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

AUC - Academy for Trauma Surgery

Annual Report 2022

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TraumaRegister DGU®

General Annual Report

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Annual Report 2022 - TraumaRegister DGU®

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Content

Preface

Dear readers,

We are pleased to send you the TraumaRegister DGU® general **2022 annual report**.

This edition includes data for the seriously injured in 2021 (basic group), which were documented by the participating hospitals through the end of March 2021. In 2021, this basic group is comprised of 28,580 cases, according to the TraumaRegister DGU® definition of a seriously injured person. This is a decrease of 1.3 % in basis group cases compared to last year.

The 3-year comparison in Table 3 (P. 9) shows a continuous decrease in primary admitted, unconscious patients as well as the number of patients in shock. A similar decrease can also be seen in the patients requiring intensive care. It is not clear if these reductions are a result of changed conditions in the hospitals due to the SARS-CoV19 pandemic, a general increase in severely injured patients due to different accidents during the pandemic, or if this reflects the difficulty of obtaining informed patient consent in this cohort of severely injured patients.

Since 2017 there has been a continuous increase in the use of pelvic binders with more than 50% of patients with relevant injuries having a pelvic binder in 2021. Furthermore, the proportion of transfused patients receiving tranexamic acid increased by 20% between 2017 and 2021.

In 2021 a total of 35,747 patients were documented in the TR-DGU®. Again, a non-negligible amount, 20 %, of patients had less severe injuries (e.g. simple concussions) than required for inclusion in the register. These cases do not fulfil the criteria of the basic group and are therefore not included in most scientific analyses and are also excluded from most aspects of this annual report. The AUC is available to provide information, advice and support to participating hospitals in order to minimize this unnecessary documentation.

At the end of 2021, a total of 700 hospitals were participating in the TraumaRegister DGU®. In addition to the 627 hospitals from Germany, hospitals from from eight other countries are also participating in the registry. This includes 23 hospitals from Austria, 28 from Belgium and 10 from Switzerland.

What is new in the 2022 annual report?

A new data set version (V2020) was released in July 2020. A selection of these new variables are presented for the first time in chapter 7 of this annual report.

We sincerely hope that the 2022 annual report will again provide you with findings that contribute to the further improvement of care for severely injured patients, in regards to quality assurance and health services research. In 2021, 24 scientific papers were prepared using data from the TraumaRegister DGU®. We would like to thank the authors, reviewers and all contributing clinicians for their commitment.

Sincerely yours,

Dan Bieler   Christine Höfer   Stefan Huber-Wagner

Rolf Lefering   Ruth Schwenzfeur   Christian Waydhas

1 Number of cases

Inclusion criteria for documenting a patient in the TraumaRegister DGU® (TR-DGU) are admission via the emergency room and the need for intensive care. 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, serious injuries.

However, the number of documented patients with only minor injuries has continuously increased over the years. This is not only unnecessary work for the hospitals, but more importantly it makes it difficult to draw comparisons both between hospitals and over time. Therefore, in 2015 a **basic group** was defined and nearly all analyses presented in this report refer to this patient group only (i.e. not to all documented patients).

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

All patients with MAIS ≥ 3 AND all MAIS 2 patients who died or were treated in the intensive care unit.

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

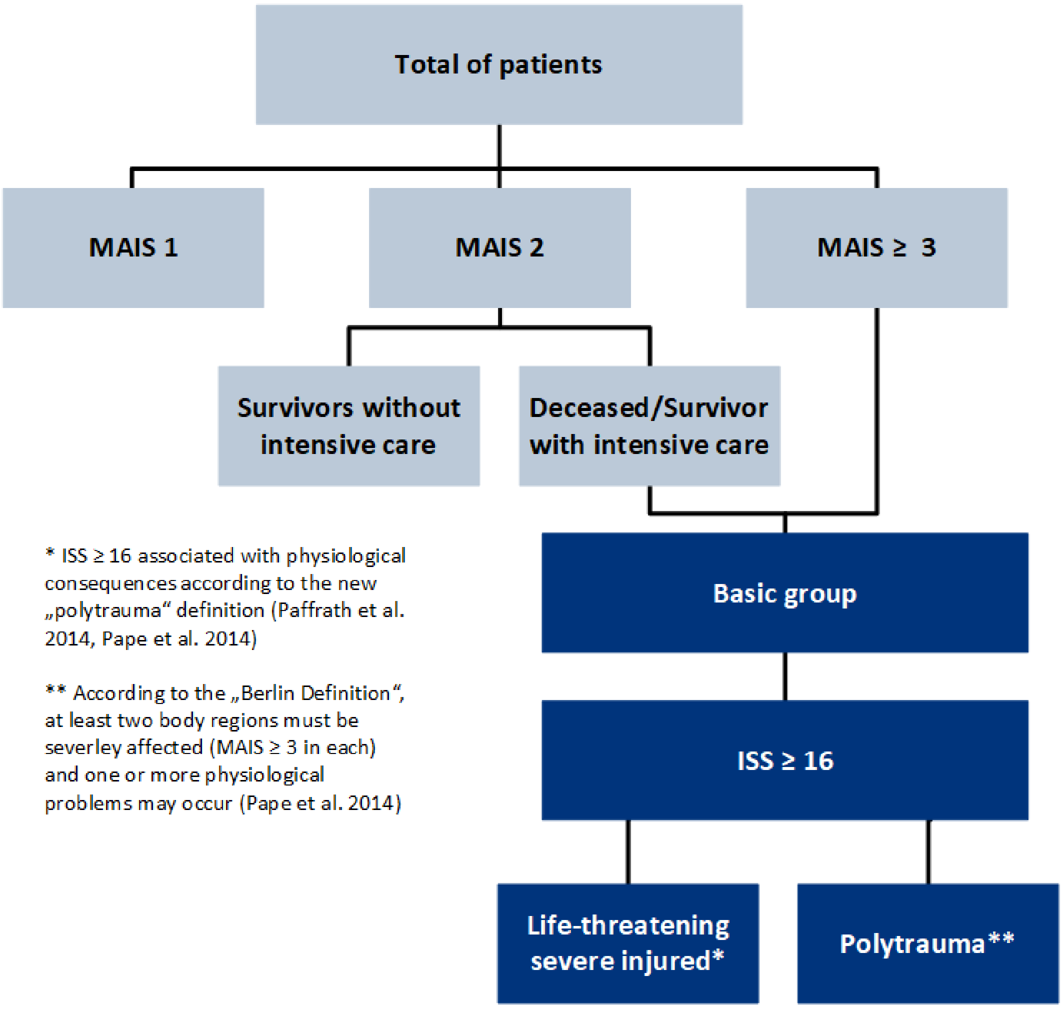


Figure 1: Flowchart describing the composition of the basic group

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 2021 from the TR-DGU

	TR-DGU 2021	Primary admitted	Transfer in	Early transfer out
Total number of documented patients.	**35,747**	31,169	2,420	2,158
MAIS 1 For these patients, the most severe injury was 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 all further analyses (except chapter 5.3).	**4,425** (12 %)	4,250	28	147
MAIS 2 survivors without intensive care The most severe injury was of AIS grade 2. These patients survived and did not receive intensive care.	**2,697** (8 %)	4,388	192	146
MAIS 2 deceased or survivors needing intensive care The most severe injury was of AIS grade 2. The patients died or survived but required intensive care.	**4,852** (14 %)	22,669	2,121	722
MAIS ≥ 3 The most severe injury was of AIS grade 3 or more (MAIS 3+). This criteria is also used by the EU as an internationally agreed to definition of a „*serious injury*" in the context of road accidents.	**23,728** (66 %)	20,020	2,141	1,567
Non-basic group Patients with MAIS 1 as well as patients with MAIS 2 that survived without intensive care.	**7,167** (20 %)	6,648	74	445
From this point onward all absolute numbers and percentages refer only 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. Patient age must also be documented.	**28,580**	**24,521**	**2,346**	**1,713**
Intensive care Patients admitted to the ICU.	**23,903** (84 %)	21,141	2,098	664
Deceased Patients who died in the acute care hospital.	**3,361** (12 %)	3,056	305	0
ISS 16+ The definition ISS ≥ 16 (or > 15) is commonly used to define a serious injury.	**15,424** (54 %)	12,745	1,638	1,041
Life-threatening severe injury Injury severity of ISS ≥ 16 in conjunction with physiological problems according to the „polytrauma" definition (Paffrath et al. 2014, Pape et al. 2014).	**8,804** (31 %)	7,502	773	529
Polytrauma According to the „Berlin Definition", two body regions are severly affected and one or more physiological problems are present (Pape et al. 2014).	**4,006** (14 %)	3,573	275	158

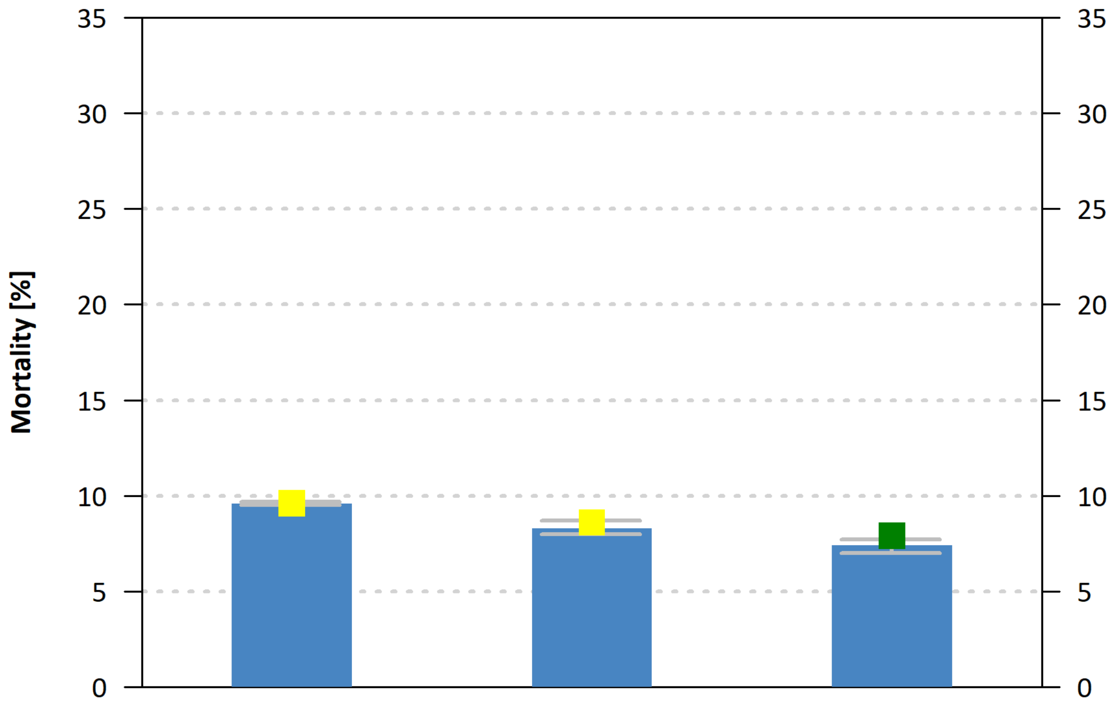
2 Observed mortality and prognosis

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 using the **RISC II** prognostic score (Revised Injury Severity Classification; Lefering et al. 2014). This score can be calculated for all primarily admitted patients. The analysis in chapter 2 is confined to the **basic group** as defined on page 5.

No. of basic group patients documented in the TR-DGU in the last 10 years (2012-2021)	n = **313,461**
- of these, documented last year (2021)	n = **28,580**
- of these, only primary cases (no transfer in; no early transfer out; no patients deceased within the first week with a patient's volition)	n = **23,170**

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 = 2,346 in 2021), the initial status from primary admission is missing; for patients **transferred out early** (within 48 hours after admission; n = 1,713 in 2021), no final outcome is documented. Additionally, patients deceased within the first week with a patient's volition (n = 1,351 in 2021) are excluded from this analysis to ensure a correct presentation of the quality of treatment in a hospital.

The mean age of the remaining 23,170 patients was 53.1 years and 69 % were male. The mean ISS was 17.3 points. Of these patients 1,705 died in hospital, which is **7.4 %** (95 % CI: 7.0 - 7.7). The risk of death prognosis based on RISC II is **7.9 %**. You find these values for the TR-DGU in figure 2.



	TR-DGU 10 years	TR-DGU 2020	TR-DGU 2021
No. of pat. (n):	259,424	24,105	23,170
Mortality [%]:	9.6	8.3	7.4
RISC II [%]:	9.6	8.6	7.9

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

Expanded information for Figure 2:

The bars represent the observed mortality rate; percentages are given in the table at the bottom of each bar. The predicted mortality rate, RISC II, is given as a yellow **box**. This box 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 must be considered that these findings depend on statistical uncertainty. Therefore, the 95 % confidence interval (CI) for the observed mortality rate is given as well (grey vertical error bars). 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.

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 2017, all 13 required variables are recorded by both datasets. Even though the only mandatory components are age and injury severity, every additional piece of information 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) **more than 95 %** of cases were well documented,
- (yellow) **80 - 94 %** of cases were well documented,
- (red) **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 2020	TR-DGU 2021
Total cases (n)	259,424	24,105	23,170
„Well documented" (n)	206,358	19,370	19,123
„Well documented" (%)	80	80	82
Data quality colour code	(yellow)	(yellow)	(yellow)
Average number 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 2021:	Patients in the basic group:	**23,170**	primary admitted cases
	Deviation between mortality and prognosis:	**-0.5 %**	

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 2021**. 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 **fewer than 5 patients** are not included due to the large statistical uncertainty.

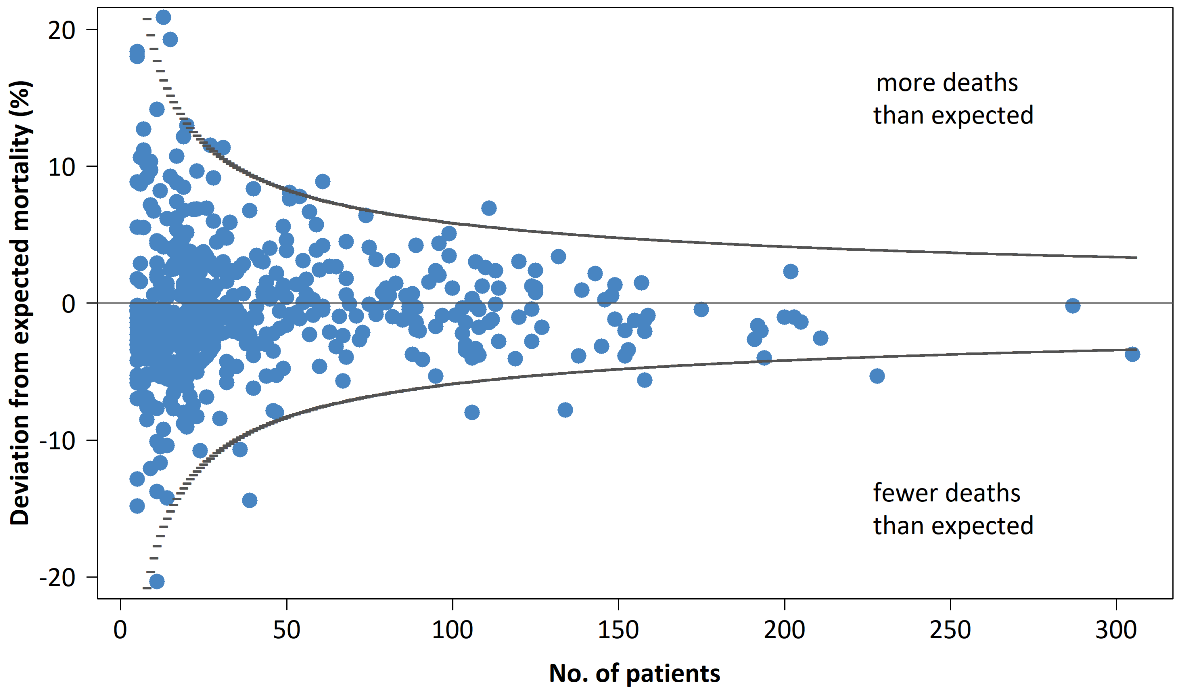


Figure 3: Deviation between the observed mortality and the risk of death prognosis (RISC II) of every hospital participating in the TR-DGU with more than 5 cases in the year 2021

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 should 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	2019	2020	**2021**
Total number of patients	(n)	313,461	30,358	29,434	**28,580**
Primary admitted and treated patients	(n)	264,959	25,500	25,337	**24,521**
Patients transferred out early	(n)	20,426	1,999	1,773	**1,713**
All primary admissions	(n)	285,385	27,499	27,110	**26,234**
Patients transferred in	(n)	28,076	2,859	2,324	**2,346**

Table 3 continuation:

		TR-DGU			
		10 years	2019	2020	**2021**
Demography (all patients in the basic group)					
Mean age	[years]	51.9	53.3	54.2	**54.1**
70 years or older	[%]	26.7	28.1	29.0	**29.4**
Proportion male	[%]	69.8	69.2	70.0	**69.2**
Trauma (all patients in the basic group)					
Blunt trauma	[%]	95.9	96.2	96.2	**95.8**
Mean ISS	[points]	18.4	18.2	18.3	**18.1**
ISS ≥ 16	[%]	54.3	53.4	54.3	**54.0**
TBI (AIS head ≥ 3)	[%]	36.7	35.7	36.4	**36.5**
Prehospital care (only primary admissions)					
Intubation by emergency physician	[%]	20.8	19.0	18.9	**18.2**
Unconscious (GCS ≤ 8)	[%]	16.6	16.3	15.6	**14.7**
Shock (RR ≤ 90 mmHg)	[%]	8.8	8.1	7.9	**7.5**
Average amount of volume	[ml]	638	604	595	**589**
Emergency room care (only primary admissions)					
Whole-body CT	[%]	76.1	78.1	75.5	**73.7**
X-ray of thorax	[%]	31.0	24.6	21.6	**19.0**
Patients with blood transfusion	[%]	7.6	6.9	7.3	**7.8**
Treatment in hospital (all patients in the basic group)					
Patients with surgery [1)]	[%]	66.7	66.2	67.8	**67.6**
if yes, no. of pat. with surgery [2)]	(n)	3.4	3.3	3.3	**3.1**
Patients treated in the ICU	[%]	86.5	85.8	85.6	**83.6**
Length of stay in the ICU [3)]	[days]	6.4	6.1	6.0	**5.8**
Intubated/ventilated patients in the ICU [3)]	[%]	37.9	34.6	35.2	**34.5**
Length of intubation [3)]	[days]	7.4	7.3	6.9	**6.8**
Outcome (all patients in the basic group)					
Length of stay in hospital [4)]	[days]	15.8	15.4	14.6	**14.3**
Hospital mortality [4)]	[n]	33,899	3,385	3,500	**3,361**
	[%]	11.6	11.9	12.7	**12.5**
Multiple organ failure [2) 4)]	[%]	19.1	17.8	17.2	**15.4**
Discharge to other hospital	[%]	17.4	18.0	16.9	**16.8**

1) years where less than 20 % patients underwent surgery are excluded

2) not available in the reduced QM dataset

3) only ICU patients

4) excludes patients transferred out early

4 Indicators of process quality

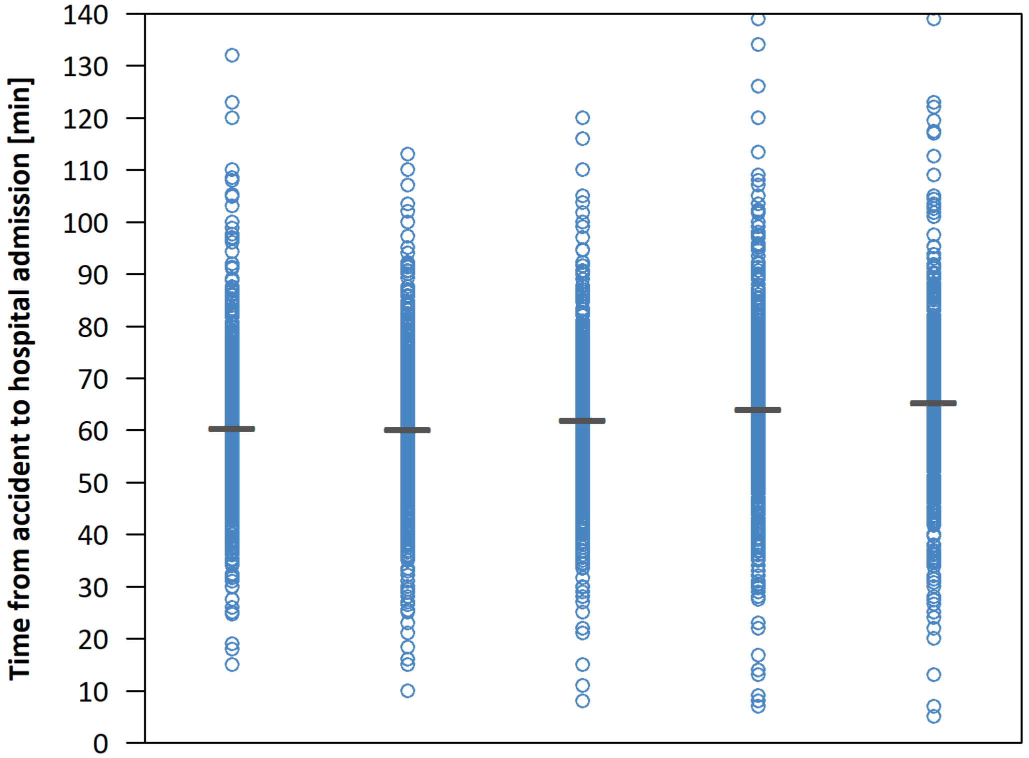
Quality indicators are measurements which are presumed to be associated with the quality of care and outcome. All results presented here are based on **primary admitted cases only from the basic group in 2021** with valid data or respective subgroups thereof. This includes early transfer out cases.

For each indicator, the distribution of the values of all participating hospitals is presented graphically over time. The light blue circles present the individual hospital values. The grey horizontal line is the mean across all hospitals for that 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 are excluded.

