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Does Trauma Room Duration Affect Patient Outcome in a Level I Trauma Center?

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Abstract

Background: Trauma is the leading cause of death and morbidity in younger people aged 15-29 years worldwide. Implementation of guidelines, care algorithms, Standard Operating Procedures (SOPs) or white books aim at improving quality and safety of trauma care. Therefore, time is a common item to evaluate the quality of trauma care (e.g. the duration of trauma room care or the duration of certain interventions). This study evaluates the influence of the duration of trauma room care on patient outcome at a well-trained level I trauma center.

Materials and Methods: Study population: 382 (ISS > 16) patients primarily admitted to the trauma room of a level I trauma center were included in a 64 month period. The study population was grouped according to the prognostic RISC-Score for expected fatality (expected fatality rate: RISC-group 1: [0%-5%], RISC-group 2: [5%-50%], RISC-group 3: [50%-100%]). Moreover, each RISC-group was sub-grouped according to the total duration of trauma room treatment (SHORT-sub-group: <median trauma room time, LONG-sub-group: ≥ median trauma room time).

Results: Comparative analysis demonstrated shortest trauma room times in cases with expected fatality of ≥ 50% (total trauma room duration: RISC-group 1: 66.7 ± 28.2 min, RISC-group 2: 69.1 ±29.1 min, RISC-group 3: 58.0 ± 32.2 min; p=0.006). A second trauma room phase (after primary trauma room phase and CT-scan) was associated with an increase of the interventions performed and a prolonged trauma room time. With regard to hospital mortality, no significant difference was found in the SHORT- versus LONG-sub-group. The Standard Mortality Ratio (SMR) of the study sample (SMR=0.63) and all sub-groups were lower compared to the 2007 - 2012 cases of the Trauma Register DGU® (trauma registry of the German Trauma Society).

Conclusion: This study indicates that the individual duration of trauma room care in the optimized setting of a level I trauma center does not impact on patient outcome indicators. On the contrary, it reflects a financially and resource demanding trauma room care, that has to be provided for a more complex trauma patient care.

Keywords: Trauma room; Trauma center; Multiple trauma; ATLS; DGU; Traumanetzwerk; RISC

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Introduction

Injury can be considered as a global burden of disease. More than one million people are killed while involved in Road Traffic Accidents (RTA) every year. RTAs are ranked as the 8th leading cause of death all over the world with a rising trend, so that they are expected to be the 5th leading cause of death in 2030 worldwide. Moreover, RTAs are ranked as the leading cause of death and morbidity for younger people aged 15-29 years throughout the world [1].

An optimized trauma care system is essential to provide high quality trauma care to road users and all the other seriously injured patients. Guidelines (e.g. S3-Guideline on Treatment of Patients with Severe and Multiple Injuries), structured training courses (e.g. ATLS®, PHTLS®, ETC), Standard Operating Procedures (SOPs) and designated white books (e.g. Whitebook Medical Care of the Severely Injured) are valuable and established tools to improve trauma care in terms of structure, process and outcome quality [2-7]. Several countries or regions run mature trauma systems (e.g. TraumaNetzwerk DGU®) and quality management tools, like large-scale trauma registries (e.g. TraumaRegister DGU® or TARN) [8-10]. In fact, these instruments proved to be feasible, effective and efficient. However, they require continuing evaluation and adjustment [11-13].

“Time-to-intervention” belongs to the most well-known and referenced quality indicators in

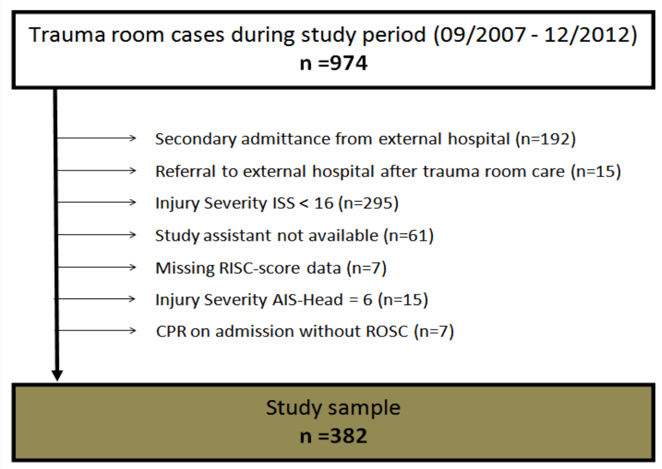

Figure 1: Selection of study sample.

