24 patients (6.1 %) vs. BAL + : 61 patients (17.2 %), p < 0.001). There was no difference regarding in-hospital complications, length of stay or mortality rate.

CONCLUSIONS AND IMPLICATIONS: Our data demonstrate that alcohol exposure in trauma patients has no impact on complication or mortality rates. On the other hand, there are initially clear differences in the mechanism of injury, sedation, mode of transport and the acid-base balance.

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Epidemiology of open tibia fractures in a population-based database: update on current risk factors and clinical implications

Weber CD, Hildebrand F, Kobbe P, Lefering R, Sellei RM, Pape HC; TraumaRegister DGU.

BACKGROUND: Open tibia fractures usually occur in high-energy mechanisms and are commonly associated with multiple traumas. The purposes of this study were to define the epidemiology of open tibia fractures in severely injured patients and to evaluate risk factors for major complications.

METHODS: A cohort from a nationwide population-based prospective database was analyzed (TraumaRegister DGU®). Inclusion criteria were: (1) open or closed tibia fracture, (2) Injury Severity Score (ISS) ≥ 16 points, (3) age ≥ 16 years, and (4) survival until primary admission. According to the soft tissue status, patients were divided either in the closed (CTF) or into the open fracture (OTF) group. The OTF group was subdivided according to the Gustilo/Anderson classification. Demographic data, injury mechanisms, injury severity, surgical fracture management, hospital and ICU length of stay and systemic complications (e.g., multiple organ failure (MOF), sepsis, mortality) were collected and analyzed by SPSS (Version 23, IBM Inc., NY, USA).

RESULTS: Out of 148.498 registered patients between 1/2002 and 12/2013; a total of 4.940 met the inclusion criteria (mean age 46.2 ± 19.4 years, ISS 30.4 ± 12.6 points). The CTF group included 2000 patients (40.5 %), whereas 2940 patients (59.5 %) sustained open tibia fractures (I°: 49.3 %, II°: 27.5 %, III°: 23.2 %). High-energy trauma was the leading mechanism in case of open fractures. Despite comparable ISS and NISS values in patients with closed and open tibia fractures, open fractures were significantly associated with higher volume resuscitation (p < 0.001), more blood (p < 0.001), and mass transfusions (p = 0.006). While the rate of external fixation increased with the severity of soft tissue injury (37.6 to 76.5 %), no major effect on mortality and other major complications was observed.

CONCLUSION: Open tibia fractures are common in multiple trauma patients and are therefore associated with increased resuscitation requirements, more surgical procedures and increased in-hospital length of stay. However, increased systemic complications are not observed if a soft tissue adapted surgical protocol is applied.

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Prehospital capnometry as quality indicator for trauma patients – initial analysis from the TraumaRegister DGU®

Wilharm A, Kulla M, Baacke M, Wagner F, Behnke M, Lefering R, Trentzsch H, TraumaRegister DGU®.

BACKGROUND: The end-tidal capnometry allows the continuous position control of the endotracheal tube and ventilation of ventilated trauma patients. It is of high value for quality and safety. The TraumaRegister DGU® has recently registered its prehospital application. The aim of this study is to explore application and effects of prehospital capnometry.

METHODS: The database is the TraumaRegister DGU®. Inclusion criteria were admission via the shock room and complete information on airway management. Documentation completeness, frequency and type of application as well as effects of capnometry on clinical course and outcome were analysed descriptively. To identify situations that affect the frequency of use, subgroups have been formed (e.g. rescue facilities, injury pattern, injury severity, prehospital care time, etc.). Additionally, the consequences of a lack of capnometry on the clinical course and outcome were analysed.

RESULTS: 43,470 cases were included. Data on prehospital capnometry were available in 62.3 %. The frequency of use in 27,099 cases was as follows: 82.9 % after endotracheal intubation and 26.9 % after alternative airway management using the supraglottic airway. This is independent of means of transport and injury patterns. Significant effects on clinical outcome, outcome or lethality could not be established. A significant impact on clinical course, outcome and mortality could not be proven. However, there is a tendency for higher mortality when prehospital capnometry is not used and patients had severe craniocerebral injuries.

CONLCUSIONS: Although current guidelines recommend capnometry for the monitoring of ventilated trauma patients, it has to be stated that capnometry has either not been documented or not been performed in a relevant percentage of patients, especially when alternative methods of airway management were applied. The degree of fulfilment of this important indicator of care quality and patient safety should be further increased. Their importance must continue to be emphasised in education and training.

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16 List of abbreviations

AIS	Abbreviated Injury Scale
ASA	American Society of Anaesthesiologists (classification)
AUC	AUC – Academy for Trauma Surgery (Akademie der Unfallchirurgie GmbH)
BE	Base excess
BGA	Blood gas analysis
CI	Confidence interval
CT	Computer tomography
cCT	Cranial computer tomography
CPR	Cardio-pulmonary resuscitation
DGU	German Trauma Society (Deutsche Gesellschaft für Unfallchirurgie e.V.)
DVT	Deep vein thrombosis
EMS	Emergency medical services
ER	Emergency room
FAST	Focused assessment with sonography for trauma
FFP	Fresh frozen plasma
GCS	Glasgow coma scale
h	Hours
ICU	Intensiv care unit
IFOM	Institute for Research in Operative Medicine (Institut für Forschung in der Operativen Medizin)
INR	International normalised ratio
ISS	Injury severity score
LOS	Length of stay
LTC	Local trauma centre
M	Mean
m	Metre
MAIS	Maximum AIS severity score
Max	Maximum
MCI	Mass casualty incident
MI	Myocardial infarction
[min]	Minute
Min	Minimum
ml	Millilitre
mmHg	Millimetre of mercury
mmol	Millimol
MOF	Multiple organ failure
NIS	Committee on Emergency Medicine, Intensive Care and Trauma Management of the German Trauma Society DGU (Sektion Notfall-, Intensivmedizin und Schwerverletztenversorgung (Sektion NIS) der DGU)
NISS	New injury severity score
No.	Number

OP	Operation
Pat.	Patients
phys.	physiological
pRBC	packed red blood cells
QM	Quality management
REBOA	Resuscitative endovascular balloon occlusion of the aorta
RTC	Regional trauma centre
RISC	Revised injury severity score (prognostic score)
RR	Systolic blood pressure (according to Riva-Rocci in mmHg)
S	Standard dataset
sBP	Systolic blood pressure
SD	Standard deviation
SMR	Standardised mortality ratio
STC	Supra-regional trauma centre
tab.	table
TBI	Traumatic brain injury
TR-DGU	TraumaRegister DGU®
TXA	Tranexamic acid
vs.	versus
WBCT	Whole-body computer tomography