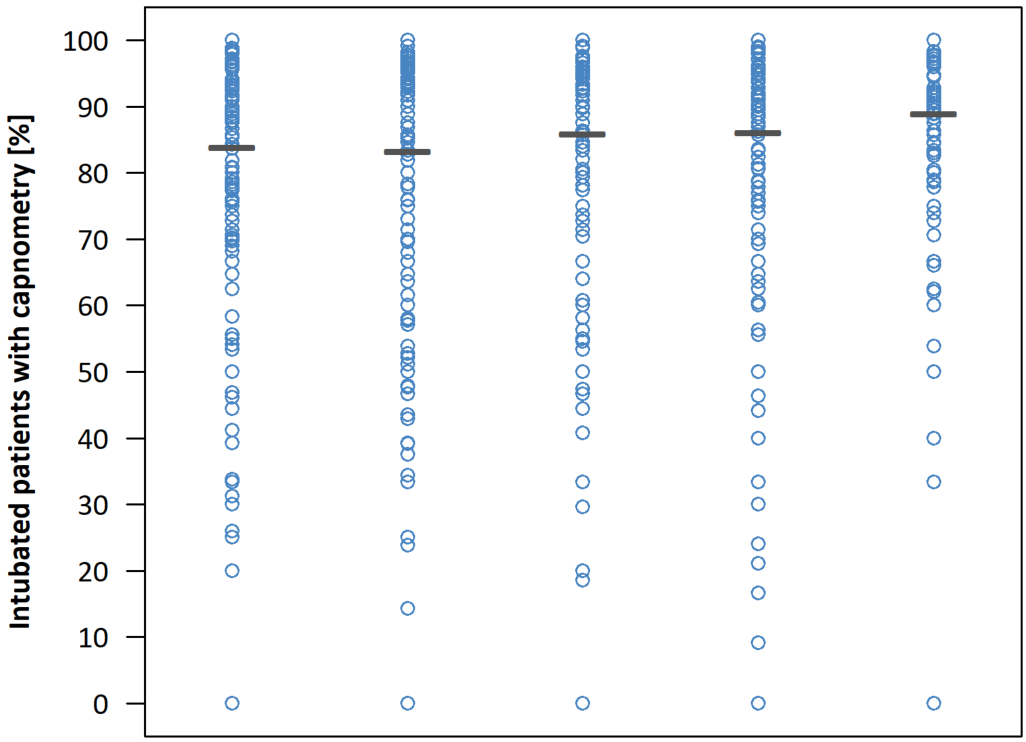


Year:	2017	2018	2019	2020	2021
TR-DGU:	60 [min]	60 [min]	62 [min]	64 [min]	65 [min]
n:	12,959	12,263	10,880	11,020	10,261
Min-Max:	5-240 [min]	5-240 [min]	5-240 [min]	5-240 [min]	5-240 [min]

Figure 4: Distribution of the mean duration from accident until hospital admission of patients with mit ISS ≥ 16 over all hospitals, 2017-2021, — TR-DGU, o single hospital value

4.1.2 Capnometry in intubated patients

Capnometry helps to assess the effectiveness of intubation in intubated patients. Only patients with a prehospital endotracheal intubation with valid data for capnometry are considered here. Intubated patients without information regarding capnometry cannot be analysed (n = 1,374).

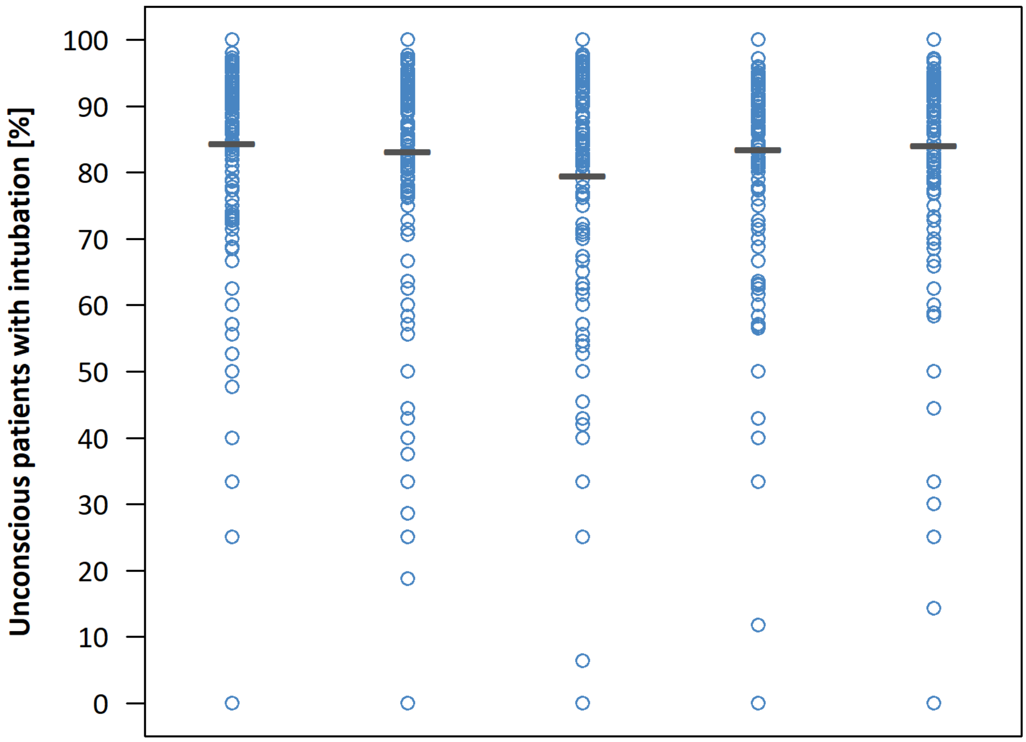


Year:	2017	2018	2019	2020	2021
TR-DGU:	84 %	83 %	86 %	86 %	89 %
Capnometry (n):	3,677	3,398	3,185	3,019	3,033
Intubated (N):	4,381	4,081	3,707	3,506	3,411

Figure 5: Distribution of the capnometry rate in prehospital intubated patients over all hospitals, 2017-2021, — TR-DGU, o single hospital value

4.1.3 Intubation of unconscious patients

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

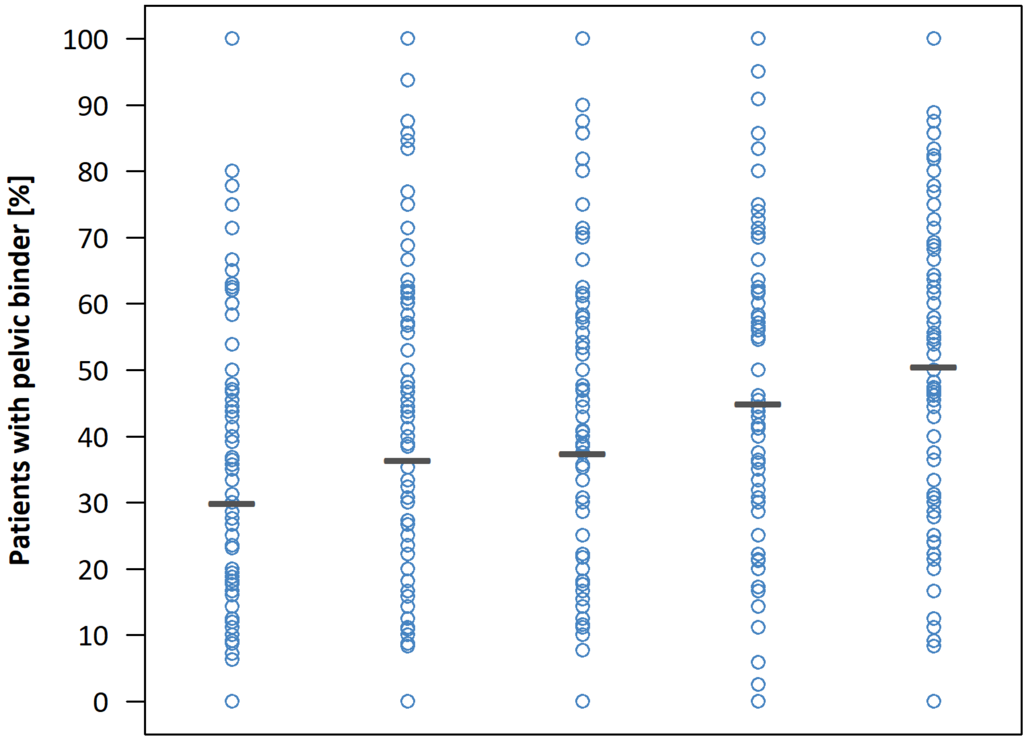


Year:	**2017**	**2018**	**2019**	**2020**	**2021**
TR-DGU:	84 %	83 %	80 %	84 %	84 %
Intubated (n):	4,074	3,732	3,315	3,234	2,936
Unconscious (N):	4,828	4,489	4,167	3,873	3,492

Figure 6: Distribution of the intubation rate in unconscious patients over all hospitals, 2017-2021, — 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.



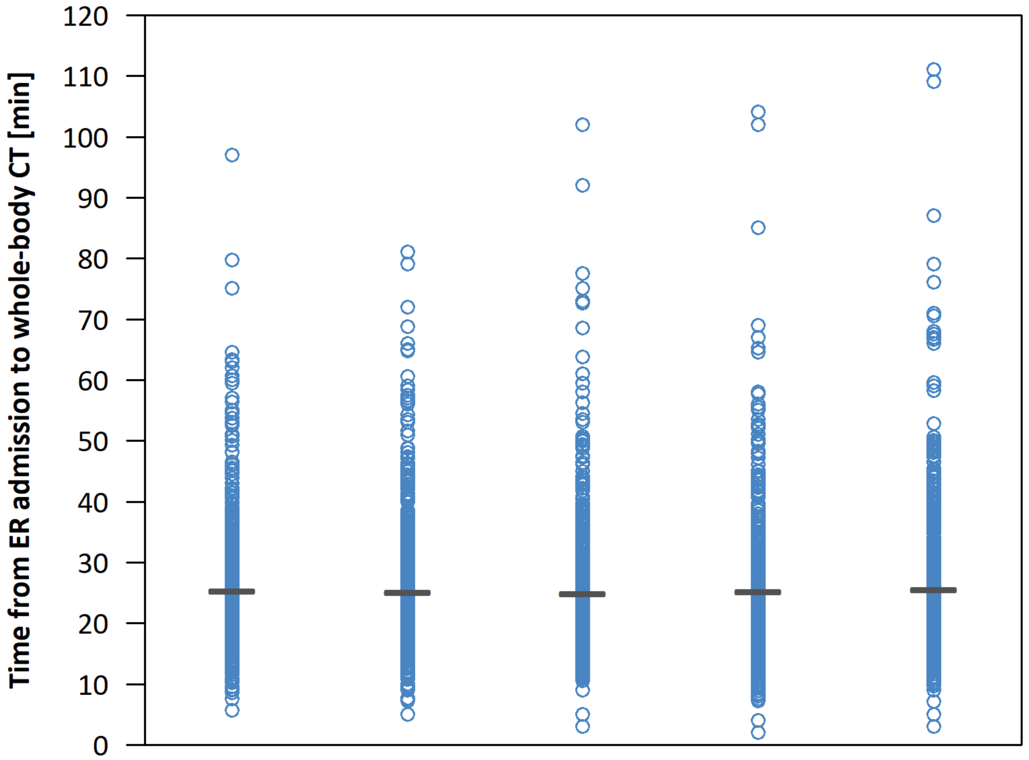
Year:	**2017**	**2018**	**2019**	**2020**	**2021**
TR-DGU:	30 %	36 %	37 %	45 %	50 %
Pelvic binder (n):	467	513	504	623	777
Pelvic fracture (N):	1,561	1,409	1,348	1,387	1,539

Figure 7: Distribution of the pelvic binder rate in patients with an instable pelvic fracture over all hospitals, 2017-2021, — TR-DGU, o single hospital value

4.2 Process times in the emergency room

4.2.1 Time 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 in a timely manner. Time periods > 120 minutes are excluded from the following analysis. All patients who received a whole-body CT are considered here.

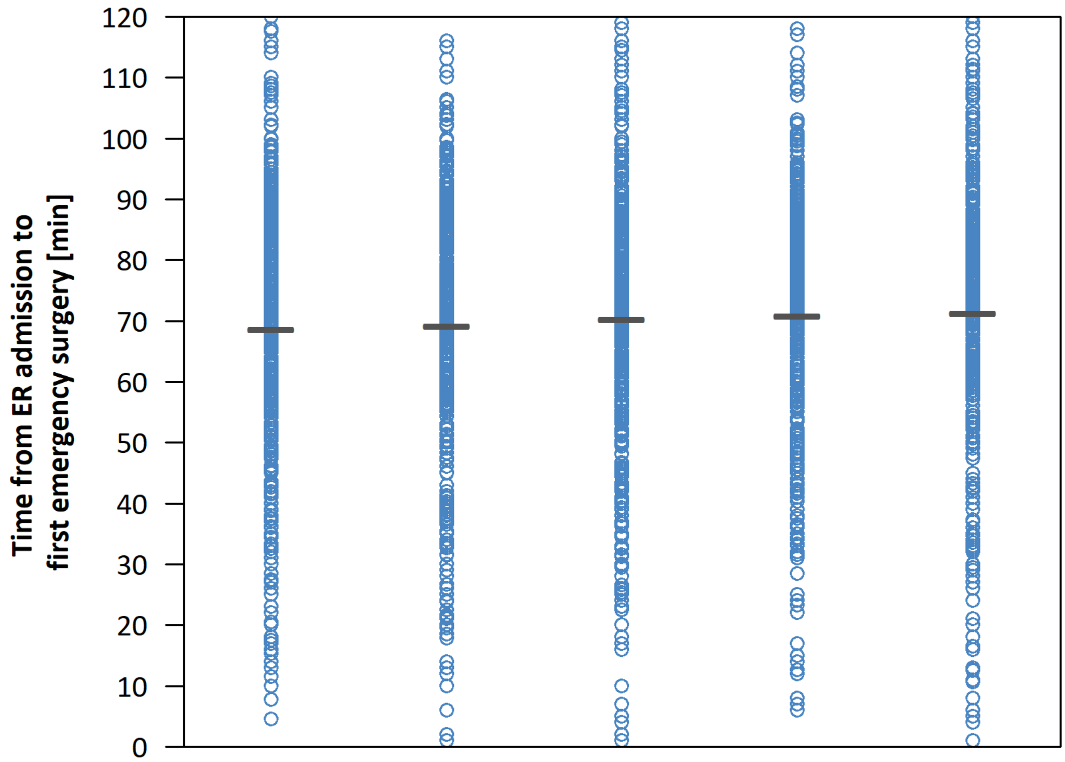


Year:	2017	2018	2019	2020	2021
TR-DGU:	25 [min]	25 [min]	25 [min]	25 [min]	26 [min]
n:	25,102	23,638	20,951	20,185	19,096
Min-Max:	1-120 [min]	1-120 [min]	1-120 [min]	1-120 [min]	1-120 [min]

Figure 8: Distribution of the mean duration from admission to the ER until whole-body CT over all hospitals, 2017-2021, — TR-DGU, o single hospital value

4.2.2 Time until first emergency surgery

Eight different emergency interventions are documented in TR-DGU (surgical liquid 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.

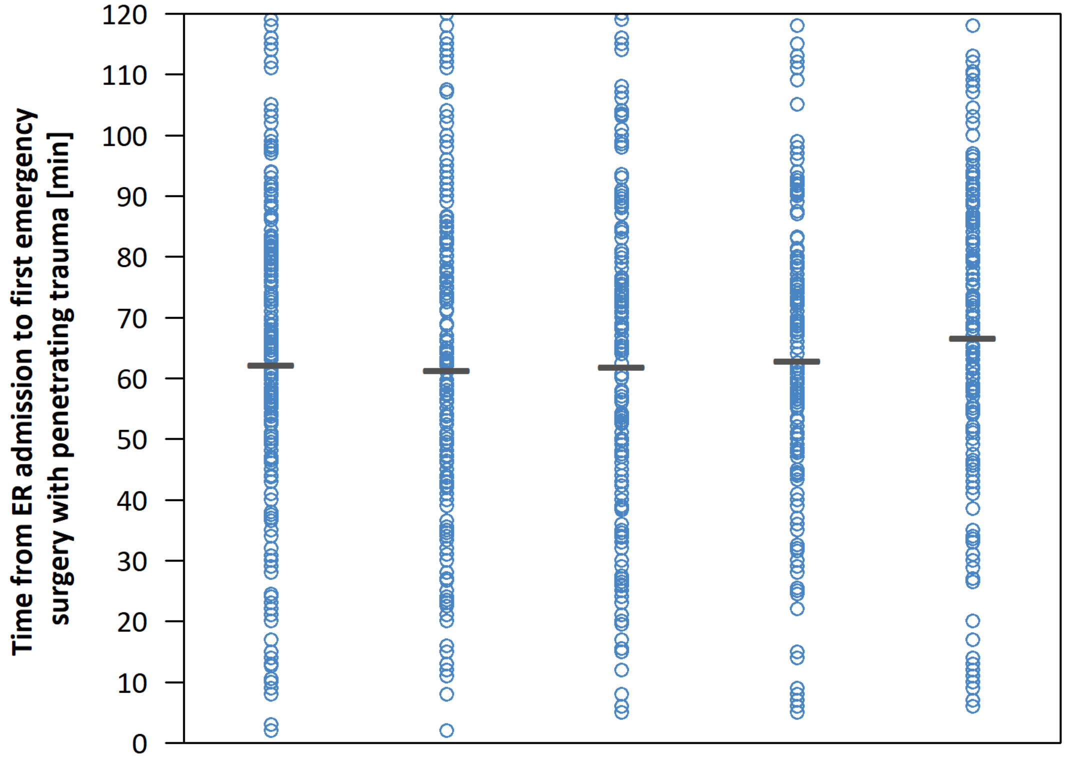


Year:	2017	2018	2019	2020	2021
TR-DGU:	69 [min]	69 [min]	70 [min]	71 [min]	71 [min]
n:	5,197	4,550	4,041	3,908	3,607
Min-Max:	1-120 [min]	1-120 [min]	1-120 [min]	1-120 [min]	1-120 [min]

Figure 9: Distribution of the mean duration from admission to the ER until the first emergency surgery over all hospitals, 2017-2021, — TR-DGU, o single hospital value

4.2.3 Time 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 longer than 120 minutes are excluded from this analysis.

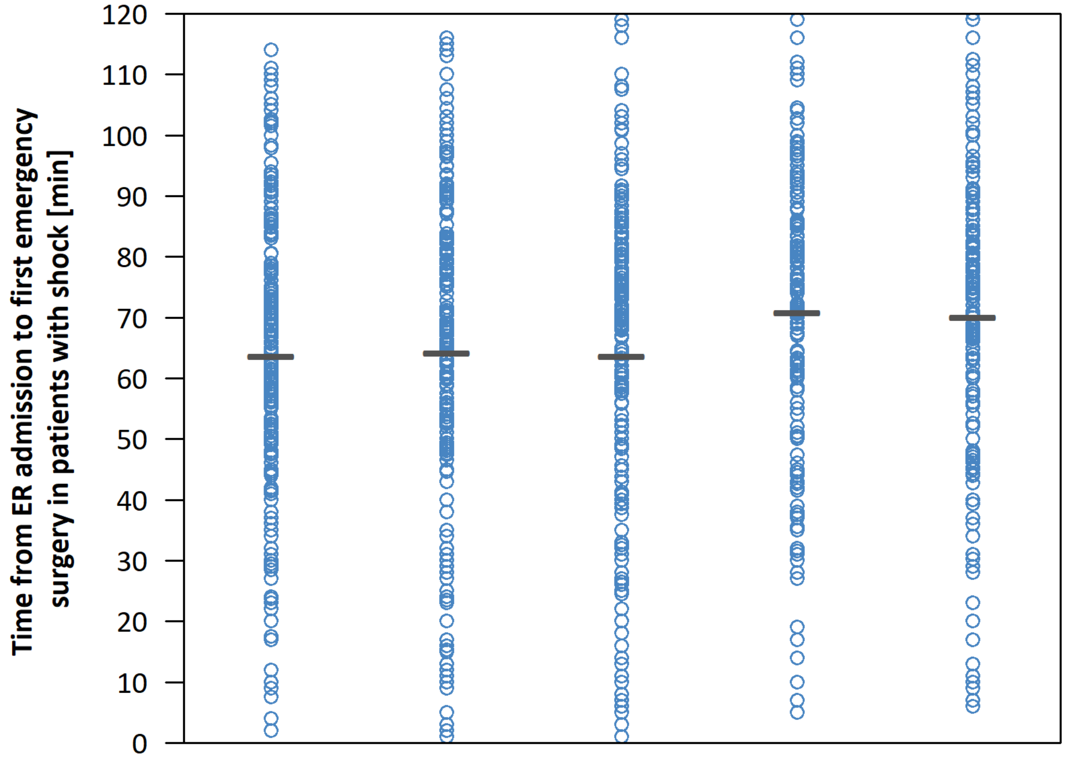


Year:	2017	2018	2019	2020	2021
TR-DGU:	62 [min]	61 [min]	62 [min]	63 [min]	67 [min]
n:	514	418	401	334	366
Min-Max:	1-120 [min]	1-120 [min]	1-120 [min]	1-120 [min]	6-120 [min]

Figure 10: Distribution of the mean duration from admission to the ER until surgery in patients with penetrating trauma over all hospitals, 2017-2021, — TR-DGU, o single hospital value

4.2.4 Time until surgery in patients in shock

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

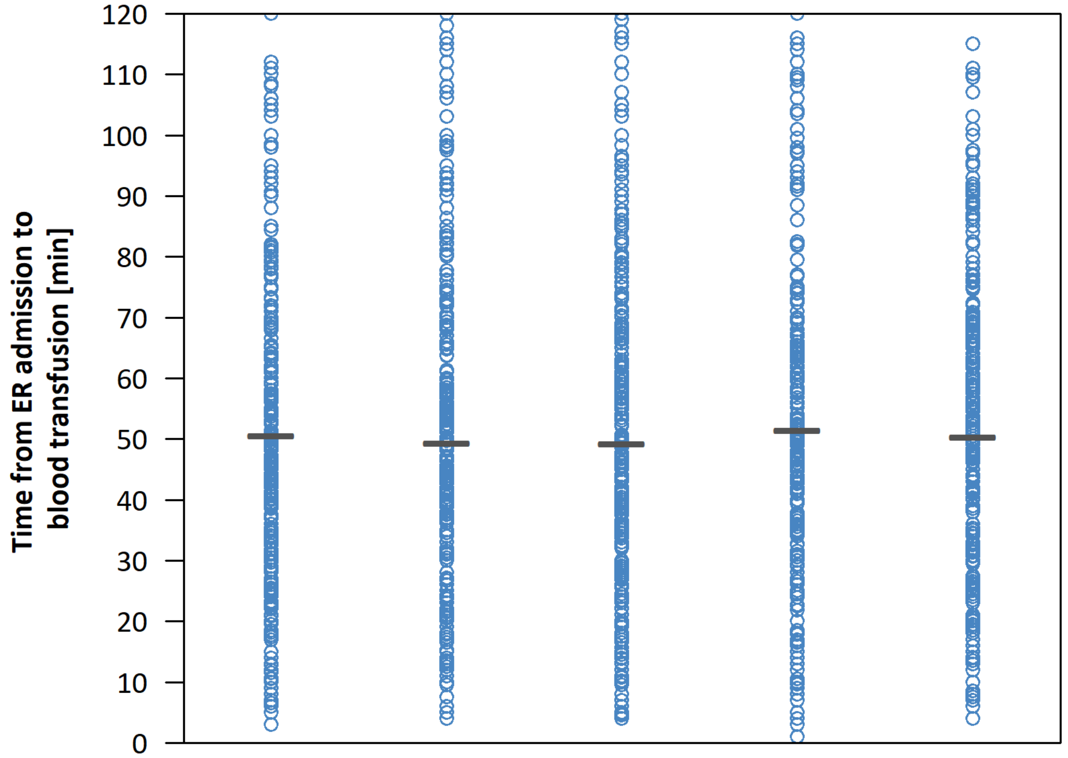


Year:	2017	2018	2019	2020	2021
TR-DGU:	64 [min]	64 [min]	64 [min]	71 [min]	70 [min]
n:	758	696	596	543	509
Min-Max:	1-120 [min]	1-120 [min]	1-120 [min]	1-120 [min]	2-120 [min]

Figure 11: Distribution of the mean duration from admission to the ER until surgery in patients with shock over all hospitals, 2017-2021, — TR-DGU, o single hospital value

4.2.5 Time until start of blood transfusion

If blood substitution is required, this should be done as quickly 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 minutes are excluded from this analysis.