the context of the time-critical prehospital and early in-hospital phase [14-16]. It was Cowley in 1976 who illustrated the correlation of time-to-intervention and outcome with the shining term "Golden Hour of Shock" [17]. An example for the importance of time management in trauma care is the "time to laparotomy for intra-abdominal bleeding", as Clarke showed in 2001 [18]. Nevertheless, recent data indicates that "time-to-intervention" is not a universal or stand-alone indicator for the assessment of trauma care quality [19-27]. Kleber et al. Published that prolonged rescue time in the physician-based German Emergency Medical System is not associated with worse patient outcome in general [28]. With regard to early in-hospital trauma management, it was shown that tools like SOPs, Quality Management (QM) and early Multislice-Computed Tomography (MSCT) can significantly reduce trauma room time and mortality [11,16,29,30]. To the best knowledge of the author's systematic investigations concerning the impact of trauma room time on the outcome of seriously injured patients in an optimized trauma room setting have not been published yet.

This study analyses the potential association of the duration of trauma room care on diverse outcome parameters in a study sample primarily admitted to a level I trauma center and university hospital. In addition, various pre-hospital and early in-hospital interventions, as well as the duration of these interventions, are investigated.

Materials and Methods

Study sample

The study was approved by the ethics committee of the University of Regensburg (Nr: 14-101-0004). A total of 974 trauma room cases were documented during the study period (64 months: 09/2007 - 12/2012), of which n=382 were included in this study and are referred to as "study sample" from now on (Figure 1).

- 4.2. InclusionPrimary admission to the study hospital's trauma room
- Admission to the study hospital after trauma room care (no referral to an external hospital)
- Injury Severity Score ISS ≥ 16
- Complete real-time documentation in the trauma room by a qualified study assistant
- Calculation of RISC-score possible (no missing data)

Exclusion criteria

All cases that were initially treated in an outside hospital or transferred to an outside hospital after trauma room care were excluded. Moreover, cases with head injuries on admission that cannot be survived (AIS-Head =6) and those with cardiopulmonary resuscitation and no Return of Spontaneous Circulation (ROSC) were also excluded.

Data recruitment

All cases were documented in a prospective manner by qualified study assistants, who were present in the trauma room during trauma management. In addition, the study assistants collected all other data, i.e. regarding post-trauma room management and outcome. This method has been established in the study hospital since 2007, and is believed to generate the highest data quality feasible. The standard data entry form of the German Trauma Society's trauma registry (TraumaRegister DGU®, http://www.traumaregister.de) was applied as the framework of the study's data entry form, and various parameters were documented in addition (Table 1-4).

Comparative analysis of subgroups by risk of death and duration of trauma room care

The prognostic RISC-score (Revised Injury Severity Classification) was used to categorize the study population into three groups. The RISC was developed and evaluated on basis of large-scale data sets from the TraumaRegister DGU® and estimates the fatality risk (comparable to the TRISS: Trauma Injury Severity Score) of an individual case [31]. For the TraumaRegister DGU®, the RISC score has an area under the curve (AUC) of 0.939 in the ROC-analysis 2012, and is the most exact predictor score for this dataset [31,32].

As a result, the following three RISC-groups were analyzed:

RISC-group 1 (RG1), RISC = [0-5%], n=198 "low fatality risk"

RISC-group 2 (RG2), RISC = [5-50%], n=116 "medium fatality risk"

RISC-group 3 (RG3), RISC = [50-100%], n=68 "high fatality risk"

Furthermore, each RISC-group was dichotomized according to the duration of trauma room care:

Table 1: Study sample key data (demographics, trauma scores, Pre-hospital interventions and injury pattern).