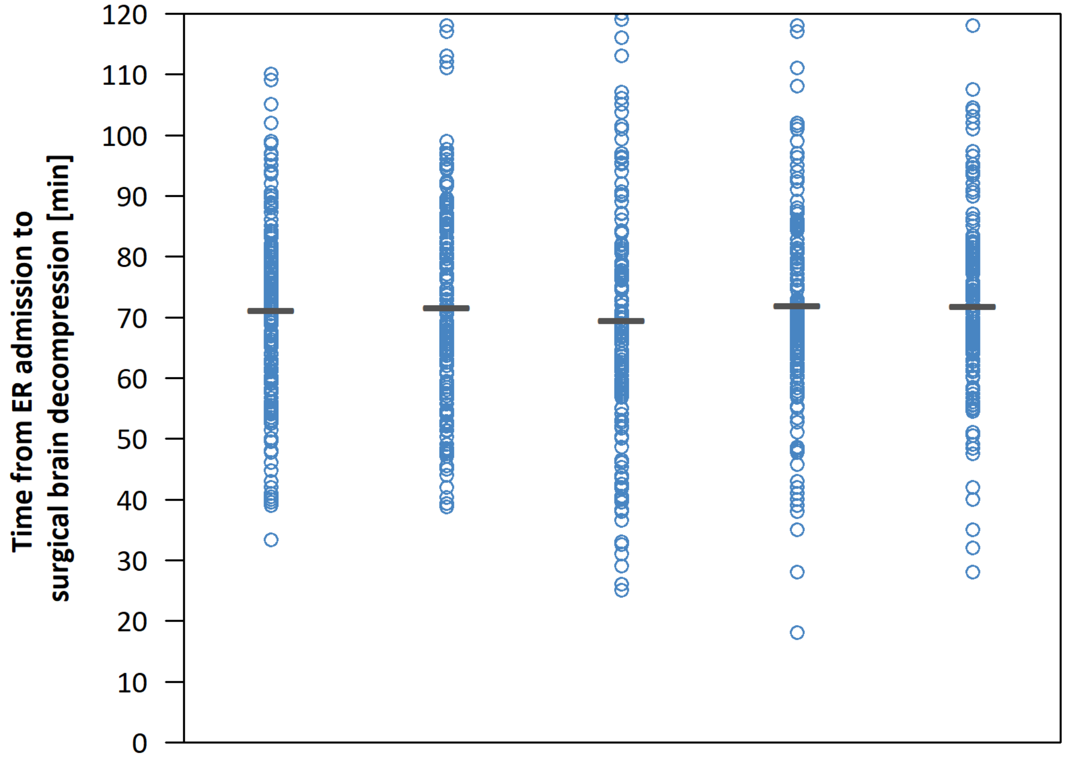


Year:	2017	2018	2019	2020	2021
TR-DGU:	51 [min]	49 [min]	49 [min]	51 [min]	50 [min]
n:	1,488	1,366	1,237	1,151	1,181
Min-Max:	1-120 [min]	1-120 [min]	1-120 [min]	1-120 [min]	1-120 [min]

Figure 12: Distribution of the mean duration from admission to the ER until start of the transfusion over all hospitals, 2017-2021, — 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.



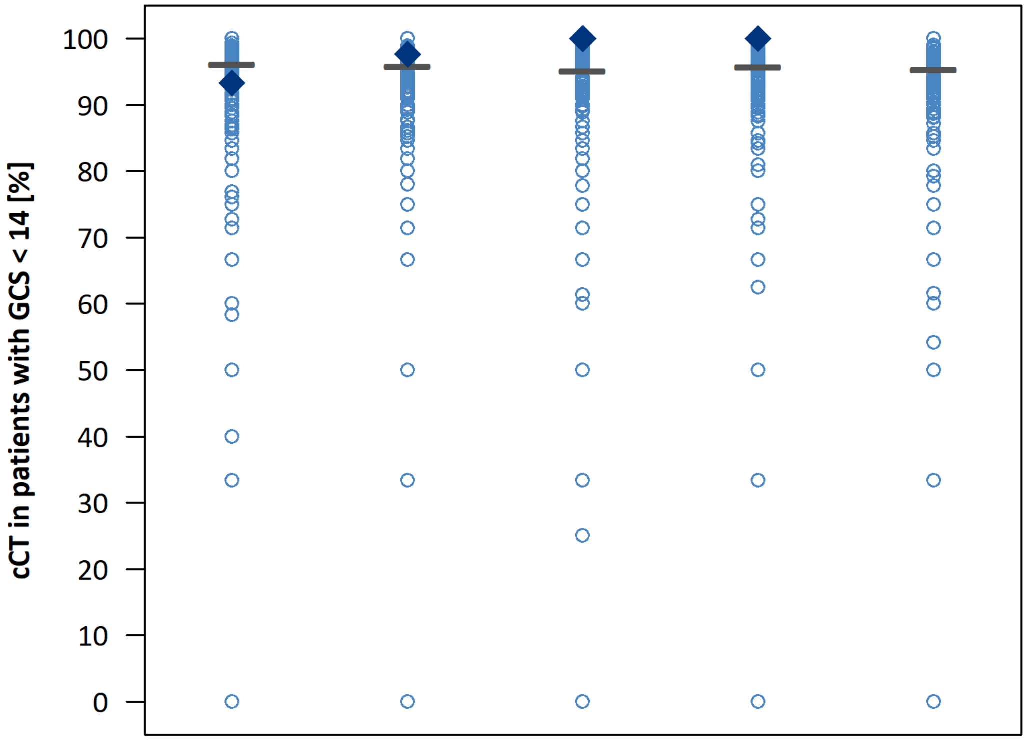
Year:	2017	2018	2019	2020	2021
TR-DGU:	71 [min]	72 [min]	69 [min]	72 [min]	72 [min]
n:	790	712	628	668	588
Min-Max:	1-120 [min]	1-120 [min]	1-120 [min]	14-120 [min]	16-120 [min]

Figure 13: Distribution of the mean duration from admission to the ER until surgical brain decompression over all hospitals, 2017-2021, — 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 of 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 no longer possible. A missing value regarding cCT / whole-body CT is considered as „not performed".

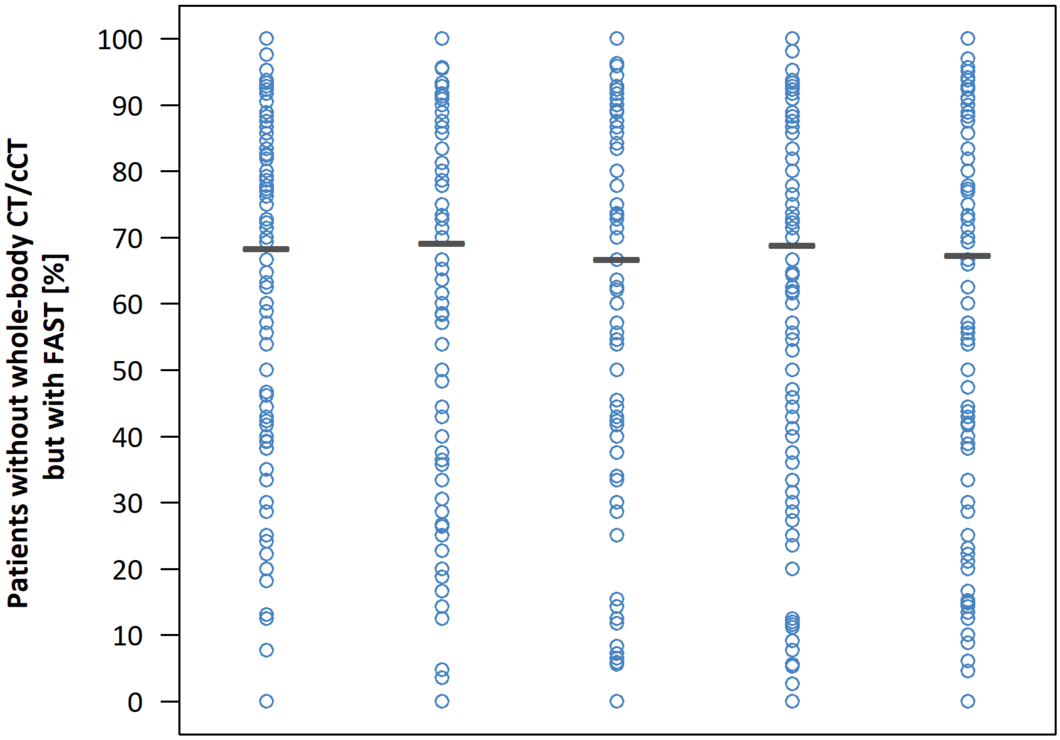


Year:	2017	2018	2019	2020	2021
TR-DGU:	96 %	96 %	95 %	96 %	95 %
cCT (n):	9,669	8,755	7,700	7,493	7,138
GCS < 14 (N):	10,053	9,129	8,092	7,829	7,482

Figure 14: Distribution of the cCT rate in patients with GCS < 14 over all hospitals, 2017-2021, — 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 without a documented whole-body CT / cCT are included in this analysis. A missing value regarding the FAST is considered as „not performed”.

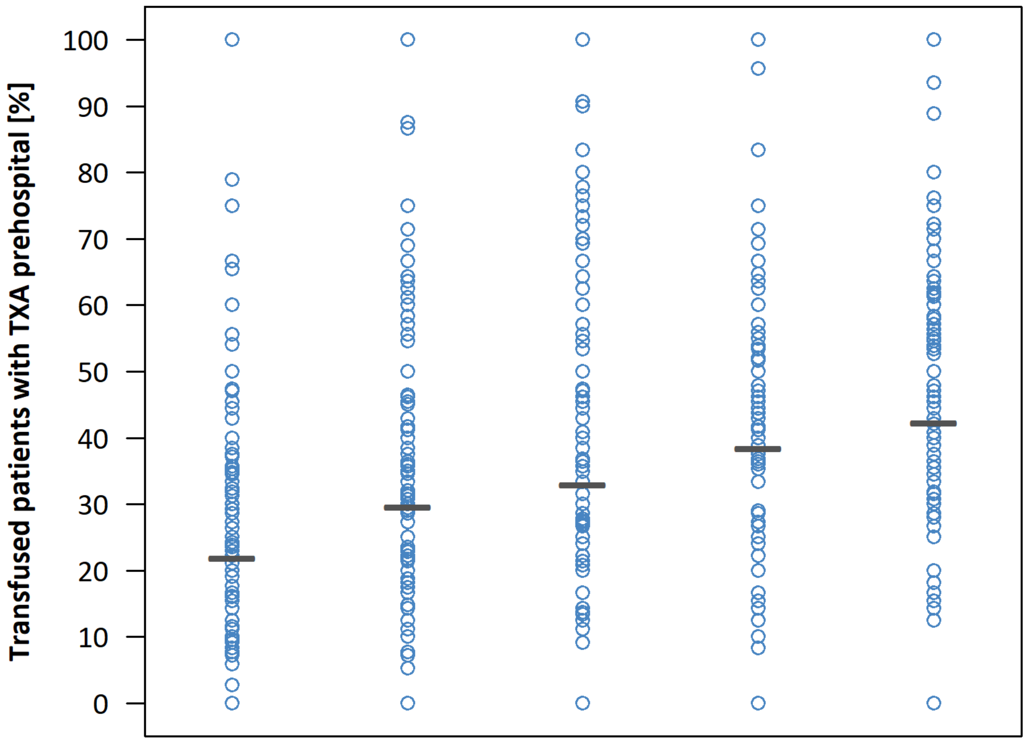


Year:	2017	2018	2019	2020	2021
TR-DGU:	68 %	69 %	67 %	69 %	67 %
FAST (n):	2,092	1,968	1,764	2,092	2,041
No WBCT/cCT (N):	3,058	2,845	2,644	3,039	3,031

Figure 15: Distribution of the sonography rate in patients without whole-body CT / ccT over all hospitals, 2017-2021, — TR-DGU, o single hospital value

4.3.3 Prehospital tranexamic acid in patients with blood transfusion

Based on a randomized trial, patients receiving tranexamic acid (TXA) need a reduced transfusion volume or even no transfusion at all. Therefore, patients who require a blood transfusion should have been previously given TXA. 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".

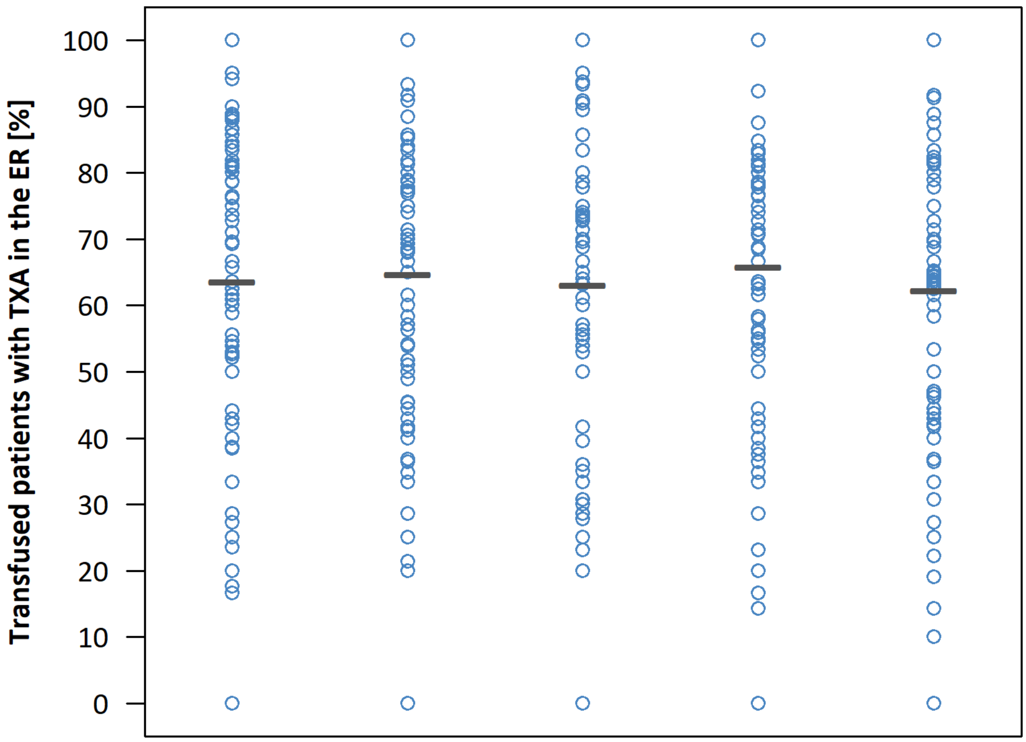


Year:	2017	2018	2019	2020	2021
TR-DGU:	22 %	30 %	33 %	38 %	42 %
TXA prehosp. (n):	509	618	629	756	862
Transfused (N):	2,324	2,086	1,911	1,968	2,039

Figure 16: Distribution of the prehospital tranexamic acid rate in the ER or surgery phase transfused patients over all hospitals, 2017-2021, — TR-DGU, o single hospital value

4.3.4 Tranexamic acid in the ER in patients with blood transfusion

Currently, tranexamic acid given in the ER is only documented 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:	2017	2018	2019	2020	2021
TR-DGU:	64 %	65 %	63 %	66 %	62 %
TXA in ER (n):	996	921	821	867	982
Transfused (N):	1,567	1,423	1,302	1,318	1,577

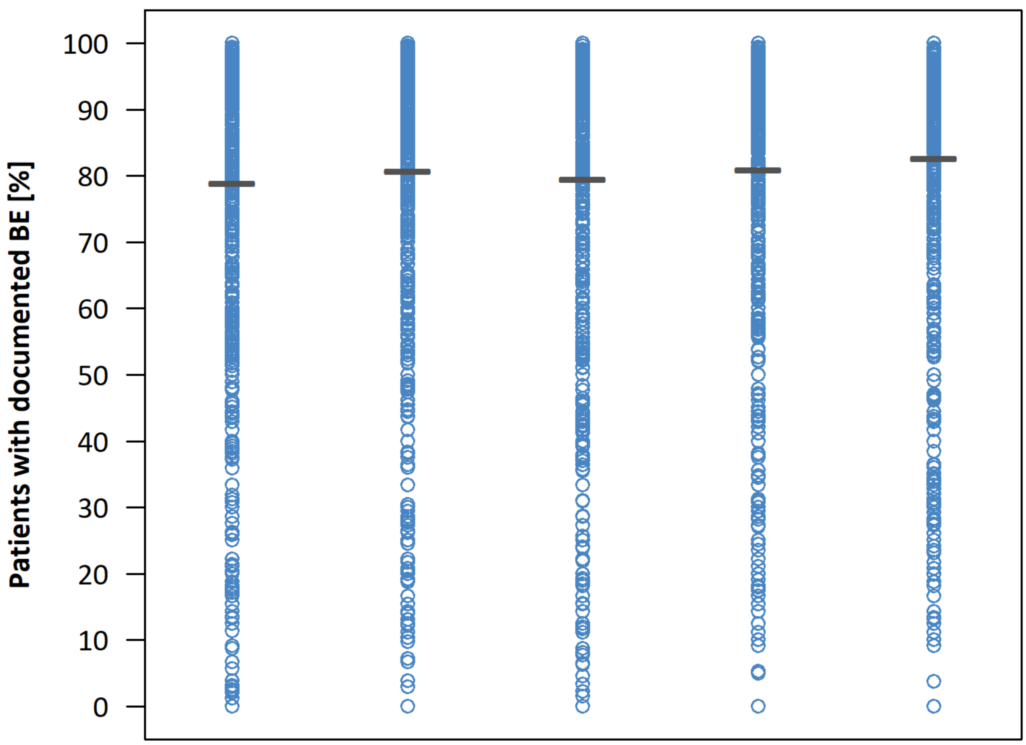
Figure 17: Distribution of the TXA admission rate in the ER in patients transfused between ER and intensive therapy over all hospitals, 2017-2021, — TR-DGU, o single hospital value

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 proportion of patients with valid BE values is calculated. BE values less than -50 mmol/l or greater than 20 mmol/l are excluded.



Year:	2017	2018	2019	2020	2021
TR-DGU:	79 %	81 %	80 %	81 %	83 %
Document. BE (n):	25,777	24,729	21,881	21,957	21,688
Patients (N):	32,682	30,639	27,499	27,110	26,234

Figure 18: Distribution of the patient rate with documented base excess (BE) over all hospitals, 2017-2021, — 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 TraumaNetzwerk DGU® patients in the last 10 years

Figure 19 presents the number of documented trauma patients treated in certified TraumaNetzwerk DGU® centres in the last ten years. Only cases from the **basic group** are considered here (see page 5 for definition). In the TraumaNetzwerk DGU® **274,694 patients** were documented in the last 10 years, including **27,333 patients in 2021** alone.

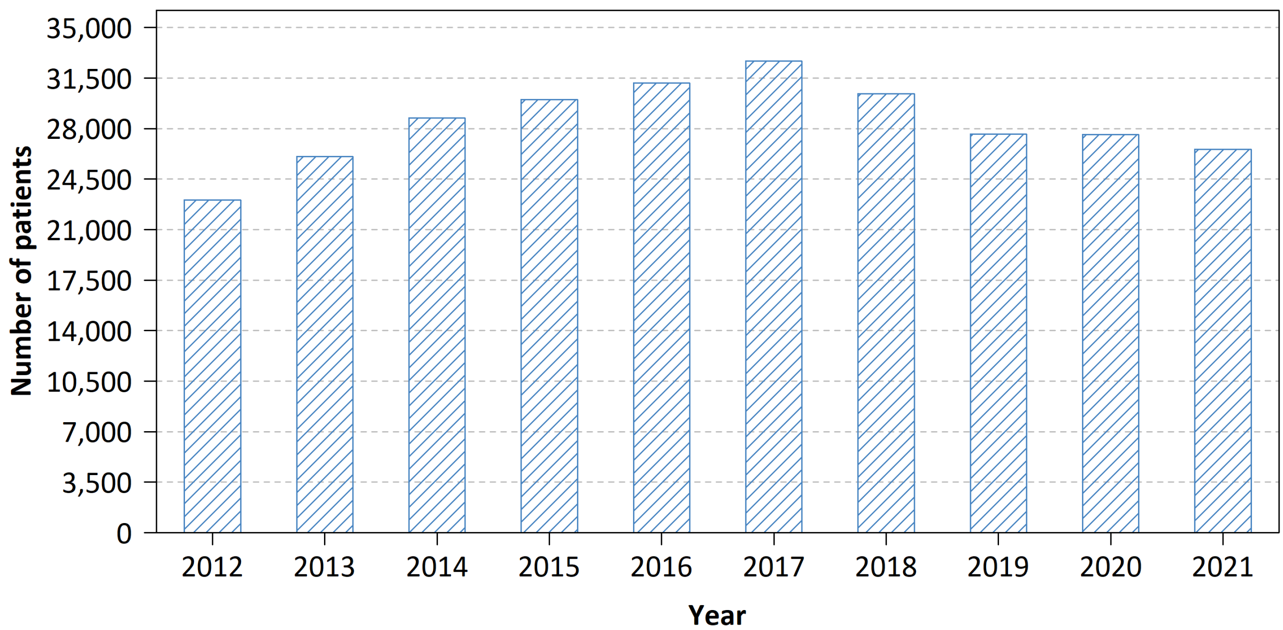


Figure 19: Documented number of patients in the TraumaNetzwerk DGU® basic group from 2012-2021 (bars)

5.2 Number of patients in each trauma level

In 2021, the TraumaNetzwerk DGU® documented **27,333 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.

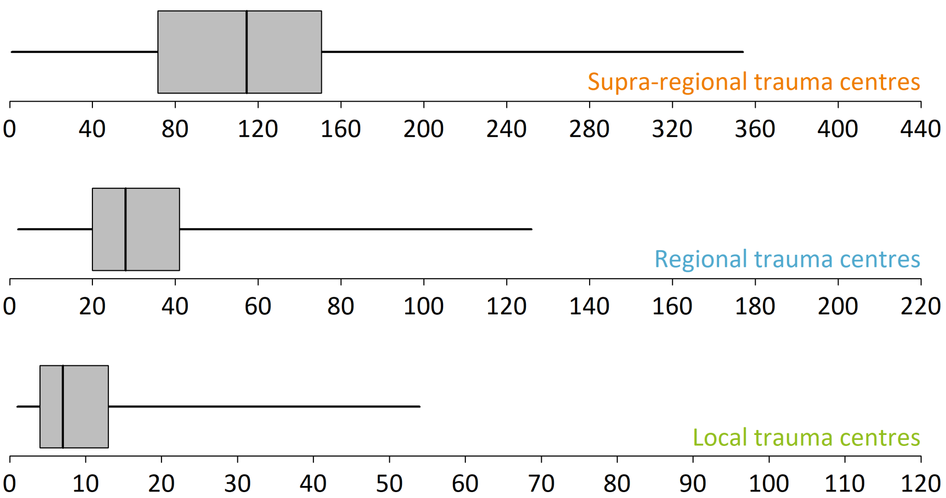


Figure 20: Median number of cases of the in the TraumaNetzwerk DGU® participating trauma centres separated by the trauma level in 2021

5.3 Comparisons between the trauma levels

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		297	232	130	659
Portion of patients in the TR-DGU		11 %	30 %	59 %	100 %
Patients per year and hospital (mean)	n	**10** / year	**35** / year	**123** / year	**41** / year
Patients (3 years, cumulated)	n	8,940	24,667	48,150	81,757
Primary admitted and treated	n (%)	7,135 (80 %)	21,180 (86 %)	41,779 (87 %)	70,094 (86 %)
Primary admitted and transferred out early (< 48 h)	n (%)	1,677 (19 %)	2,761 (11 %)	748 (2 %)	5,186 (6 %)
Transferred in from another hospital	n (%)	128 (1 %)	726 (3 %)	5,623 (12 %)	6,477 (8 %)

Table 4 continuation:

		Trauma centre			
Characteristics		**local**	**regional**	**supra-regional**	**TR-DGU**
Patients					
Average age [years]	M	56.1	56.5	52.7	54.2
Patients aged 70 years and older	%	31 %	33 %	27 %	29 %
Males	%	67 %	68 %	71 %	69 %
ASA 3-4	%	20 %	24 %	20 %	21 %
Injuries					
Injury Severity Score (ISS) [points]	M	13.4	16.1	19.9	18.1
Proportion with ISS ≥ 16	%	33 %	46 %	60 %	53 %
Proportion polytrauma *	%	7 %	11 %	18 %	14 %
Proportion with life-threatening severe injury **	%	17 %	26 %	36 %	31 %
Patients with TBI, AIS ≥ 3	%	17 %	28 %	42 %	35 %
Patients with thoracic injury, AIS ≥ 3	%	35 %	38 %	38 %	38 %
Patients with abdominal injury, AIS ≥ 3	%	7 %	9 %	10 %	10 %
Prehospital care (primary admissions only)					
Rescue time (accident to hospital) [min]	M	59.8	62.1	70.6	66.4
Prehospital volume administration [ml]	M	446	528	675	599
Prehospital intubation	%	3 %	9 %	27 %	19 %
Proportion unconscious (GCS ≤ 8)	%	4 %	8 %	19 %	14 %
Emergency room (primary admissions only)					
Blood transfusion	%	3 %	4 %	10 %	7 %
Whole-body CT	%	66 %	71 %	81 %	76 %
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	3.0	4.9	6.7	6.2
Length of stay on the intensiv care unit [days]	M	2.4	3.9	6.4	5.3
Length of stay in the hospital [days]	M	9.7	12.4	16.5	14.7
Outcome and prognosis (without transfers in and early transfers out and patients deceased within the first week with a patient's volition)					
Patients	n	7,135	21,180	41,779	70,094
Non-survivors	n	283	1,355	3,921	5,559
Hospital mortality	%	4.0 %	6.6 %	9.9 %	8.3 %
RISC II prognosis	%	4.3 %	6.7 %	10.1 %	8.5 %

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 transfer status of all patients in the TraumaNetzwerk DGU® is displayed in the following figure, classified according to the trauma level for the year 2021. As expected, the proportion of patients that are transferred out of a local trauma centre as well as the proportion of patients that are transferred into a supra-regional trauma centre are the highest.

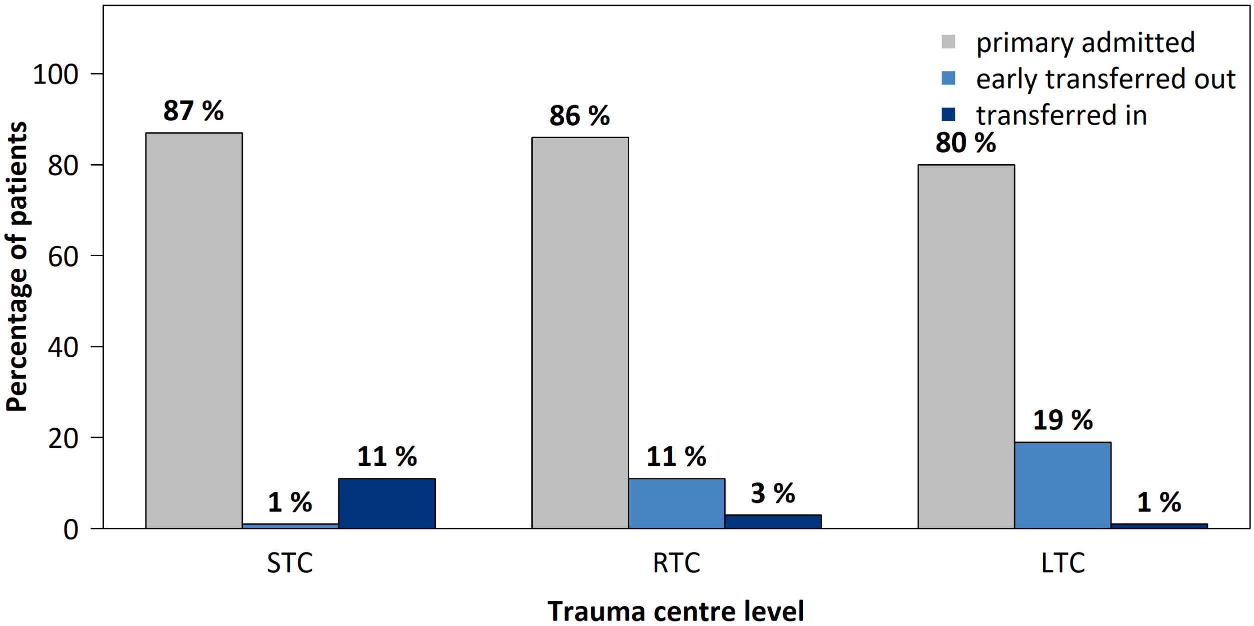


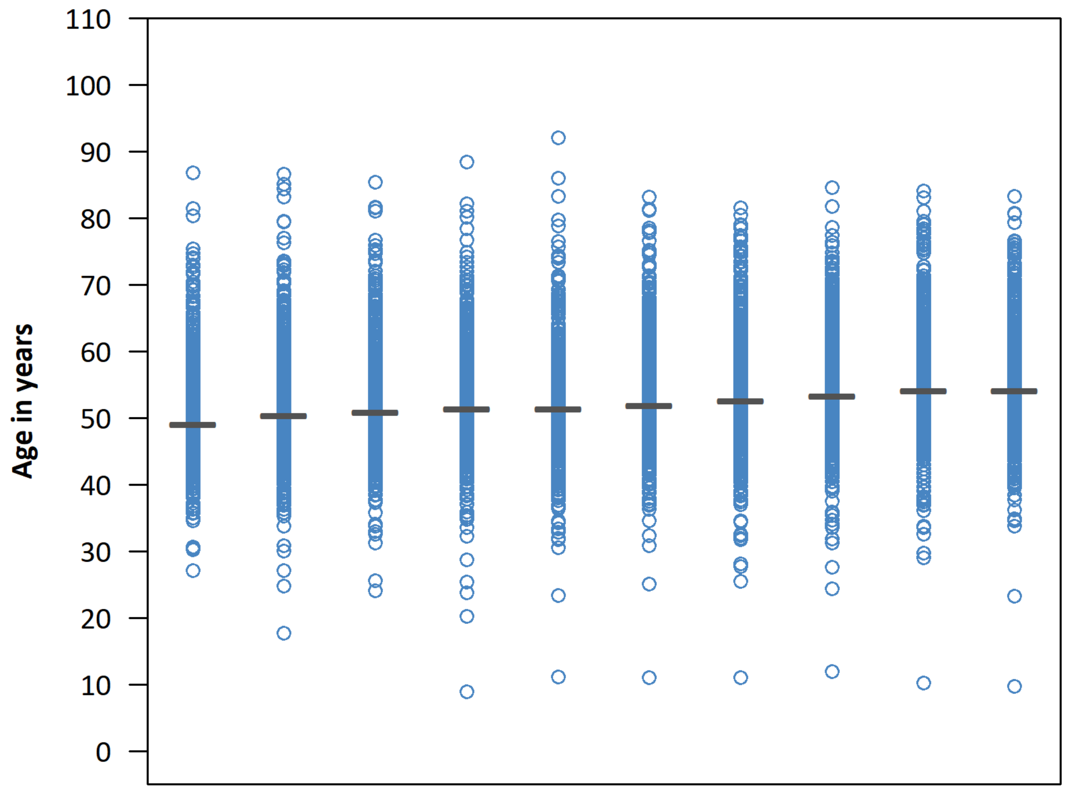
Figure 21: Transfer status classified according to the trauma level in 2021

6 Graphical comparisons with other hospitals

Below, selected information about the patients from the years **2012-2021** 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 figure below shows the distribution of mean age of the patients from the TR-DGU **with at least 3 patients** over the past ten years.

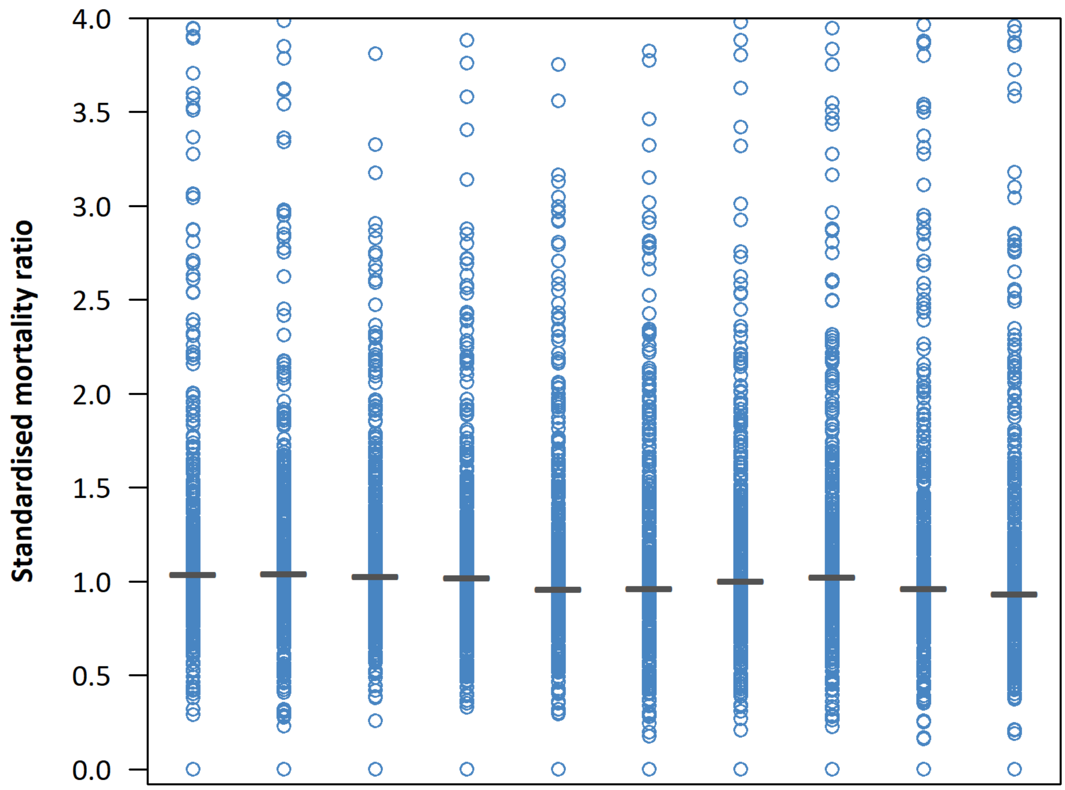


Year:	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
TR-DGU:	49.1	50.4	50.9	51.4	51.4	51.9	52.6	53.3	54.2	54.1

Figure 22: Mean patient's age in the — TR-DGU compared to the o single hospital values in the TR-DGU for the years 2012-2021

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

Only primary admitted patients are displayed here (from hospitals with at least 3 cases). Early transfers out (< 48 h) are excluded. 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 than expected. A SMR value < 1 indicates that the observed mortality is lower than expected. Figure 23 shows an SMR slightly under 1 for 2021.



Year:	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
TR-DGU:	1.04	1.04	1.03	1.02	0.96	0.96	1.00	1.02	0.97	0.93

Figure 23: Standardised mortality ratio of the — TR-DGU compared to the o single hospital values in the TR-DGU for the years 2012-2021

6.3 Length of stay and injury severity

The length of stay of patients is highly 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= 4,242) are excluded here. Hospitals with **fewer than 3 patients** are **not** displayed in the figure due to their statistical uncertainty.

TR-DGU 2021:

The value is based on:
20,975 patients

Mean length of stay:
15.2 days

Mean ISS:
16.0 points

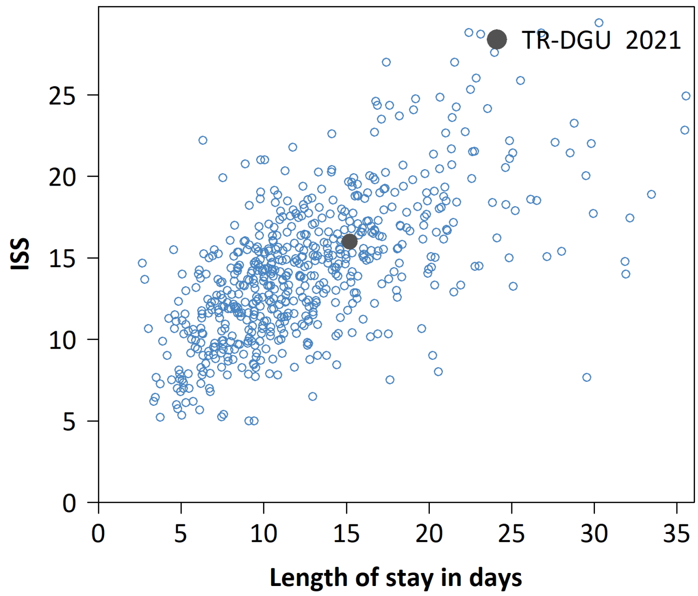


Figure 24: Relationship between length of stay and injury severity over all hospitals in 2021

6.4 Length of stay of the deceased patients

The following figure shows the distribution of length of stay of the deceased patients (N = 3,359) within the first 30 days (n = 3,237) in the TR-DGU in 2021.

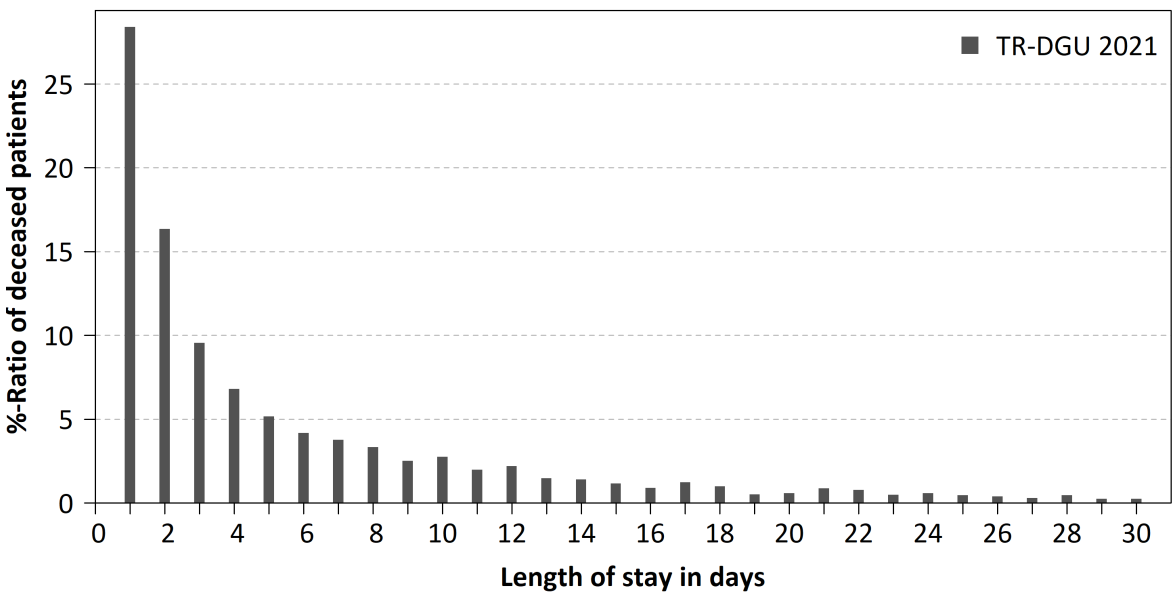


Figure 25: Time point of death of the patients from the TR-DGU [length of stay in days] in 2021

7 Basic data of trauma care

The following pages present basic data from the trauma care of the actual year 2021. The data refer to patients from the **basic group** (see page 5). Shown is data from the TraumaRegister DGU® basic group in the current year, (**TR-DGU 2021**), and the registry data sumarized from the last 10 years, 2012-2021 (**TR-DGU 10 years**).

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

(S) Patient and accident	TR-DGU 2021		TR-DGU 10 years	
Patients in the **basic group** (n)	28,580		313,461	
Primary admissions / transfers	%	n	%	n
Primary admitted	**91.8 %**	26,234	**91.0 %**	285,385
... and transferred out within 48 h	**6.0 %**	1,713	**6.5 %**	20,426
Transferred in within 24 h after accident	**7.5 %**	2,134	**8.1 %**	25,314
Transferred in after 24 h	**0.7 %**	212	**0.9 %**	2,762
Patient characteristics	M ± SD*/%	n	M ± SD*/%	n
Age [years]	**54.1** ± 22.8	28,580	**51.9** ± 22.7	313,461
Children under 16 years	**3.6 %**	1,037	**4.0 %**	12,501
Elderly over 70 years	**29.4 %**	8,407	**26.7 %**	83,544
Males	**69.2 %**	19,789	**69.8 %**	218,725
ASA 3-4 prior to trauma (since 2009)	**22.3 %**	6,042	**18.2 %**	51,249
Mechanism of injury	%	n	%	n
Blunt	**95.8 %**	25,716	**95.9 %**	285,553
Penetrating	**4.2 %**	1,126	**4.1 %**	12,059
Type and cause of accident	%	n	%	n
Traffic: Car	**16.7 %**	4,647	**19.7 %**	60,728
... thereof as car passenger (since 2020)	**15.9 %**	4,415	**2.7 %**	8,239
... thereof as lorry passenger (since 2020)	**0.7 %**	193	**0.1 %**	351
... thereof as bus passenger (since 2020)	**0.1 %**	36	**0.0 %**	67
Traffic: Motor bike	**11.2 %**	3,112	**12.1 %**	37,100
Traffic: Bicycle	**11.7 %**	3,232	**9.9 %**	30,668
... thereof as supported bike (since 2020)	**1.3 %**	364	**.2 %**	697
Traffic: Pedestrian	**3.9 %**	1,073	**5.7 %**	17,586
Traffic: E-scooter (since 2020)	**0.6 %**	153	**0.1 %**	221
High fall (> 3m)	**15.3 %**	4,239	**15.3 %**	47,145
Low fall (≤ 3m)	**28.7 %**	7,946	**25.9 %**	79,657
... thereof as ground level fall (since 2020)	**9.1 %**	2,520	**1.5 %**	4,569
Suicide (suspected)	**4.8 %**	1,347	**4.4 %**	13,530
Assault (suspected)	**2.4 %**	674	**2.5 %**	7,599

* M = Mean; SD = Standard deviation

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

Time point A: Findings at the accident scene	TR-DGU 2021		TR-DGU 10 years	
Primary admitted patients (n) (%-ratio of the basic group)	26,234 (92 %)		285,385 (91 %)	
Vital signs	**M** ± SD*	n	**M** ± SD*	n
Systolic blood pressure [mmHg]	**135.2** ± 32.4	22,263	**133.1** ± 33.1	246,783
Respiratory rate [1/min]	**15.9** ± 5.6	17,823	**15.8** ± 5.8	180,603
Glasgow Coma Scale (GCS) [points]	**12.9** ± 3.8	23,761	**12.6** ± 3.9	263,154
Findings	%	n	%	n
Shock (systolic blood pressure ≤ 90 mmHg)	**7.5 %**	1,679	**8.8 %**	21,689
Unconsciousness (GCS ≤ 8)	**14.7 %**	3,492	**16.6 %**	43,772
Therapy	%	n	%	n
Cardio-pulmonary resuscitation	**2.9 %**	763	**2.9 %**	8,197
Pre-hospital thoracotomy (since 2020)	**0.1 %**	37	**0.0 %**	70
Endotracheal intubation	**18.2 %**	4,785	**20.8 %**	59,266
Alternative airway	**1.0 %**	272	**.9 %**	2,580
Surgical airway (since 2020)	**0.1 %**	18	**0.0 %**	30
Cervical spine immobilization (since 2020)	**63.5 %**	14,667	**62.9 %**	26,869
Analgo-sedation **	**48.9 %**	12,841	**32.2 %**	91,940
Chest drain (with and without needle decompression) **	**2.5 %**	654	**1.7 %**	4,742
... thereof only with needle decompression (since 2020)	**0.5 %**	137	**0.1 %**	273
Catecholamines **	**7.3 %**	1,921	**4.5 %**	12,822
Pelvic binder **	**15.0 %**	3,945	**5.0 %**	14,274
Tourniquet (since 2020)	**1.4 %**	370	**0.2 %**	626
Intraosseous access (since 2020)	**1.7 %**	447	**0.3 %**	764
Tranexamic acid	**14.6 %**	3,820	**5.9 %**	16,940
Volume administration	**M** ± SD*/%	n	**M** ± SD*/%	n
Patients without volume administration	**20.3 %**	4,919	**18.7 %**	49,967
with volume administration	**79.7 %**	19,308	**81.3 %**	217,936
with colloids	**1.8 %**	408	**4.9 %**	12,413
Average amount in patients with volume administration [ml]	**589** ± 507	24,227	**638** ± 547	267,903
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 2021		TR-DGU 10 years	
Primary admitted patients (n) (%-ratio of the basic group)	26,234 (92 %)		285,385 (91 %)	
Transportation to the hospital	%	n	%	n
With helicopter	**19.0 %**	4,996	**18.9 %**	53,810
Glasgow Coma Scale (GCS)	**MW** ± SA*	n	**MW** ± SA*	n
Prehospital intubated patients	**3.3** ± 1.7	3,120	**3.3** ± 1.5	34,705
Patients not prehospital intubated	**14.0** ± 2.2	12,193	**13.8** ± 2.4	103,477
Initial diagnostics	%	n	%	n
Sonography of the abdomen	**79.5 %**	20,864	**80.6 %**	230,085
X-ray of the thorax	**19.0 %**	4,975	**31.0 %**	88,506
cCT (isolated or whole-body)	**88.4 %**	23,203	**89.3 %**	254,818
Whole-body CT	**73.7 %**	19,333	**76.1 %**	217,243
Selective CT: Cervical spine	**10.4 %**	2,739	**1.7 %**	4,857
Selective CT: Chest/thoraric spine	**5.0 %**	1,323	**.8 %**	2,360
Selective CT: Abdomen/lumbar spine/pelvis	**74.4 %**	19,531	**12.6 %**	36,034
Time period in the emergency room	**M** ± SD*/%	n	**M** ± SD*/%	n
Transfer to the operating theatre	**23.4 %**	5,873	**23.9 %**	42,009
If so: Duration from admission to the ER* until surgery [min]	**82.2** ± 62.8	5,368	**77.7** ± 61.9	37,819
Transfer to intensive care unit	**61.4 %**	15,377	**63.5 %**	111,675
If so: Duration from admission to the ER* until ICU* [min]	**103.7** ± 85.4	13,720	**89.5** ± 76.8	96,758
Bleeding and transfusion	**M** ± SD*/%	n	**M** ± SD*/%	n
Pre-existing coagulopathy	**22.0 %**	5,036	**20.1 %**	30,273
Systolic blood pressure ≤ 90 mmHg	**6.5 %**	1,606	**7.7 %**	20,351
Hemostasis therapy**	**22.4 %**	3,343	**18.7 %**	24,113
Administration of tranexamic acid**	**14.3 %**	3,161	**15.1 %**	15,525
ROTEM / thrombelastography**	**10.3 %**	1,384	**10.6 %**	11,539
Patients with blood transfusion	**7.8 %**	2,039	**7.6 %**	21,742
Number of pRBC, if transfused	**5.0** ± 5.8	2,039	**5.2** ± 6.3	21,742
Number of FFP, if transfused	**0.0** ± 0.0	2,039	**2.7** ± 5.4	21,742
Treatment in the ER*	%	n	%	n
Cardio-pulmonary resuscitation **	**2.0 %**	484	**1.8 %**	3,884
Chest drain**	**9.0 %**	2,161	**7.5 %**	15,833
Endotracheal intubation**	**8.8 %**	2,080	**13.3 %**	20,677
Initial laboratory values	**M** * ± SD	n	**M** * ± SD	n
Base excess [mmol/l]	**-1.5** ± 4.8	21,709	**-1.7** ± 4.7	219,397
Haemoglobin [g/dl]	**13.1** ± 2.2	25,591	**13.2** ± 2.2	273,706
INR	**1.1** ± 00.4	24,603	**1.2** ± 00.5	263,543
Quick's value [%]	**89.2** ± 21.3	23,966	**87.8** ± 21.5	257,021
Temperature [C°]**	**36.2** ± 1.0	16,939	**36.2** ± 1.1	94,076

* 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 2021		TR-DGU 10 years	
Patients with **intensive care therapy** (n) (%-ratio of the basic group)	23,903 (84 %)		271,063 (86 %)	
Treatment	%	n	%	n
Hemostasis therapy **	**12.3 %**	1,824	**14.5 %**	19,876
Dialysis / hemofiltration **	**2.2 %**	328	**2.2 %**	3,004
Blood transfusion ** (within the first 48 h after admission to ICU)	**25.7 %**	2,879	**25.8 %**	28,966
Mechanical ventilation / intubated	**34.5 %**	8,241	**37.9 %**	102,672
Complications on ICU	%	n	%	n
Organ failure **	**28.9 %**	4,368	**32.9 %**	45,777
Multiple organ failure (MOF) **	**15.4 %**	2,337	**19.1 %**	26,322
Sepsis **	**4.1 %**	620	**5.5 %**	7,510
Length of stay and ventilation	**M** ± SD*	n	**M** ± SD*	n
Length of intubation [days]	**6.8** ± 9.1 Median **3**	8,110	**7.4** ± 10.2 Median **3**	101,520
Length of stay on ICU* [days]	**5.8** ± 9.0 Median **2**	23,903	**6.4** ± 10.0 Median **2**	271,063

* 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 2021		TR-DGU 10 years	
Patients from the basic group	28,580		313,461	
Diagnoses	**M** ± SD*/%	n	**M** ± SD*/%	n
Number of injuries / diagnoses per patient	**4.5** ± 3.0		**4.5** ± 2.9	
Patients with only **one** injury	**10.8 %**	3,074	**10.3 %**	32,159
Surgeries	**M** ± SD*/ %	n	**M** ± SD*/ %	n
Patients requiring surgery	**67.6 %**	12,809	**66.7 %**	110,324
Number of surgeries per patient, if undergone surgery**	**3.1** ± 15.6		**3.4** ± 7.2	
Thrombo-embolic events (MI; pulmonary embolism; DVT; stroke; etc.)	%	n	%	n
Patients with at least one event **	**3.3 %**	546	**2.8 %**	4,186
Outcome (without early transfers out)	%	n	%	n
Survivors	**87.5 %**	23,506	**88.4 %**	259,136
Hospital mortality	**12.5 %**	3,361	**11.6 %**	33,899
Died within 30 days	**12.0 %**	3,237	**11.1 %**	32,505
Died within 24 hours	**4.5 %**	1,211	**4.4 %**	12,959
Died in the ER (without ICU)	**1.6 %**	438	**1.5 %**	4,523
Died with end-of-life-decision (since 2015)	**70.5 %**	2,217	**52.1 %**	9,479
... palliative reason (since 2020)	**47.6 %**	1,065	**45.6 %**	1,869
... presumed will of the patient (since 2020)	**34.8 %**	780	**36.6 %**	1,501
... written willingness of the patient (since 2020)	**17.6 %**	394	**17.8 %**	729

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

Table 9 continuation:

Time point D: Discharge / outcome	**TR-DGU 2021**		**TR-DGU 10 years**	
Patients from the basic group	28,580		313,461	
Transfer / discharge (all survivors)	**%**	n	**%**	n
Survivors who were discharged and …	**100.0 %**	25,219	**100.0 %**	279,562
transferred into another hospital	**16.8 %**	4,242	**17.4 %**	48,595
... among them early discharges (< 48 h)	**6.8 %**	1,713	**7.3 %**	20,426
transferred into a rehabilitation center	**14.1 %**	3,559	**17.0 %**	47,401
other destination	**3.8 %**	954	**3.6 %**	10,200
sent home	**65.3 %**	16,464	**62.0 %**	173,366
Condition at the time of discharge (according to the parameter „outcome"; without early transfers out)	**%**	n	**%**	n
Patients with a valid value		26,585		285,068
of these surviving patients		23,224		251,169
- good recovery	**59.5 %**	13,814	**64.8 %**	162,639
- moderate disability	**29.3 %**	6,806	**25.2 %**	63,328
- severe disability	**9.9 %**	2,304	**8.6 %**	21,721
- persistant vegetative state	**1.3 %**	300	**1.4 %**	3,481
Length of stay in hospital [days] (all patients from the basic group)	**M** ± SD*	n	**M** ± SD*	n
All patients	**13.6** ± 15.9	28,576	**14.8** ± 17.1	313,424
Median	**9**		10	
Only survivors	**14.4** ± 16.2	25,217	**15.7** ± 17.4	279,532
Median survivors	10		**11**	
Only non-survivors	**7.4** ± 12.4	3,359	**7.4** ± 12.7	33,892
Median non-survivors	3		3	
LOS when transferred to a rehabilitation centre	**26.5** ± 22.1	3,559	**28.5** ± 22.0	47,397
when transferred to another hospital	**10.5** ± 15.5	4,242	**10.2** ± 14.7	48,594
when sent home	**12.4** ± 12.9	16,463	**13.5** ± 14.3	173,344
Costs of treatment *** (without early transfers out)	**€**	n	**€**	n
Average costs in € per patient				
... all patients	**22,484**	8,531	**22,341**	116,390
... only non-survivors	**12,678**	2,210	**12,645**	25,401
... only survivors	**25,913**	6,321	**25,048**	90,989
... only patients with ISS ≥ 16	**24,400**	6,700	**25,176**	86,830
Sum of all costs	191,815,116 €		2,600,310,821 €	
Sum of all days in hospital	176,890 days		2,421,908 days	
Average costs per day per patient	1084.4 €		1073.7 €	

* 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, 2019). 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 (2019-2021) 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 are a total of **75,358 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 2019-2021	**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	75,358	38,434	27,216	9,708	4,947	23,098	21,553
	%	100 %	51.0 %	36.1 %	12.9 %	6.6 %	30.7 %	28.6 %
Patients								
Age [years]	M	53.9	50.8	55.2	62.4	53.6	62.8	80.6
Males	%	69.3 %	70.9 %	68.8 %	64.2 %	69.1 %	66.2 %	55.8 %
ASA 3-4	%	20.4 %	15.8 %	22.0 %	35.1 %	24.9 %	34.0 %	49.7 %
Injuries								
ISS [points]	M	18.0	14.4	22.8	18.2	29.8	28.2	18.6
Head injury (AIS ≥ 3)	%	34.0 %		58.4 %	100.0 %	47.0 %	64.3 %	45.6 %
Thoracic injury (AIS ≥ 3)	%	38.8 %	45.5 %	43.2 %		56.5 %	51.2 %	35.3 %
Abdominal injury (AIS ≥ 3)	%	9.4 %	13.2 %	7.3 %		22.3 %	13.4 %	4.8 %
Prehospital care								
Duration from accident to hospital [min]	M	67	66	68	70	73	72	69
Intubation	%	19.3 %	9.6 %	29.4 %	29.9 %	58.1 %	44.4 %	18.4 %
Volume [ml]	M	602.8	603.0	643.6	484.6	940.6	733.8	513.0
Emergency room								
Blood transfusion	%	7.5 %	7.3 %	9.4 %	3.2 %	37.5 %	17.8 %	6.3 %
Whole-body CT	%	76.3 %	77.6 %	82.0 %	55.3 %	78.4 %	78.2 %	68.1 %
Cardio-pulmonary resuscitation	%	2.3 %	2.0 %	3.0 %	1.7 %	14.9 %	6.3 %	2.4 %
Physiological problems *								
Age ≥ 70 years	%	28.6 %	21.7 %	31.3 %	48.1 %	29.6 %	52.8 %	100.0 %
Shock (sBP ≤ 90 mmHg)	%	11.2 %	9.9 %	13.7 %	9.2 %	100.0 %	28.5 %	11.1 %
Acidosis (BE < -6)	%	12.2 %	10.0 %	15.2 %	11.8 %	44.3 %	29.0 %	12.0 %
Coagulopathy	%	11.3 %	8.6 %	13.9 %	14.5 %	35.1 %	26.5 %	19.5 %
Unconsciousness (GCS ≤ 8)	%	15.9 %	4.3 %	25.4 %	35.3 %	44.9 %	43.2 %	18.6 %

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

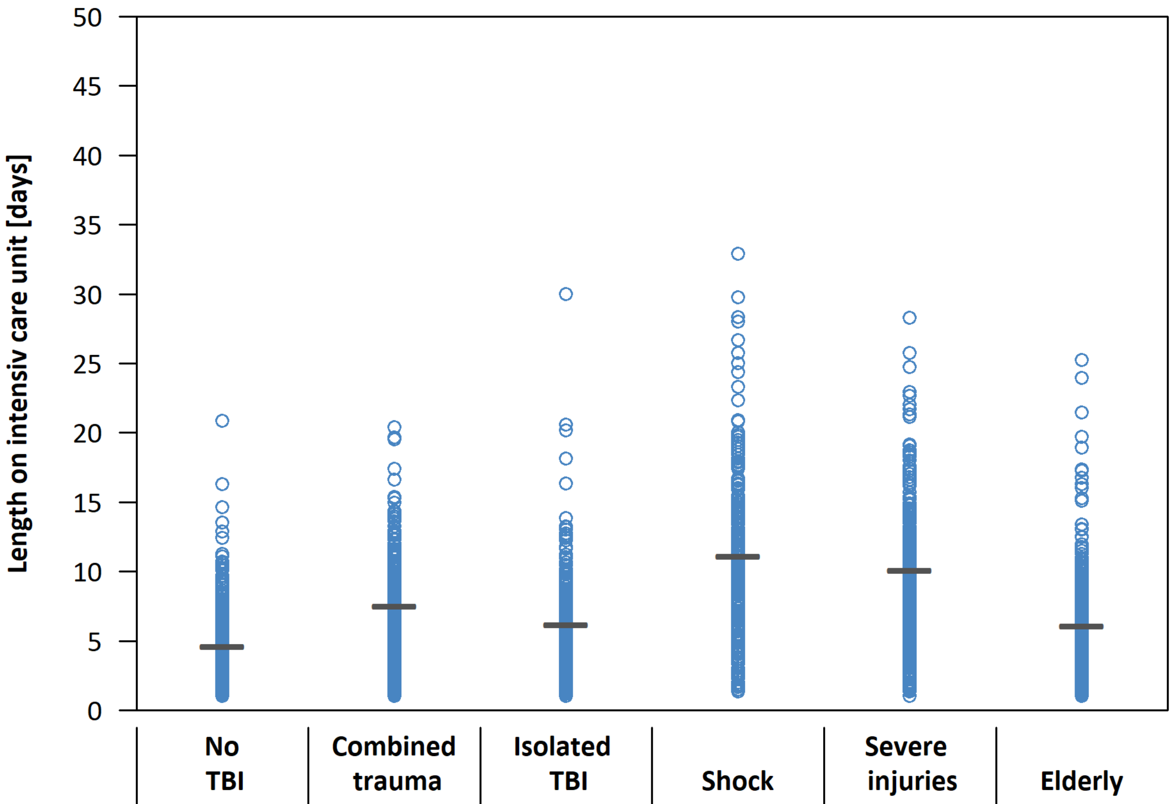
Table 10 continuation:

		Primary patients 2019-2021	Subgroups					
			No TBI	Combined trauma	Isolated TBI	Shock	Severe injuries	Elderly
Length of stay								
Patients with intensive care therapy	n	66,071	32,232	25,170	8,669	4,184	20,643	18,622
- Intubation on intensive care unit [days]	M	7.1	5.8	8.2	6.3	8.1	8.2	6.7
- Intensive care unit [days]	M	6.0	4.7	7.6	6.3	11.2	10.2	6.1
Days in hospital, all patients	M	14.6	14.5	15.6	12.0	18.9	18.1	14.1
Mortality and prognosis (without patients deceased within the first week with a patient's volition)								
Non-survivors	n	6,112	1,552	2,977	1,583	1,420	4,978	3,179
Mortality	%	8.5 %	4.1 %	11.6 %	19.0 %	32.2 %	24.6 %	16.6 %
Risk of death prognosis (RISC II)	%	8.7 %	4.1 %	12.4 %	18.3 %	35.1 %	25.4 %	16.9 %

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.

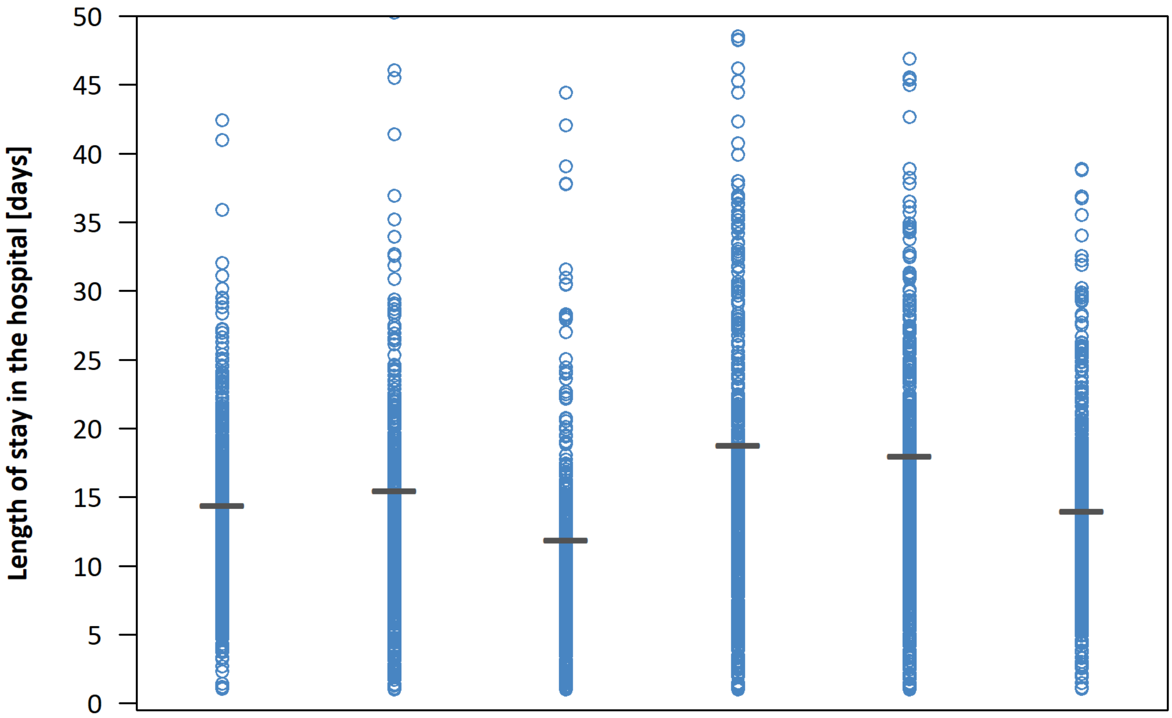
Figure 26 shows the **length of stay in the intensive care unit** in days for 2019-2021 between the subgroups defined in table 10 for all primary admitted and treated patients of the TR-DGU in the basic group.



	No TBI	Combined trauma	Isolated TBI	Shock	Severe injuries	Elderly
TR-DGU:	4.6	7.5	6.2	11.1	10.1	6.1
n:	32,738	25,468	8,575	3,982	20,815	18,867

Figure 26: Length of stay in the intensive care unit [days] and number of patients divided into subgroups, for definition see tab. 10, patients 2019-2021, — TR-DGU, o single hospital value

Figure 27 compares the **length of stay in hospital** in days for 2019-2021 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:	14.4	15.5	11.9	18.8	18.0	14.0
n:	39,187	27,703	9,894	5,028	23,507	21,994

Figure 27: Length of stay in hospital [days] and number of patients divided into subgroups, for definition see tab. 10, patients 2019-2021, — 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 2021** are compared with the data from the previous years (**since 2012**). 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
	Good	> 95 %	≥ 70 %
	Moderate	90 %-95 %	50 %-69 %
	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 2021		TR-DGU 2012-2020	
Pre-hospital data (A)		%	{}	%	{}
Only primary admitted patients, who have not admitted themselves / were not admitted privately		n = 25,693		n = 253,946	
GCS	RISC II requires the motor component; quality indicators use the GCS for the definition of cases	**92 %**	2,061	**94 %**	16,509
Blood pressure	Initial blood pressure is important for validating the volume therapy and for the definition of shock	**86 %**	3,477	**88 %**	30,261
Pupils *	Pupil size and reactivity are relevant for prognosis (RISC II)	**93 %**	1,830	**72 %**	71,760
CPR	Cardio-pulmonary resuscitation is seldom but highly predictive for outcome; required for RISC II	**86 %**	3,543	**91 %**	21,802
Emergency room (B)					
Only primary admitted patients		n = 26,234		n = 259,151	
Time of admission	Required to calculate the diagnostic time periods (quality indicators)	**%**		**99 %**	1,963
Blood pressure	Blood pressure on admission is used by RISC II as a prognostic variable and to define shock	**94 %**	1,665	**93 %**	17,979
Base excess	The initial base excess is part of the RISC II and an important prognostic factor	**83 %**	4,546	**76 %**	61,636
Coagulation	The INR (or Quick's value) is needed for the RISC II as coagulation marker	**94 %**	1,631	**92 %**	20,211
Haemoglobin	Prognostic factor; is part of the RISC II prognosis	**98 %**	643	**96 %**	11,036
Patients and outcome					
All patients from the basic group		n = 28,580		n = 284,881	
ASA	Prior diseases are relevant for outcome prediction (RISC II)	**95 %**	1,531	**89 %**	30,520
Surgical treatment *	A low rate of surgical patients could be based on incomplete documentation	**62 %**	10,957	**49 %**	145,723
Outcome	The levels according to the parameter „outcome" describe the patient's condition at discharge or transfer	**98 %**	446	**96 %**	12,056
Process data - Period of time until documentation					
All patients from the basic group		n = 28,580		n = 284,881	
Time from 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	**3.7 months**		**4.3 months**	
Time from discharge to case completion in the TR-DGU**	Time from discharge of a patient to **completion** of documentation in the registry	**4.7 months**		**5.4 months**	

* Since the dataset revision in 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 the case documentation

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), haemoglobin
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 for the TR-DGU in 2021 and comparison over the time

Data quality: Completeness	TR-DGU 2021	TR-DGU 2012-2020
Primary admitted patients from the basic group	n = 26,234	n = 259,151
Expected number of documented values	n = 262,340	n = 2,591,510
Number of missing values	{} 20,610	{} 230,353
Average completeness rate (%) based on the 10 specified parameters	**92.1 %**	**91.1 %**

9.2.1 Graphical comparison with other hospitals

Figure 28 summarises the average completeness value from all 694 hospitals with documented basic group cases **in 2021**. It follows the idea of a box plot in which the light blue box ranging from 87.5 % to 96.4 % covers half of all hospital values. The black vertical line within the box is the median average completeness value 92.5 %.

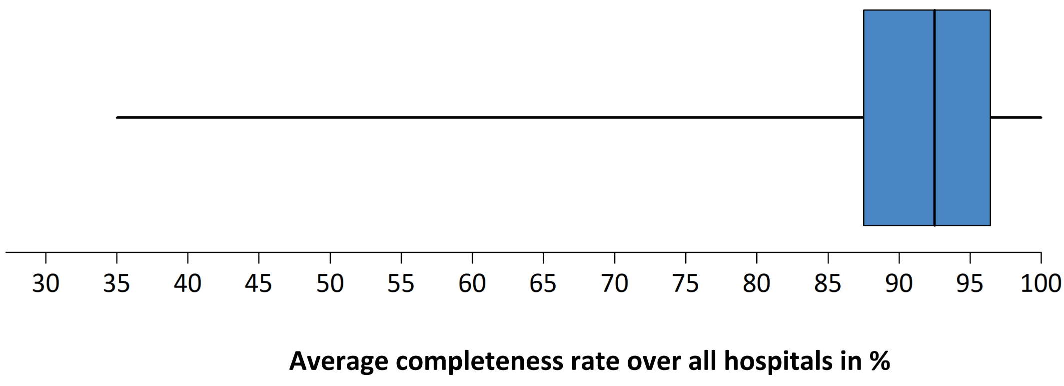


Figure 28: Distribution of the data completeness rate in 2021 over all hospitals

9.2.2 Development over time

Figure 29 shows the development of data completeness over the last ten years since 2012. 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 been approaching that of the QM dataset for years. In 2021 the completeness of the standard dataset is actually higher than that of the QM dataset.

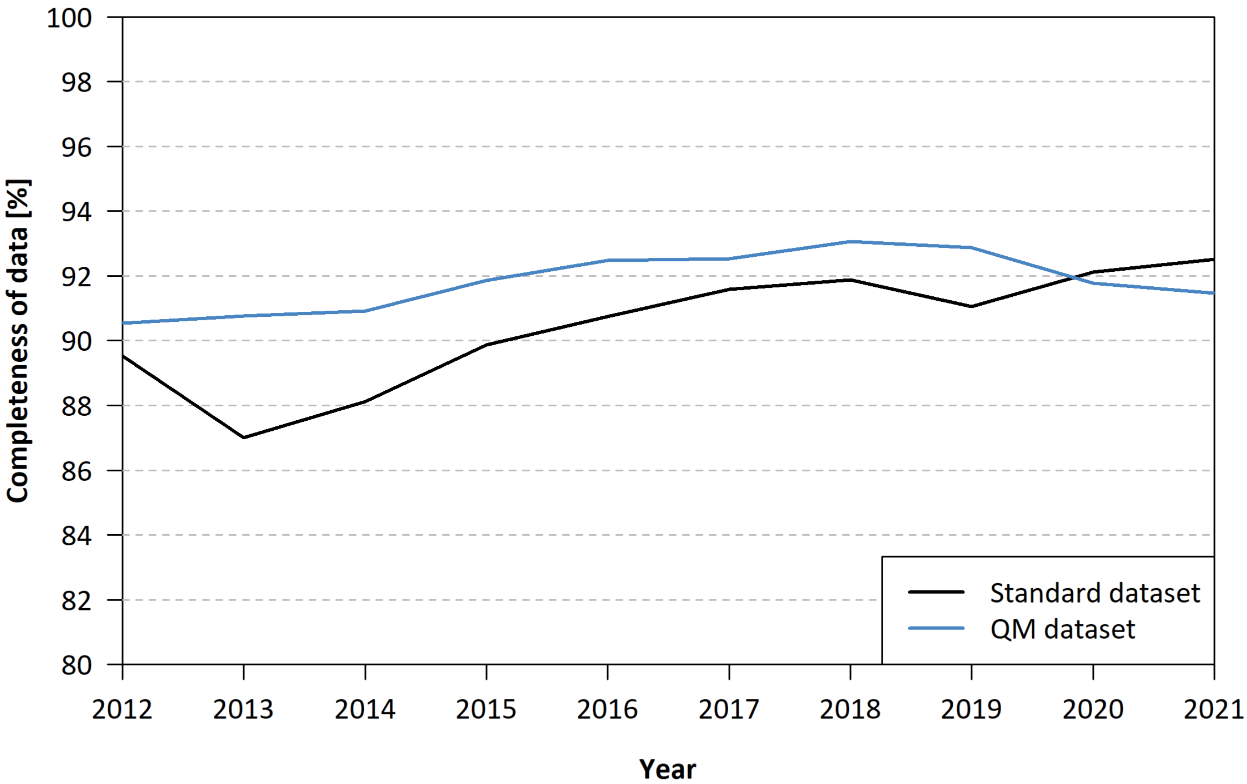


Figure 29: Development over time of the documentation quality: completeness rate in the TR-DGU 2012-2021

10 Injury pattern

In table 14, the average injury pattern of the TraumaRegister DGU® patients is presented. Only cases from the **basic group** are considered. In order to increase precision, all patients from the **last three years (2019-2021)** are pooled. Data are presented for each of the nine body regions according to the **Abbreviated Injury Scale (AIS)**. The percents 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 2021.

Table 14: Distribution of the injuries from all recorded patients (basic group) for the years 2019-2021

	TR-DGU 2019-2021
Patients in the basic group	**100 %** (N = 88,372)
Head	**45.5 %** (n = 40,242)
Face	**10.6 %** (n = 9,320)
Neck	**1.7 %** (n = 1,509)
Thorax	**45.2 %** (n = 39,940)
Abdomen	**13.9 %** (n = 12,315)
Spine	**29.6 %** (n = 26,199)
Arms	**29.1 %** (n = 25,723)
Pelvis	**15.4 %** (n = 13,621)
Legs	**23.1 %** (n = 20,397)

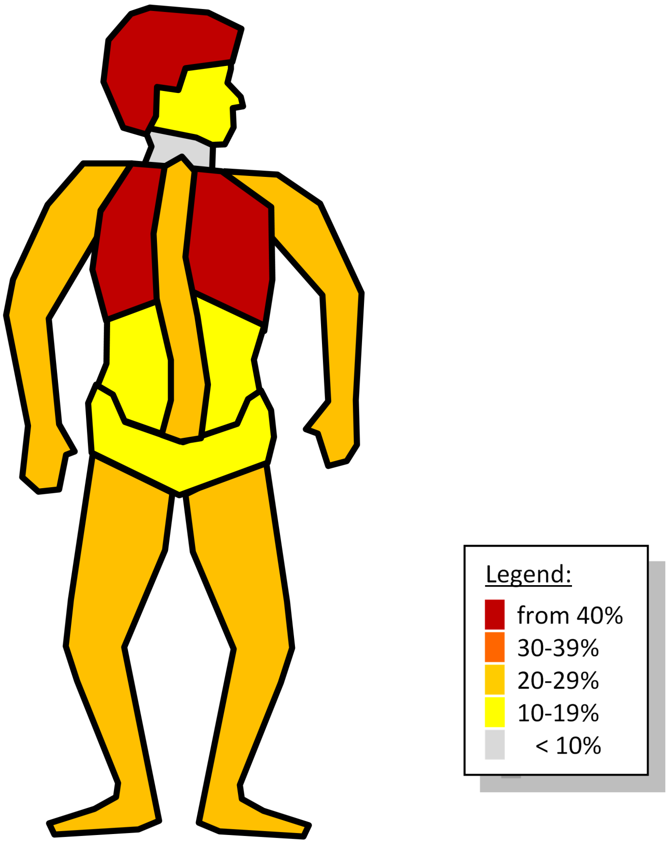


Figure 30: Injury pattern in the TR-DGU for the basic group from 2021

Serious injuries (AIS 3+)

Injuries with a severity of 3 points or more (AIS) are considered „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). Spinal injuries are assigned to the respective regions head, thorax or abdomen.

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

Table 15: Ratio of serious injured patients (AIS ≥ 3) per body region for the years 2019-2021 (basic group)

	TR-DGU 2019-2021
Serious injury (AIS ≥ 3)	**82.3 %** (N = 72,686)
... of the **head**	**44.0 %** (n = 31,960)
... of the **thorax**	**46.1 %** (n = 33,490)
... of the **abdomen**	**11.7 %** (n = 8,533)
... of the **extremities**	**28.2 %** (n = 20,486)
Patients with **more than one** seriously injured body region	**28.9 %** (n = 20,989)

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 2021, 35,747 patients were registered from 700 hospitals that documented cases in the TraumaRegister DGU®. The **basic group** that this report is based on comprises **28,580 patients** from 694 hospitals (details on the definition see chapter 1). There are already **185,279 patients** that have been documented with the in 2015 updated dataset.

There were 15,424 patients with ISS ≥ 16 from 644 hospitals in the basic group. The distribution of the number of ISS ≥ 16 patients per hospital is shown in figure 31.

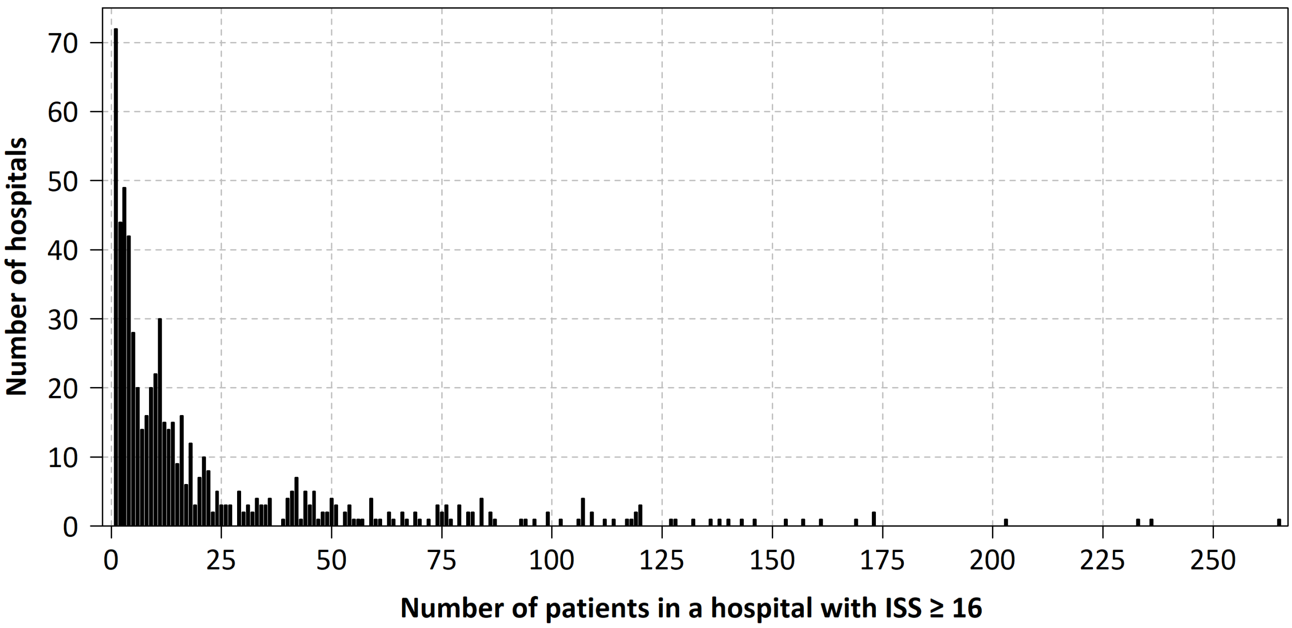


Figure 31: Frequency distribution of ISS ≥ 16 patients numbers per hospital in the TR-DGU 2021

Patients

Figure 32 demonstrates the continuous increase of registered patients over time since 2002. In 2021, 7,167 documented patients did not fulfill the criteria to be included in the basic group and were not seriously injured per TR-DGU definition. There were 60.2 % German patients in the basic group that were documented by the standard dataset (S) in 2021.

In 2021, there were **694 hospitals** that documented patients in the basic group, 72 hospitals were from foreign countries (10.4 %), namely Belgium, Finland, Luxembourg, The Netherlands, Austria, Switzerland, Slovenia and the United Arab Emirates and 622 hospitals from Germany.

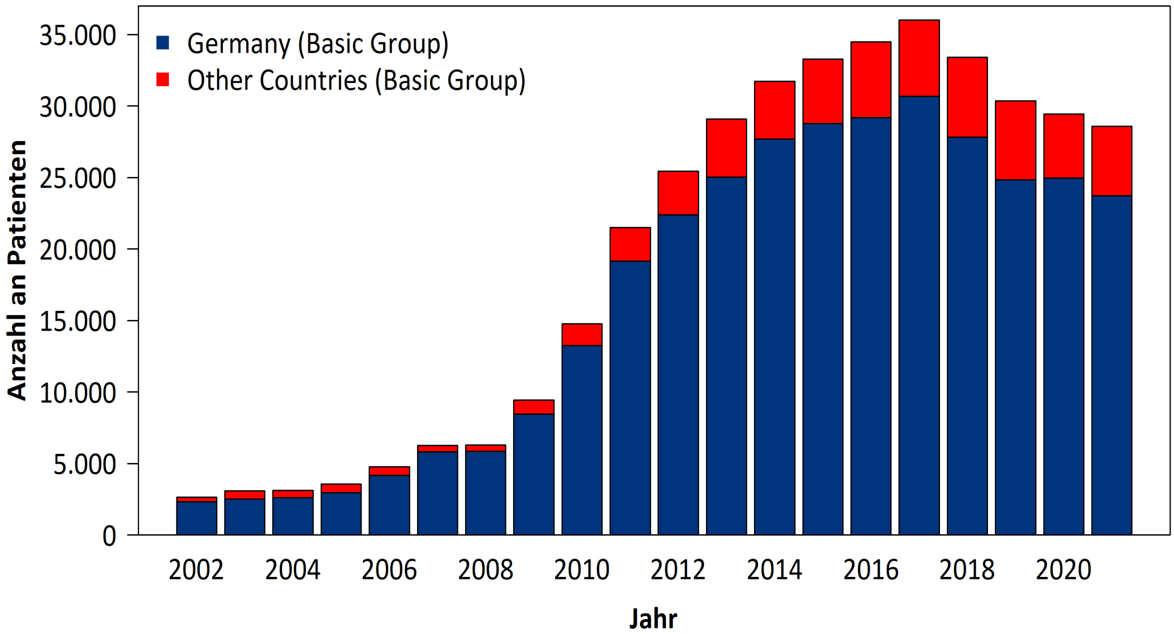


Figure 32: Number of cases in the TR-DGU 2002-2021

11.2 COVID-19

In July 2021, in parallel to the introduction of the new data set version (V2020), questions pertaining to COVID-19 were added to the emergency room questionairre.
Here we present the number of COVID-19 tests conducted, the distribution of test results and mortality rates of tested patients in 2021.

Tabelle 16: Number of Patients tested for COVID-19, their test results and the distrubtion of deaths

	2021
Number of patients from the basic group tested for COVID-19	**11,986 / 28,947 (41 %)**
COVID +	**115 (1 %)**
.... of these, number of deaths	27 (23 %)
COVID -	**11,797 (98 %)**
.... of these, number of deaths	1,261 (11 %)
COVID test result unknown	**94 (1 %)**
.... of these, number of deaths	13 (18 %)

11.3 Patients with a documented patient's volition

With the revision of the data set in 2017, the new parameter "Patient's volition" was added in order to more accurately assess treatment quality. This parameter allows for the identification of patients who were against life-sustaining treatments. In this report all analyses comparing the actual mortality rates with the risk of death prognoses, excluded patients who denied care of their own volition and subsequently died within the first week of treatment. 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 17 shows the deceased of the basic group, separated according to patient's volition available or not available.

Table 17: Number of deceased patients with a documented patient's volition for the years 2017-2021

Year	2017	2018	2019	2020	2021
Number of deceased	3,610	3,711	3,628	3,361	3,452
Number of deceased **without** a patient's volition	1,751	1,675	1,048	1,056	929
Number of deceased **with** a patient's volition	1,239	1,322	1,143	1,988	2,217
...among them deceased within the first 7 days	759	812	733	1,318	1,473
Proportion of deceased **with a patient's volition**	41 %	44 %	52 %	65 %	70 %

The analysis of the age of the deceased shows (Table 18) that their mean age in the past 5 years was over 65. Furthermore, that deceased patients with a patient's volition were on average approximately 15 years older compared to the deceased without a patient's volition.

Table 18: Mean age of the deceased separated by availability of a patient's volition in the years 2017-2021

Year	2017	2018	2019	2020	2021
Mean age of the deceased [years]	66.7	67.7	67.2	68.1	69.4
Mean age of the deceased **with** a patient's volition [years]	77.5	76.9	76.4	74.2	74.0
Mean age of the deceased **without** a patient's volition [years]	60.6	61.2	59.7	58.1	59.4

12 Publications from the TraumaRegister DGU®

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

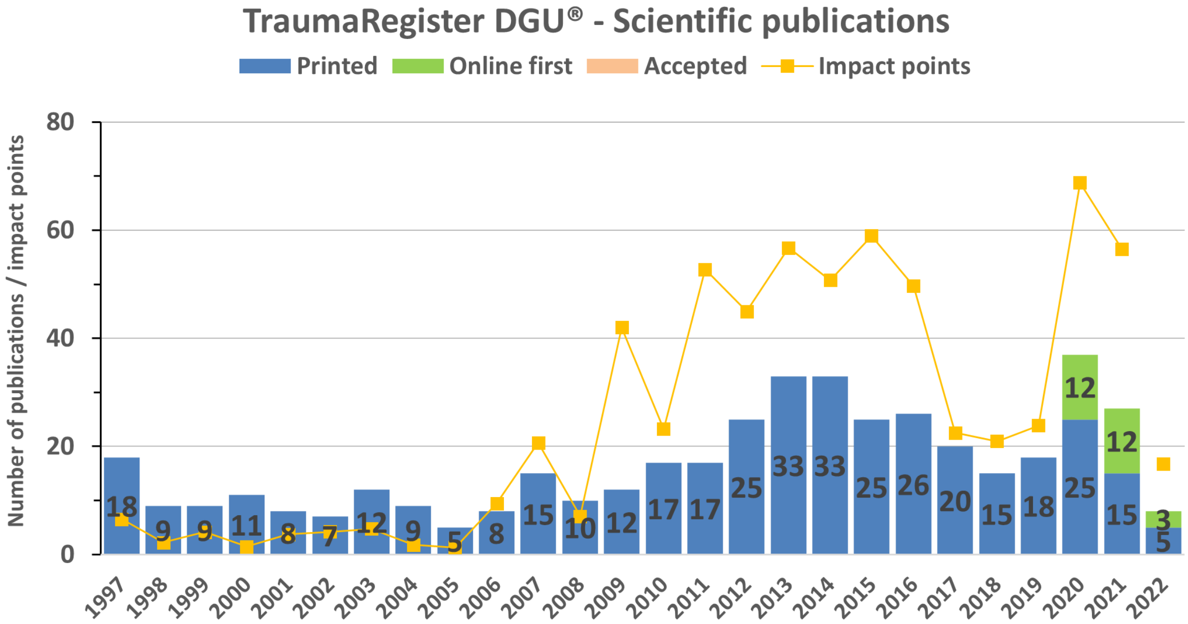


Figure 33: Number of publications from the TraumaRegister DGU® and their impact points since 1997

12.1 Facts from the Reviewboard in 2021

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 Ms. Nienaber. The administrative management is performed by Ms. Isserstedt. Table 19 gives an overview over the work of the TraumaRegister DGU® Reviewboard in the year 2021.

Table 19: Facts from the Reviewboard 2021

	2021
Number of new research proposals	40
Number of research proposals discussed in the Reviewboard (incl. Revisions)	52
Number of research proposals reviewed (incl. resubmissions)	34
Number of manuscripts reviewed	13
Number of manuscripts approved for publication	12
Number of participating reviewers	57

13.2 Publications from the TR-DGU 2021 - 05/2022

2022

Becker L, Schulz-Drost S, Spering C, Franke A, Dudda M, Lefering R, Matthes G, Bieler D; Committee on Emergency Medicine, Intensive Care, Trauma Management (Sektion NIS) of the German Trauma Society (DGU). Effect of surgical stabilization of rib fractures in polytrauma: an analysis of the TraumaRegister DGU®. Eur J Trauma Emerg Surg. 2022 [Epub ahead of print].

Halvachizadeh S, Störmann PJ, Özkurtul O, Berk T, Teuben M, Sprengel K, Pape HC, Lefering R, Jen-sen KO; TraumaRegister DGU. Discrimination and calibration of a prediction model for mortality is decreased in secondary transferred patients: a validation in the TraumaRegister DGU. BMJ Open. 2022; 12: e056381.

Jaekel C, Oezel L, Bieler D, Grassmann JP, Rang C, Lefering R, Windolf J, Thelen S; Sektion Notfall-, Intensivmedizin und Schwerverletztenversorgung (Sektion NIS) der DGU. Implikationen der prähospitalen Einschätzung des Traumapatienten auf den Behandlungsverlauf – Eine Auswertung aus dem TraumaRegister DGU®. Anaesthesist. 2022; 71: 94-103.

Spering C, Müller G, Füzesi L, Bouillon B, Rüther H, Lehmann W, Lefering R; and Section of Injury Prevention DGOU; and TraumaRegister DGU. Prevention of severe injuries of child passengers in motor vehicle accidents: is re-boarding sufficient? Eur J Trauma Emerg Surg. 2022 [Epub ahead of print].

Tanner L, Neef V, Raimann FJ, Störmann P, Marzi I, Lefering R, Zacharowski K, Piekarski F; Commit-tee on Emergency Medicine, Intensive Care and Trauma Management (Sektion NIS) of the German Trauma Society (DGU). Influence of anaemia in severely injured patients on mortality, transfusion and length of stay: an analysis of the TraumaRegister DGU®. Eur J Trauma Emerg Surg. 2022 [Epub ahead of print].

Vollrath JT, Schindler CR, Marzi I, Lefering R, Störmann P; TraumaRegister DGU. Lung failure after polytrauma with concomitant thoracic trauma in the elderly: an analysis from the TraumaRegister DGU®. World J Emerg Surg. 2022; 17: 12.

Weber CD, Lefering R, Sellei RM, Horst K, Migliorini F, Hildebrand F, TraumaRegister Dgu. Traumatic Hip Dislocations in Major Trauma Patients: Epidemiology, Injury Mechanisms, and Concomitant Injuries. J Clin Med. 2022;11: 472.

Willms A, Güsgen C, Schwab R, Lefering R, Schaaf S, Lock J, Kollig E, Jänig C, Bieler D; Committee on Emergency Medicine, Intensive Care, Trauma Management (Sektion N. I. S.) of the German Trauma Society (DGU). Status quo of the use of DCS concepts and outcome with focus on blunt abdominal trauma : A registry-based analysis from the TraumaRegister DGU®. Langenbecks Arch Surg. 2022; 407: 805-817.

2021

Bakir MS, Langenbach A, Pinther M, Lefering R, Krinner S, Grosso M, Ekkernkamp A, Schulz-Drost S; TraumaRegister DGU The significance of a concomitant clavicle fracture in flail chest patients: incidence, concomitant injuries, and outcome of 12,348 polytraumata from the TraumaRegister DGU®. Eur J Trauma Emerg Surg. 2021 [Epub ahead of print].

Barbati ME, Hildebrand F, Andruszkow H, Lefering R, Jacobs MJ, Jalaie H, Gombert A. Prevalence and outcome of abdominal vascular injury in severe trauma patients based on a TraumaRegister DGU international registry analysis. Sci Rep. 2021; 11: 20247.

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Bieler D, Kollig E, Hackenberg L, Rathjen JH, Lefering R, Franke A; Committee on Emergency Medi-cine, Intensive Care and Trauma Management (Sektion NIS) of the German Trauma Society (DGU). Penetrating injuries in Germany - epidemiology, management and outcome an analysis based on the TraumaRegister DGU®. Scand J Trauma Resusc Emerg Med. 2021; 29: 80.

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13.3 Abstracts 08/2021 - 05/2022

Eur J Trauma Emerg Surg. 2022 Feb 3. Online ahead of print.

Effect of surgical stabilization of rib fractures in polytrauma: an analysis of the TraumaRegister DGU ®.

Becker L, Schulz-Drost S, Spering C, Franke A, Dudda M, Lefering R, Matthes G, Bieler D, Committee on Emergency Medicine, Intensive Care, Trauma Management (Sektion NIS) of the German Trauma Society (DGU)

PURPOSE: In severely injured patients with multiple rib fractures the beneficial effect of surgical stabilization is still unknown. The existing literature shows divergent results and especially the indication and the right timing of an operation are subject of a broad discussion. The aim of this study was to determine the influence of a surgical stabilization of rib fractures (SSRF) on the outcome in a multi-center database with special regard to the duration of ventilation, intensive care and overall hospital stay.

METHODS: Data from the TraumaRegister DGU® collected between 2008 and 2017 were used to evaluate patients over 16 years with severe rib fractures (AIS ≥ 3). In addition to the basic comparison a matched pair analysis of 395 pairs was carried out in order to find differences and to increase comparability.

RESULTS: In total 483 patients received an operative treatment and 29,447 were treated conservatively. SSRF was associated with a significantly lower mortality rate (7.6% vs. 3.3%, $p = 0.008$) but a longer ventilation time and longer stay as well as in the intensive care unit (ICU) as the overall hospital stay. Both matched pair groups showed a good or very good neurological outcome according to the Glasgow Outcome Scale (GOS) in 4 of 5 cases. Contrary to the existing recommendations most of the patients were not operated within 48 h.

CONCLUSIONS: In our data set, obviously most of the patients were not treated according to the recent literature and showed a delay in the time for operative care of well over 48 h. This may lead to an increased rate of complications and a longer stay at the ICU and the hospital in general. Despite of these findings patients with operative treatment show a significant lower mortality rate.

BMJ Open. 2022 Apr 13;12(4).

Discrimination and calibration of a prediction model for mortality is decreased in secondary transferred patients: a validation in the TraumaRegister DGU.

Halvachizadeh S, Störmann PJ, Özkurtul O, Berk T, Teuben M, Sprengel K, Pape HC, Lefering R, Jensen KO; TraumaRegister DGU.

INTRODUCTION: The Revised Injury Severity Classification II (RISC II) score represents a data-derived score that aims to predict mortality in severely injured patients. The aim of this study was to assess the discrimination and calibration of RISC II in secondary transferred polytrauma patients.

METHODS: This study was performed on the multicentre database of the TraumaRegister DGU. Inclusion criteria included Injury Severity Score (ISS)≥9 points and complete demographic data. Exclusion criteria included patients with 'do not resuscitate' orders or late transfers (>24 hours after initial trauma). Patients were stratified based on way of admission into patients transferred to a European trauma centre after initial treatment in another hospital (group Tr) and primary admitted patients who were not transferred out (group P). The RISC II score was calculated within each group at admission after secondary transfer (group Tr) and at primary admission (group P) and compared with the observed mortality rate. The calibration and discrimination of prediction were analysed.

RESULTS: Group P included 116 112 (91%) patients and group Tr included 11 604 (9%) patients. The study population was predominantly male (n=86 280, 70.1%), had a mean age of 53.2 years and a mean ISS of 20.7 points. Patients in group Tr were marginally older (54 years vs 52 years) and a had slightly higher ISS (21.5 points vs 20.1 points). Median time from accident site to hospital admission was 60 min in group P and 241 min (4 hours) in group Tr. Observed and predicted mortality based on RISC II were nearly identical in group P (10.9% and 11.0%, respectively) but predicted mortality was worse (13.4%) than observed mortality (11.1%) in group Tr.

CONCLUSION: The way of admission alters the calibration of prediction models for mortality in polytrauma patients. Mortality prediction in secondary transferred polytrauma patients should be calculated separately from primary admitted polytrauma patients.

Anaesthesist. 2022 Feb;71(2):94-103

Implications of prehospital estimation of trauma patients for the treatment pathway-An evaluation of the TraumaRegister DGU®.

Jaekel C, Oezel L, Bieler D, Grassmann JP, Rang C, Lefering R, Windolf J, Thelen S.

BACKGROUND: In the prehospital acute treatment phase of severely injured patients, the stabilization of the vital parameters is paramount. The rapid and precise assessment of the injuries by the emergency physician is crucial for the initial treatment and the selection of the receiving hospital.

OBJECTIVE: The aim of this study was to determine whether the prehospital emergency medical assessment has an influence on prehospital and emergency room treatment.

MATERIAL AND METHODS: Data from the TraumaRegister DGU® between 2015 and 2019 in Germany were evaluated. The prehospital emergency medical assessment of the injury pattern and severity was recorded using the emergency physician protocol and compared with the in-hospital documented diagnoses using the abbreviated injury scale.

RESULTS: A total of 47,838 patients with an average injury severity score (ISS) of 18,7 points (SD 12.3) were included. In summary, 127,739 injured body regions were documented in the hospitals. Of these, a total of 87,921 were correctly suspected by the emergency physician Thus, 39,818 injured body regions were not properly documented. In 42,530 cases a region of the body was suspected to be injured without the suspicion being confirmed in the hospital. Traumatic brain injuries and facial injuries were mostly overdiagnosed (13.5% and 14.7%, respectively documented by an emergency physician while the diagnosis was not confirmed in-hospital). Chest injuries were underdocumented (17.3% missed by an emergency physician while the diagnosis was finally confirmed in-hospital). The total mortality of all groups was very close to the expected mortality calculated with the revised injury severity classification II(RISC II)-score (12.0% vs. 11.3%).

CONCLUSION: In the prehospital care of severely injured patients, the overall injury severity is often correctly recorded by the emergency physician and correlates well with the derived treatment, the selection of the receiving hospital as well as the clinical course and the patient outcome; however, the assessment of injuries of individual body regions seems to be challenging in the prehospital setting.

Eur J Trauma Emerg Surg. 2022 Apr 1. [Online ahead of print]

Prevention of severe injuries of child passengers in motor vehicle accidents: is re-boarding sufficient?

Spering C, Müller G, Füzesi L, Bouillon B, Rüther H, Lehmann W, Lefering R; and Section of Injury Prevention DGOU; and TraumaRegister DGU.

PURPOSE: The purpose of this study was to evaluate whether prolonged re-boarding of restraint children in motor vehicle accidents is sufficient to prevent severe injury.

METHODS: Data acquisition was performed using the Trauma Register DGU® (TR-DGU) in the time period from 2010 to 2019 of seriously injured children (AIS 2 +) aged 0-5 years as motor vehicle passengers (MVP). Primarily treated and transferred patients where included.

RESULTS: The study group included 727 of 2030 (35.8%) children, who were severely injured (AIS 2 +) in road traffic accidents, among them 268 (13.2%) as MVPs in the age groups: 0-1 years (42.5%), 2-3 years (26.1%) and 4-5 years (31.3%). The pattern of severe injury was head/brain (56.0%), thoracic (42.2%), abdominal (13.1%), fractures (extremities and pelvis, 52.6%) and spine/severe whiplash (19.8%). The 0-1-year-old MVPs showed the significantly highest proportion of brain injuries with Glasgow Coma Score (GCS) < 8 and severe injury to the spine. The 2-3-year-olds showed the significantly highest proportion of fractures especially the lower extremity and highest proportion of cervical spine injuries of all spine injuries, while the 4-5-year-olds, the significantly highest proportion of abdominal injury and second highest proportion of cervical spine injury of all spine injuries. MVPs of the 0-1-year-old and 2-3-year-old groups showed a higher median Injury Severity Score (ISS) of 21.5 and 22.1 points than the older children (17.0 points). They also suffered an AIS-6-injury significantly more often (9 of 21) of spine (p = 0.001). Especially the cervical spine was significantly more often involved. Passengers at the age of 0-1 years were treated with cardiopulmonary resuscitation (CPR) three times as often as older children in the prehospital setting and twice as often at admission in the Trauma Resuscitation Unit (TRU). Their survival rate was 7 out of 8 (0-1 years), 1 out of 6 (2-3 years) and 1 out of 4 (4-5 years).

CONCLUSION: Although the younger MVPs are restraint in a re-boarding position, severe injury to the spine and head occurred more often, while older children as front-faced positioned MVPs suffered from significantly higher rates of abdominal and more often severe facial injury. Our data show, that it is more important to properly restrain children in their adequate car seats (i-size-Norm) and additionally consider the age-related physiological and anatomical specific risks of injury as well as co-factors in road traffic accidents, than only prolonging the re-boarding position over the age of 15 months as a single method.

Eur J Trauma Emerg Surg. 2022 Jan 20. [Online ahead of print].

Influence of anaemia in severely injured patients on mortality, transfusion and length of stay: an analysis of the TraumaRegister DGU ®

Tanner L, Neef V, Raimann FJ, Störmann P, Marzi I, Lefering R, Zacharowski K, Piekarski F; Committee on Emergency Medicine, Intensive Care and Trauma Management (Sektion NIS) of the German Trauma Society (DGU).

PURPOSE: Anaemia is one of the leading causes of death among severely injured patients. It is also known to increase the risk of death and prolong the length of hospital stay in various surgical groups. The main objective of this study is to analyse the anaemia rate on admission to the emergency department and the impact of anaemia on in-hospital mortality.

METHODS: Data from the TraumaRegister DGU® (TR-DGU) between 2015 and 2019 were analysed. Inclusion criteria were age ≥ 16 years and most severe Abbreviated Injury Scale (AIS) score ≥ 3. Patients were divided into three anaemia subgroups: no or mild anaemia (NA), moderate anaemia (MA) and severe anaemia (SA). Pre-hospital data, patient characteristics, treatment in the emergency room (ER), outcomes, and differences between trauma centres were analysed.

RESULTS: Of 67,595 patients analysed, 94.9% (n = 64,153) exhibited no or mild anaemia (Hb ≥ 9 g/dl), 3.7% (n = 2478) displayed moderate anaemia (Hb 7-8 g/dl) and 1.4% (n = 964) presented with severe anaemia (Hb < 7 g/dl). Haemoglobin (Hb) values ranged from 3 to 18 g/dl with a mean Hb value of 12.7 g/dl. In surviving patients, anaemia was associated with prolonged length of stay (LOS). Multivariate logistic regression analyses revealed moderate (p < 0.001 OR 1.88 (1.66-2.13)) and severe anaemia (p < 0.001 OR 4.21 (3.46-5.12)) to be an independent predictor for mortality. Further significant predictors are ISS score per point (OR 1.0), age 70-79 (OR 4.8), age > 80 (OR 12.0), severe pre-existing conditions (ASA 3/4) (OR 2.26), severe head injury (AIS 5/6) (OR 4.8), penetrating trauma (OR 1.8), unconsciousness (OR 4.8), shock (OR 2.2) and pre-hospital intubation (OR 1.6).

CONCLUSION: The majority of severely injured patients are admitted without anaemia to the ER. Injury-associated moderate and severe anaemia is an independent predictor of mortality in severely injured patients.

World J Emerg Surg. 2022 Feb 23;17(1)

Lung failure after polytrauma with concomitant thoracic trauma in the elderly: an analysis from the TraumaRegister DGU®.

Vollrath JT, Schindler CR, Marzi I, Lefering R, Störmann P; TraumaRegister DGU.

BACKGROUND: In developed countries worldwide, the number of older patients is increasing. Pulmonary complications are common in multiple injured patients with chest injuries. We assessed whether geriatric patients develop lung failure following multiple trauma with concomitant thoracic trauma more often than younger patients.

METHODS: A retrospective analysis of severely injured patients with concomitant blunt thoracic trauma registered in the TraumaRegister DGU® (TR-DGU) between 2009 and 2018 was performed. Patients were categorized into four age groups: 55-64 y, 65-74 y, 75-84 y, and ≥ 85 y. Adult patients aged 18-54 years served as a reference group. Lung failure was defined as $PaO_2/FIO_2 \leq 200$ mm Hg, if mechanical ventilation was performed.

RESULTS: A total of 43,289 patients were included, of whom 9238 (21.3%) developed lung failure during their clinical stay. The rate of posttraumatic lung failure was seen to increase with age. While lung failure markedly increased the length of hospital stay, duration of mechanical ventilation, and length of ICU stay independent of the patient's age, differences between younger and older patients with lung failure in regard to these parameters were clinically comparable. In addition, the development of respiratory failure showed a distinct increase in mortality with higher age, from 16.9% (18-54 y) to 67.2% (≥ 85 y).

CONCLUSION: Development of lung failure in severely injured patients with thoracic trauma markedly increases hospital length of stay, length of ICU stay, and duration of mechanical ventilation in patients, regardless of age. The development of respiratory failure appears to be related to the severity of the chest trauma rather than to increasing patient age. However, the greatest effects of lung failure, particularly in terms of mortality, were observed in the oldest patients.

J Clin Med. 2022 Jan 18;11(3):472

Traumatic Hip Dislocations in Major Trauma Patients: Epidemiology, Injury Mechanisms, and Concomitant Injuries.

Weber CD, Lefering R, Sellei RM, Horst K, Migliorini F, Hildebrand F, TraumaRegister Dgu.

INTRODUCTION: Traumatic hip dislocations (THDs) are severe injuries associated with considerable morbidity. Delayed recognition of fracture dislocations and neurovascular deficits have been proposed to cause deleterious long-term clinical outcomes. Therefore, in this study, we aimed to identify characteristics of epidemiology, injury mechanisms, and associated injuries to identify patients at risk.

METHODS: For this study based on the TraumaRegister DGU® (January 2002-December 2017), the inclusion criterion was an Injury Severity Score (ISS) ≥9 points. Exclusion criteria were an isolated head injury and early transfer to another hospital. The THD group was compared to a control group without hip dislocation. The ISS and New ISS were used for injury severity and the Abbreviated Injury Scale for associated injuries classification. Univariate and logistic regression analyses were performed.

RESULTS: The final study cohort comprised n = 170,934 major trauma patients. We identified 1359 individuals (0.8%) with THD; 12 patients had sustained bilateral hip dislocations. Patients with THD were predominantly male (79.5%, mean age 43 years, mean ISS 22.4 points). Aortic injuries (2.1% vs. 0.9%, $p \leq 0.001$) were observed more frequently in the THD group. Among the predictors for THDs were specific injury mechanisms, including motor vehicle accidents (odds ratio (OR) 2.98, 95% confidence interval (CI) 2.57-3.45, $p \leq 0.001$), motorcycle accidents (OR 1.99, 95% CI 1.66-2.39, $p \leq 0.001$), and suicide attempts (OR 1.36, 95% CI 1.06-1.75, $p = 0.016$). Despite a lower rate of head injuries and a comparable level of care measured by trauma center admission, both intensive care unit and total hospital stay were prolonged in patients with THD.

CONCLUSIONS: Since early diagnosis, as well as timely and sufficient treatment, of THDs are of high relevance for long-term outcomes of severely injured individuals, knowledge of patients at risk for this injury pattern is of utmost importance. THDs are frequently related to high-energy mechanisms and associated with severe concomitant injuries in major trauma patients.

Langenbecks Arch Surg. 2022 Mar;407(2):805-817.

Status quo of the use of DCS concepts and outcome with focus on blunt abdominal trauma : A registry-based analysis from the TraumaRegister DGU®.

Willms A, Güsgen C, Schwab R, Lefering R, Schaaf S, Lock J, Kollig E, Jänig C, Bieler D; Committee on Emergency Medicine, Intensive Care, Trauma Management (Sektion N. I. S.) of the German Trauma Society (DGU).

INTRODUCTION: Damage control surgery (DCS) is a standardized treatment concept in severe abdominal injury. Despite its evident advantages, DCS bears the risk of substantial morbidity and mortality, due to open abdomen therapy (OAT). Thus, identifying the suitable patients for that approach is of utmost importance. Furthermore, little is known about the use of DCS and the related outcome, especially in blunt abdominal trauma.

METHODS: Patients recorded in the TraumaRegister DGU® from 2008 to 2017, and with an Injury Severity Score (ISS) ≥ 9 and an abdominal injury with an Abbreviated Injury Scale (AIS) score ≥ 3 were included in that registry-based analysis. Patients with DCS and temporary abdominal closure (TAC) were compared with patients who were treated with a laparotomy and primary closure (non-DCS) and those who did receive non-operative management (NOM). Following descriptive analysis, a matched-pairs study was conducted to evaluate differences and outcomes between DCS and non-DCS group. Matching criteria were age, abdominal trauma severity, and hemodynamical instability at the scene.

RESULTS: The injury mechanism was predominantly blunt (87.1%). Of the 8226 patients included, 2351 received NOM, 5011 underwent laparotomy and primary abdominal closure (non-DCS), and 864 were managed with DCS. Thus, 785 patient pairs were analysed. The rate of hepatic injuries AIS > 3 differed between the groups (DCS 50.3% vs. non-DCS 18.1%). DCS patients had a higher ISS ($p = 0.023$), required more significant volumes of fluids, more catecholamines, and transfusions ($p < 0.001$). More DCS patients were in shock at the accident scene ($p = 0.022$). DCS patients had a higher number of severe hepatic (AIS score ≥ 3) and gastrointestinal injuries and more vascular injuries. Most severe abdominal injuries in non-DCS patients were splenic injuries (AIS, 4 and 5) (52.1% versus 37.9%, $p = 0.004$).

CONCLUSION: DCS is a strategy used in unstable trauma patients, severe hepatic, gastrointestinal, multiple abdominal injuries, and mass transfusions. The expected survival rates were achieved in such extreme trauma situations.

Eur J Trauma Emerg Surg. 2021 Nov 5. [Epub ahead of print].

The significance of a concomitant clavicle fracture in flail chest patients: incidence, concomitant injuries, and outcome of 12,348 polytraumata from the TraumaRegister DGU ®

Bakir MS, Langenbach A, Pinther M, Lefering R, Krinner S, Grosso M, Ekkernkamp A, Schulz-Drost S; TraumaRegister DGU.

PURPOSE: Isolated clavicle fractures (CF) rarely show complications, but their influence in the thorax trauma of the seriously injured still remains unclear. Some authors associate CF with a higher degree of chest injuries; therefore, the clavicle is meant to be a gatekeeper of the thorax.

METHODS: A retrospective analysis of the TraumaRegister DGU® (project 2017-10) was carried out involving the years 2009-2017 (ISS ≥ 16, primary admission to a trauma center). Cohort formation: unilateral and bilateral flail chest injuries (FC), respectively, with and without a concomitant CF.

RESULTS: 73,141 patients (26.5% female) met the inclusion criteria and 12,348 had flail chest injuries (FC; 20.0% CF; 67.7% monolateral FC), 25,425 other rib fractures (17.7% CF), and 35,368 had no rib fractures (6.5% CF). On average, monolateral FC patients were 56.0 ± 17.9 years old and bilateral FC patients were 57.7 ± 19 years old. The ISS in unilateral and bilateral FC were 29.1 ± 11.7 and 42.2 ± 12.9 points, respectively. FC with a CF occurred more frequently with bicycle and motorbike injuries in monolateral FC and pedestrians in bilateral FC injuries and less frequently due to falls. Patients with a CF in addition to a FC had longer hospital and ICU stays, underwent artificially respiration for longer periods, and died less often than patients without a CF. The effects were highly significant in bilateral FC. CF indicates more relevant concomitant injuries of the lung, scapula, and spinal column. Moreover, CF was associated with more injuries of the extremities in monolateral CF.

CONCLUSION: Due to the relevance of a concomitant CF fracture in FC, diagnostics should focus on finding CFs or rule them out. Combined costoclavicular injuries are associated with a significantly higher degree of thoracic injuries and longer hospital stays.

Sci Rep. 2021 Oct 12;11(1):20247.

Prevalence and outcome of abdominal vascular injury in severe trauma patients based on a TraumaRegister DGU international registry analysis.

Barbati ME, Hildebrand F, Andruszkow H, Lefering R, Jacobs MJ, Jalaie H, Gombert A.

This study details the etiology, frequency and effect of abdominal vascular injuries in patients after polytrauma based on a large registry of trauma patients. The impact of arterial, venous and mixed vascular injuries on patients' outcome was of interest, as in particular the relevance of venous vessel injury may be underestimated and not adequately assessed in literature so far. All patients of TraumaRegister DGU with the following criteria were included: online documentation of european trauma centers, age 16-85 years, presence of abdominal vascular injury and Abbreviated Injury Scale (AIS) ≥ 3. Patients were divided in three groups of: arterial injury only, venous injury only, mixed arterial and venous injuries. Reporting in this study adheres to the STROBE criteria. A total of 2949 patients were included. All types of abdominal vessel injuries were more prevalent in patients with abdominal trauma followed by thoracic trauma. Rate of patients with shock upon admission were the same in patients with arterial injury alone (n = 606, 33%) and venous injury alone (n = 95, 32%). Venous trauma showed higher odds ratio for in-hospital mortality (OR: 1.48; 95% CI 1.10-1.98, p = 0.010). Abdominal arterial and venous injury in patients suffering from severe trauma were associated with a comparable rate of hemodynamic instability at the time of admission. 24 h as well as in-hospital mortality rate were similar in in patients with venous injury and arterial injury. Stable patients suspected of abdominal vascular injuries should be further investigated to exclude or localize the possible subtle venous injury.

Sci Rep. 2021 Jul 26;11(1):15172.

Impact of anticoagulation and antiplatelet drugs on surgery rates and mortality in trauma patients.

Bläsius FM, Laubach M, Andruszkow H, Lübke C, Lichte P, Lefering R, Hildebrand F, Horst K.

Preinjury anticoagulation therapy (AT) is associated with a higher risk for major bleeding. We aimed to evaluated the influence of preinjury anticoagulant medication on the clinical course after moderate and severe trauma. Patients in the TraumaRegister DGU ≥ 55 years who received AT were matched with patients not receiving AT. Pairs were grouped according to the drug used: Antiplatelet drugs (APD), vitamin K antagonists (VKA) and direct oral anticoagulants (DOAC). The primary end points were early (< 24 h) and total in-hospital mortality. Secondary endpoints included emergency surgical procedure rates and surgery rates. The APD group matched 1759 pairs, the VKA group 677 pairs, and the DOAC group 437 pairs. Surgery rates were statistically significant higher in the AT groups compared to controls (APD group: 51.8% vs. 47.8%, p = 0.015; VKA group: 52.4% vs. 44.8%, p = 0.005; DOAC group: 52.6% vs. 41.0%, p = 0.001). Patients on VKA had higher total in-hospital mortality (23.9% vs. 19.5%, p = 0.026), whereas APD patients showed a significantly higher early mortality compared to controls (5.3% vs. 3.5%, p = 0.011). Standard operating procedures should be developed to avoid lethal under-triage. Further studies should focus on detailed information about complications, secondary surgical procedures and preventable risk factors in relation to mortality.

Scand J Trauma Resusc Emerg Med. 2021 Jul 27;29(1):101.

Alcohol and trauma: the influence of blood alcohol levels on the severity of injuries and outcome of trauma patients - a retrospective analysis of 6268 patients of the TraumaRegister DGU ®.

Brockamp T, Böhmer A, Lefering R, Bouillon B, Wafaisade A, Mutschler M, Kappel P, Fröhlich M; Working Group of Injury Prevention of the German Trauma Society (DGU).

BACKGROUND: Blood alcohol level (BAL) has previously been considered as a factor influencing the outcome of injured patients. Despite the well-known positive correlation between alcohol-influenced traffic participation and the risk of accidents, there is still no clear evidence of a positive correlation between blood alcohol levels and severity of injury. The aim of the study was to analyze data of the TraumaRegister DGU® (TR-DGU), to find out whether the blood alcohol level has an influence on the type and severity of injuries as well as on the outcome of multiple-trauma patients.

METHODS: Datasets from 11,842 trauma patients of the TR-DGU from the years 2015 and 2017 were analyzed retrospectively and 6268 patients with a full dataset and an AIS ≥ 3 could be used for evaluation. Two groups were formed for data analysis. A control group with a BAL = 0 ‰ (BAL negative) was compared to an alcohol group with a BAL of ≥0.3‰ to < 4.0‰ (BAL positive). Patients with a BAL > 0‰ and < 0.3‰ were excluded. They were compared with regard to various preclinical, clinical and physiological parameters. Additionally, a subgroup analysis with a focus on patients with a traumatic brain injury (TBI) was performed. A total of 5271 cases were assigned to the control group and 832 cases to the BAL positive group. 70.3% (3704) of the patients in the control group were male. The collective of the control group was on average 5.7 years older than the patients in the BAL positive group (p < .001). The control group showed a mean ISS of 20.3 and the alcohol group of 18.9 (p = .007). In terms of the injury severity of head, the BAL positive group was significantly higher on average than the control group (p < 0.001), whereas the control group showed a higher AIS to thorax and extremities (p < 0.001). The mean Glasgow Coma Scale (GCS) was 10.8 in the BAL positive group and 12.0 in the control group (p < 0.001). Physiological parameters such as base excess (BE) and International Normalized Ratio (INR) showed reduced values for the BAL positive group. However, neither the 24-h mortality nor the overall mortality showed a significant difference in either group (p = 0.19, p = 0.14). In a subgroup analysis, we found that patients with a relevant head injury (AIS: Abbreviated Injury Scale head ≥3) and positive BAL displayed a higher survival rate compared to patients in the control group with isolated TBI (p < 0.001).

CONCLUSIONS: This retrospective study analyzed the influence of the blood alcohol level in severely injured patients in a large national dataset. BAL positive patients showed worse results with regard to head injuries, the GCS and to some other physiological parameters. Finally, neither the 24-h mortality nor the overall mortality showed a significant difference in either group. Only in a subgroup analysis the mortality rate in BAL negative patients with TBI was significantly higher than the mortality rate of BAL positive patients with TBI. This mechanism is not yet fully understood and is discussed controversially in the literature.

J Neurotrauma. 2021 Dec 8. [Epub ahead of print].

Functional short-term outcomes and mortality in children with severe traumatic brain injury - comparing decompressive craniectomy and medical management.

Bruns N, Kamp O, Lange KM, Lefering R, Felderhoff-Muser U, Dudda M, Dohna-Schwake C.

The effect of decompressive craniectomy (DC) on functional outcomes and mortality in children after severe head trauma is strongly debated. The lack of high-quality evidence poses a serious challenge to neurosurgeons' and pediatric intensive care physicians' decision making in critically ill children after head trauma. This study was conducted to compare DC and medical management in severely head-injured children with respect to short-term outcomes and mortality. Data on patients < 18 years of age treated in Germany, Austria, and Switzerland during a ten-year period were extracted from TraumaRegister DGU®, forming a retrospective multi-center cohort study. Descriptive and multivariable analyses were performed to compare outcomes and mortality after DC and medical management. Of 2507 patients, 402 (16.0 %) received DC. Mortality was 20.6 % after DC and 13.7 % after medical management. Poor outcome (death or vegetative state) occurred in 27.6 % after DC and in 16.1 % after medical management. After risk adjustment by logistic regression modeling, the odds ratio was 1.56 (95% confidence interval 1.01-2.40) for poor outcome at intensive care unit discharge and 1.20 (0.74-1.95) for mortality after DC. In summary, DC was associated with increased odds for poor short-term outcomes in children with severe head trauma. This finding should temper enthusiasm for DC in children until a large randomized controlled trial has answered more precisely if DC in children is beneficial or increases rates of vegetative state.

Sci Rep. 2021 Dec 1;11(1):23263.

Influence of surgical stabilization of clavicle fractures in multiply-injured patients with thoracic trauma.

Eberbach H, Lefering R, Hager S, Schumm K, Bode L, Jaeger M, Maier D, Kalbhenn J, Hammer T, Schmal H, Bayer J.

Thoracic trauma has decisive influence on the outcome of multiply-injured patients and is often associated with clavicle fractures. The affected patients are prone to lung dysfunction and multiple organ failure. A multi-center, retrospective analysis of patient records documented in the TraumaRegister DGU was performed to assess the influence of surgical stabilization of clavicle fractures in patients with thoracic trauma. A total of 3,209 patients were included in the analysis. In 1362 patients (42%) the clavicle fracture was treated operatively after 7.1 ± 5.3 days. Surgically treated patients had a significant reduction in lung failure (p = 0.013, OR = 0.74), multiple organ failure (p = 0.001, OR = 0.64), intubation time (p = 0.004; -1.81 days) and length of hospital stay (p = 0.014; -1.51 days) compared to non-operative treatment. Moreover, surgical fixation of the clavicle within five days following hospital admission significantly reduced the rates of lung failure (p = 0.01, OR = 0.62), multiple organ failure (p = 0.01, OR = 0.59) and length of hospital stay (p = 0.01; -2.1 days). Based on our results, multiply-injured patients with thoracic trauma and concomitant clavicle fracture may benefit significantly from surgical stabilization of a clavicle fracture, especially when surgery is performed within the first five days after hospital admission.

BMC Emerg Med. 2021 Nov 13;21(1):134.

Does the time of the day affect multiple trauma care in hospitals? A retrospective analysis of data from the TraumaRegister DGU®.

Fitschen-Oestern S, Lippross S, Lefering R, Klüter T, Weuster M, Franke GM, Kirsten N, Müller M, Schröder O, Seekamp A; TraumaRegister DGU.

BACKGROUND: Optimal multiple trauma care should be continuously provided during the day and night. Several studies have demonstrated worse outcomes and higher mortality in patients admitted at night. This study involved the analysis of a population of multiple trauma patients admitted at night and a comparison of various indicators of the quality of care at different admission times.

METHODS: Data from 58,939 multiple trauma patients from 2007 to 2017 were analyzed retrospectively. All data were obtained from TraumaRegister DGU®. Patients were grouped by the time of their admission to the trauma center (6.00 am-11.59 am (morning), 12.00 pm-5.59 pm (afternoon), 6.00 pm-11.59 pm (evening), 0.00 am-5.59 am (night)). Incidences, patient demographics, injury patterns, trauma center levels and trauma care times and outcomes were evaluated.

RESULTS: Fewer patients were admitted during the night (6.00 pm-11.59 pm: 18.8% of the patients, 0.00-5.59 am: 4.6% of the patients) than during the day. Patients who arrived between 0.00 am-5.59 am were younger (49.4 ± 22.8 years) and had a higher injury severity score (ISS) (21.4 ± 11.5) and lower Glasgow Coma Scale (GCS) score (11.6 ± 4.4) than those admitted during the day (12.00 pm-05.59 pm; age: 55.3 ± 21.6 years, ISS: 20.6 ± 11.4, GCS: 12.6 ± 4.0). Time in the trauma department and time to an emergency operation were only marginally different. Time to imaging was slightly prolonged during the night (0.00 am-5.59 am: X-ray 16.2 ± 19.8 min; CT scan 24.3 ± 18.1 min versus 12.00 pm- 5.59 pm: X-ray 15.4 ± 19.7 min; CT scan 22.5 ± 17.8 min), but the delay did not affect the outcome. The outcome was also not affected by level of the trauma center. There was no relevant difference in the Revised Injury Severity Classification II (RISC II) score or mortality rate between patients admitted during the day and at night. There were no differences in RISC II scores or mortality rates according to time period. Admission at night was not a predictor of a higher mortality rate.

CONCLUSION: The patient population and injury severity vary between the day and night with regard to age, injury pattern and trauma mechanism. Despite the differences in these factors, arrival at night did not have a negative effect on the outcome.

Urologe A. 2021 Dec 15. [Epup ahead of print].

Do concomitant urological injuries in severely injured patients lead to poorer outcomes? : A multivariate risk analysis.

Fochtmann U, Jungbluth P, Maek M, Zimmermann W, Lefering R, Lendemans S, Hussmann B; TraumaRegister DGU Sektion Notfall- Intensivmedizin und Schwerverletztenversorgung (Sek-tion NIS) der Deutschen Gesellschaft für Unfallchirurgie (DGU).

BACKGROUND: Severely injured patients with associated genitourinary (GU) injuries have only rarely been investigated in the current literature. If at all, analyses are commonly focussed on renal injuries, marginalising other GU traumas such as ureteral injuries. In this study, we would like to characterise patients with GU injuries and analyse the impact of such injuries on mortality and length of stay.

MATERIALS AND METHODS: The inclusion criteria for this retrospective analysis of TraumaRegister DGU® data were: Injury Severity Score ≥ 16 within the period between 2009 and 2017 with available data on age and length of stay. A descriptive analysis was used to compare patients with and without GU injuries. The impact of GU injuries on mortality and length of hospital stay was evaluated by means of multivariate regression analyses.

RESULTS: In all, 90,962 patients met the inclusion criteria; 5.9% of them had suffered GU injuries (n = 5345). The prevalence in patients with pelvic fractures was up to 19%. On average, patients with GU trauma were 10 years younger (42.9 vs. 52.2 years) and more severely injured (ISS: 31.8 vs. 26.4). The multivariate analyses demonstrated that GU injuries in severely injured patients are no independent risk factor for mortality. However, particularly bladder and genital injuries result in longer hospitalisation.

CONCLUSION: GU injuries do not represent an additional risk factor for mortality. However, after adjusting for established prognosis factors, they can cause prolonged periods of hospitalisation of severely injured patients.

Unfallchirurg. 2021 Oct 26. [Epup ahead of print].

Treatment of severely injured patients by emergency physicians from different medical specialties : A retrospective multicenter investigation of data from the ADAC Air Recue Service and the German TraumaRegister DGU®.

Gäßler M, Ruppert M, Lefering R, Bouillon B, Wafaisade A; TraumaRegister DGU.

BACKGROUND AND OBJECTIVE: This study aimed to identify the prevalence and predictors of spinal injuries that The level 3 guidelines on treatment of patients with severe/multiple injuries provide a defined framework for an appropriate treatment of these patients. It is presumed that prehospital diagnostic and therapeutic decisions are affected by the clinical expertise and the medical disciplines of the emergency physicians.

METHODS: Retrospective, multicenter study based on data from the ADAC Air Recue Service and the TraumaRegister DGU®. In the study period 2011-2015, a total of 11,019 seriously injured patients were included. They were treated by emergency physicians from the following disciplines: anesthesiology (ANÄ), internal medicine (INN) and surgery (CHIR).

RESULTS: Of the patients 81.9% were treated by ANÄ, 7.6% by INN and 10.5% by CHIR. Preclinically, 40.5% of patients were intubated (ANÄ 43.0%, INN 31.2%, CHIR 28.3%; $p < 0.001$), 5.5% received pleural decompression (ANÄ 5.9%, INN 4.2%, CHIR 2.8%; $p = 0.004$),and 10.8% were treated with catecholamines (ANÄ 11.3%, INN 8.3%, CHIR 8.3%; $p = 0.022$). Unconscious patients were intubated in 96.0% (ANÄ 96.1%, INN 97.7%, CHIR 93.9%; $p = 0.205$). The mortality was not influenced by the medical specialty of the emergency physician.

CONCLUSIONS: In this air rescue cohort differences in indications for invasive procedures were observed between the groups. This may be caused by their clinical background. Using the example of intubation, it has been shown that guideline recommendations were closely followed irrespective of the medical specialty of the emergency physician.

Clin Neurol Neurosurg. 2022 Jan;212:107089.

Cranial nerve injuries in patients with moderate to severe head trauma - Analysis of 91,196 patients from the TraumaRegister DGU® between 2008 and 2017.

Huckhagel T, Riedel C, Rohde V, Lefering R.

OBJECTIVE: Traumatic brain injury (TBI) constitutes a major cause of trauma-related disability and mortality. The epidemiology and implications of associated cranial nerve injuries (CNI) in moderate to severe TBI are largely unknown. We aimed to determine the incidence of CNI in a large European cohort of TBI patients as well as clinical differences between TBI cases with and without concomitant CNI (CNI vs. control group) by means of a multinational trauma registry.

METHODS: The TraumaRegister DGU® was evaluated for trauma patients with head injuries ≥ 2 Abbreviated Injury Scale, who had to be treated on intensive care units after emergency admission to European hospitals between 2008 and 2017. CNI and control cases were compared with respect to demographic, clinical, and outcome variables.

RESULTS: 1.0% (946 of 91,196) of TBI patients presented with additional CNI. On average, CNI patients were younger than control cases (44.3 ± 20.6 vs. 51.8 ± 23.0 years) but did not differ regarding sex distribution (CNI 69.4% males vs. control 69.1%). Traffic accidents were encountered more frequently in CNI cases (52.3% vs. 46.7%; $p < 0.001$; chi-squared test) and falls more commonly in the control group (45.2% vs. 37.1%; $p < 0.001$). CNI patients suffered more frequently from concomitant face injuries (28.2% vs. 17.5%; $p < 0.001$) and skull base fractures (51.0% vs. 23.5%; $p < 0.001$). Despite similar mean Injury Severity Score (CNI 21.8 ± 11.3; control 21.1 ± 11.7) and Glasgow Coma Scale score (CNI 10.9 ± 4.2, control 11.1 ± 4.4), there was a considerably higher proportion of anisocoria in CNI patients (20.1% vs. 11.2%; $p < 0.001$). Following primary treatment, 50.8% of CNI and 35.5% of control cases showed moderate to severe disability (Glasgow Outcome Scale score 3-4; $p < 0.001$).

CONCLUSION: CNI rarely occur in the context of TBI. When present, they indicate a higher likelihood of functional impairment following primary care and complicating skull base fractures should be suspected.

Crit Care. 2021 Aug 4;25(1):277.

The impact of prehospital tranexamic acid on mortality and transfusion requirements: match-pair analysis from the nationwide German TraumaRegister DGU®.

Imach S, Wafaisade A, Lefering R, Böhmer A, Schieren M, Suárez V, Fröhlich M; TraumaRegister DGU.

BACKGROUND: Outcome data about the use of tranexamic acid (TXA) in civilian patients in mature trauma systems are scarce. The aim of this study was to determine how severely injured patients are affected by the widespread prehospital use of TXA in Germany.

METHODS: The international TraumaRegister DGU® was retrospectively analyzed for severely injured patients with risk of bleeding (2015 until 2019) treated with at least one dose of TXA in the prehospital phase (TXA group). These were matched with patients who had not received prehospital TXA (control group), applying propensity score-based matching. Adult patients (≥ 16) admitted to a trauma center in Germany with an Injury Severity Score (ISS) ≥ 9 points were included.

RESULTS: The matching yielded two comparable cohorts (n = 2275 in each group), and the mean ISS was 32.4 ± 14.7 in TXA group vs. 32.0 ± 14.5 in control group (p = 0.378). Around a third in both groups received one dose of TXA after hospital admission. TXA patients were significantly more transfused (p = 0.022), but needed significantly less packed red blood cells (p ≤ 0.001) and fresh frozen plasma (p = 0.023), when transfused. Massive transfusion rate was significantly lower in the TXA group (5.5% versus 7.2%, p = 0.015). Mortality was similar except for early mortality after 6 h (p = 0.004) and 12 h (p = 0.045). Among non-survivors hemorrhage as leading cause of death was less in the TXA group (3.0% vs. 4.3%, p = 0.021). Thromboembolic events were not significantly different between both groups (TXA 6.1%, control 4.9%, p = 0.080).

CONCLUSION: This is the largest civilian study in which the effect of prehospital TXA use in a mature trauma system has been examined. TXA use in severely injured patients was associated with a significantly lower risk of massive transfusion and lower mortality in the early in-hospital treatment period. Due to repetitive administration, a dose-dependent effect of TXA must be discussed.

Eur Geriatr Med. 2022 Feb;13(1):233-241.

A retrospective cohort study of 27,049 polytraumatized patients age 60 and above: identifying changes over 16 years.

Kalbas Y, Lempert M, Ziegenhain F, Scherer J, Neuhaus V, Lefering R, Teuben M, Sprengel K, Pape HC, Jensen KO; TraumaRegister DGU.

PURPOSE: The number of severely injured patients exceeding the age of 60 has shown a steep increase within the last decades. These patients present with numerous co-morbidities, polypharmacy, and increased frailty requiring an adjusted treatment approach. In this study, we establish an overview of changes we observed in demographics of older severe trauma patients from 2002 to 2017.

METHODS: A descriptive analysis of the data from the TraumaRegister DGU® (TR-DGU) was performed. Patients admitted to a level one trauma center in Germany, Austria and Switzerland between 2002 and 2017, aged 60 years or older and with an injury severity score (ISS) over 15 were included. Patients were stratified into subgroups based on the admission: 2002-2005 (1), 2006-2009 (2), 2010-2013 (3) and 2014-2017 (4). Trauma and patient characteristics, diagnostics, treatment and outcome were compared.

RESULTS: In total 27,049 patients with an average age of 73.9 years met the inclusion criteria. The majority were males (64%), and the mean ISS was 27.4. The proportion of patients 60 years or older [(23% (1) to 40% (4)] rose considerably over time. Trauma mechanisms changed over time and more specifically low falls (< 3 m) rose from 17.6% (1) to 40.1% (4). Altered injury patterns were also identified. Length-of-stay decreased from 28.9 (1) to 19.5 days (4) and the length-of-stay on ICU decreased from 17.1 (1) to 12.7 days (4). Mortality decreased from 40.5% (1) to 31.8% (4).

CONCLUSION: Length of stay and mortality decreased despite an increase in patient age. We ascribe this observation mainly to increased use of diagnostic tools, improved treatment algorithms, and the implementation of specialized trauma centers for older patients allowing interdisciplinary care.

World J Emerg Surg. 2021 Aug 26;16(1):42.

Thromboembolic complications among multiple injured patients with pelvic injuries: identifying risk factors for possible patient-tailored prophylaxis.

Kirchner T, Lefering R, Sandkamp R, Eberbach H, Schumm K, Schmal H, Bayer J; TraumaRegister DGU.

BACKGROUND: Patients with pelvic and/or acetabular fractures are at high risk of developing thromboembolic (TE) complications. In our study we investigate TE complications and the potential negative effects of concomitant pelvic or acetabular injuries in multiple injured patients according to pelvic/acetabular injury severity and fracture classification.

METHODS: The TraumaRegister DGU® was analyzed between 2010 and 2019. Multiple injured patients with pelvic and/or acetabular fractures with ISS ≥ 16 suffering from TE complications were identified. We conducted a univariate and multivariate analysis with TE events as independent variable to examine potential risk factors and contributing factors.

RESULTS: 10.634 patients met our inclusion criteria. The overall TE incidence was 4.9%. Independent risk factors for the development of TE complications were sepsis, ≥ 10 operative interventions, mass transfusion (≥ 10 PRBCs), age ≥ 65 years and AISAbdomen ≥ 3 (all p < 0.001). No correlation was found for overall injury severity (ISS), moderate traumatic brain injury, additional injury to lower extremities, type B and C pelvic fracture according to Tile/AO/OTA and closed or open acetabular fracture.

CONCLUSIONS: Multiple injured patients suffering from pelvic and/or acetabular fractures are at high risk of developing thromboembolic complications. Independent risk factors for the development of thromboembolic events in our study cohort were age ≥ 65 years, mass transfusion, AISAbdomen ≥ 3, sepsis and ≥ 10 surgery procedures. Among multiple injured patients with acetabular or pelvic injuries the severity of these injuries seems to have no further impact on thromboembolic risk. Our study, however, highlights the major impact of early hemorrhage and septic complications on thromboembolic risk in severely injured trauma patients. This may lead to individualized screening examinations and a patient-tailored thromboprophylaxis in high-risk patients for TE. Furthermore, the number of surgical interventions should be minimized in these patients to reduce thromboembolic risk.

Shock. 2021 Nov 1;56(5):727-732.

The Influence of Alcohol on the Base Excess Parameter in Trauma Patients.

Leiblein M, Sturm R, Franz N, Mühlenfeld N, Relja B, Lefering R, Marzi I, Wagner N.

BACKGROUND: The base excess (BE) parameter can be used as an indicator of mortality. However, study results on the influence of alcohol on the validity of BE as a prognostic parameter in alcohol-intoxicated patients are controversial. Thus, this study examined the hypothesis: An increasing blood alcohol level reduces the prognostic value of the BE parameter on mortality.

PATIENTS AND METHODS: In a retrospective analysis of the multicenter database of the TraumaRegister DGU, patients from 2015 to 2017 were grouped depending on their blood alcohol level (BAL) into a BAL+ and BAL- group. The hypothesis was verified using logistic regression with an assumed significance level of 1% (P < 0.01).

RESULTS: Eleven thousand eight hundred eighty-nine patients were included; 9,472 patients in the BAL- group and 2,417 patients in the BAL+ group. Analysis of the BE showed lower values in the BAL+ group (BAL-: -1.8 ± 4.4 mmol/L vs. BAL+: -3.4 ± 4.6 mmol/L). There is a trend toward lower BE levels when BAL increases. Assuming a linear relationship, then BE decreases by 0.6 points per mille alcohol (95% CI: 0.5-0.7; P < 0.001). The mortality rate was significantly lower in the BAL+ group (BAL-: 11.1% vs. BAL+: 7.9%). The logistic regression analysis showed a significant beneficial influence of BAL+ on the mortality rate (OR 0.706, 95% CI 0.530-0.941, P = 0.018). To analyze whether a low BE (≤-6 mmol/L) has different prognostic effects in patients with and without alcohol, logistic regression models were calculated. However, the effect of BE ≤ -6 mmol/L was similar in both models (regression coefficients in BAL-/+ patients: 0.379/0.393).

CONCLUSIONS: The data demonstrate an existing influence of alcohol on the BE parameter; however, this does not negatively affect the BE as a prognostic parameter at a threshold of ≤ -6 mmol/L.

Int J Environ Res Public Health. 2021 Dec 17;18(24):13322.

Impact of DST (Daylight Saving Time) on Major Trauma: A European Cohort Study.

Nohl A, Seelmann C, Roenick R, Ohmann T, Lefering R, Brune B, Weichert V, Dudda M, The Trau-maRegister Dgu.

BACKGROUND: Approximately 73 countries worldwide implemented a daylight saving time (DST) policy: setting their clocks forward in spring and back in fall. The main purpose of this practice is to save electricity. The aim of the present study was to find out how DST affects the incidence and impact of seriously injured patients.

METHODS: In a retrospective, multi-center study, we used the data recorded in the TraumaRegister DGU® (TR-DGU) between 2003 and 2017 from Germany, Switzerland, and Austria. We compared the included cases 1 week before and after DST.

RESULTS: After DST from standard time to summertime, we found an increased incidence of accidents of motorcyclists up to 51.58%. The result is consistent with other studies.

CONCLUSION: However, our results should be interpreted as a tendency. Other influencing factors, such as time of day and weather conditions, were not considered.

Unfallchirurg. 2021 Oct 15. [Epup ahead of print].

Differences in injury patterns in motorcycle accidents involving children and adolescents.

Oezel L, Jaekel C, Bieler D, Stuewe D, Neubert A, Lefering R, Grassmann JP, Windolf J, Thelen S; Sektion Notfall-, Intensivmedizin und Schwerverletztenversorgung (Sektion NIS) der DGU.

BACKGROUND: Traffic accidents and the traumatic injury consequences are frequent causes of mortality and irreversible damage in children and young adults. In motorcycle accidents the injury patterns differ depending on the age of the patient.

OOBJECTIVE: The aim of this study was to describe the typical injury patterns after motorcycle accidents involving children and adolescents as these can have a decisive influence on the prevention and the adequate treatment in the respective patient groups.

MATERIAL AND METHODS: The study included 22,923 patients from the years 2002-2018 which were extracted from the TraumaRegister DGU®. Injury patterns of 4 age categories were analyzed: group 1 (4-15 years), group 2 (16-17 years), group 3 (18-20 years) and group 4 (21-50 years).

RESULTS: In both younger age groups, limb injuries mostly of the lower extremities, showed the highest incidence. Moreover, younger patients with traumatic brain injury showed better outcomes despite of initially poor conditions. Ribcage, abdominal, pelvic and spinal injuries are the least frequent in younger patients. In terms of diagnostics, children are less likely to undergo whole-body computed tomography (CT) diagnostics than adults.

CONCLUSION: The study revealed age-specific differences with respect to injury patterns in patients involved in motorcycle accidents, either as drivers or co-drivers. Furthermore, the analysis of preclinical and in-hospital treatment elucidated the relevance of preventive and protective measures.

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17 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