	RISC-group 1 Exp. mortality [0-5%] n=198			RISC-group 2 Exp. mortality [5-50%] n=116			RISC-group 3 Exp. mortality [50-100%] n=68		p
Male (n/%)	147/ 74.2			83/71.6			43/63.2		0.222
Age (years ± SD)	32.7 (± 14.1)*			45.1 (± 24.4)			48.1 (± 24.7)		<0.001
Blunt trauma (n/%)	192/97.0			114/98.3			64/94.1		0.293
ISS (± SD)	24.3 (± 6.8)*			32.7 (± 9.9) *			43.0 (± 13.7) *		<0.001
NISS (± SD)	28.7 (± 8.8)*			41.0 (± 12.1) *			57.2 (± 13.1) *		<0.001
RISC (% ± SD)	2.2 (± 1.0)*			21.3 (± 12.4) *			78.1 (± 14.7) *		<0.001
Pre-hospital airway (n/%)	109/55.1*			88/75.9*			62/91.2*		<0.001
Pre-hospital chest tube (n/%)	22/11.1 (* to 3)			22/19.0			15/22.1 (* to 1)		0.047
Pre-hospital CPR (n/%)	0			0			15/22.1*		<0.001
Rescue time (n/min ± SD)	186/83.9 (± 27.5)			107/83.1 (± 27.7)			64/85.6 (± 32.5)		0.967
Pre-hospital RR <90 mmHg (n/%)	36/18.2			30/25.9			36/52.9*		<0.001
Trauma room RR <90 mmHg (n/%)	15/7.6*			19/16.4			19/27.9		<0.001
Blood transfusion >10 units (n/%)	0*			6/5.2*			16/23.5*		<0.001
AIS-Head ≥ 3 (n/%)	85/42.9*			89/76.7			56/82.4		<0.001
AIS-Thorax ≥ 3 (n/%)	122/61.6			67/57.8			36/52.9		0.435
AIS-Abdomen ≥ 3 (n/%)	36/18.2			19/16.4			25/36.8*		0.002
AIS-Extremities ≥ 3 (n/%)	83/41.9			45/38.8			32/47.1		0.548
Number of diagnoses (n ± SD)	8.2 (± 3.9)(* to 2)			9.2 (± 4.0)(* to 1)			9.9 (± 5.5)		0.019
Number of surgeries(n ± SD)	5.1 (± 4.8)			6.1 (± 5.9)			6.3 (± 5.7)		0.388
	SHORT-group n=98	**LONG-group n=100**	**p**	**SHORT-group n=58**	**LONG-group n=58**	**p**	**SHORT-group n=34**	**LONG-group n=34**	**p**
Male (n/%)	76 / 77.6	71/71.0	0.292	38/65.5 %	45/77.6	0.15	23/67.6	20/58.8	0.451
Age (years ± SD)	33.1 (± 14.6)	32.3 (± 13.7)	0.702	46.9 (± 23.6)	43.3 (± 25.3)	0.434	42.8 (± 24.0)	53.4 (± 24.6)	0.076
Blunt trauma (n/%)	94/95.9	98/98.0	0.442	57/98.3	57/98.3	1	31/91.2	33/97.1	0.614
ISS (± SD)	24.3 (± 7.5)	24.4 (± 6.1)	0.439	31.6 (± 10.0)	33.7 (± 9.9)	0.264	44.7 (± 13.7)	41.4 (± 13.6)	0.337
NISS (± SD)	29.5 (± 9.1)	27.9 (± 8.3)	0.316	41.3 (± 12.6)	40.7 (± 11.7)	0.819	59.4 (± 12.1)	54.9 (± 13.8)	0.177
RISC (% ± SD)	2.2 (± 1.0)	2.2 (± 1.0)	0.751	21.9 (± 14.0)	20.7 (± 10.7)	0.905	80.8 (± 13.6)	75.4 (± 15.4)	0.126
Pre-hospital airway (n/%)	53/54.1	56/56.0	0.786	40/69.0	48/82.8	0.083	32/94.1	30/88.2	0.673
Pre-hospital chest tube (n/%)	9/9.2	13/13.0	0.379	8 / 13.8	14/24.1	0.155	6/17.6	9/26.5	0.38
Pre-hospital CPR (n/%)	0	0	---	0	0	---	10/29.4	5/14.7	0.144
Rescue time (n/min ± SD)	91/82.2 (± 25.5)	95/85.4 (± 29.3)	0.427	53/78.0 (± 24.2)	54/88.1 (± 30.1)	0.06	31/83.5 (± 33.9)	33/87.6 (± 31.5)	0.624
Pre-hospital RR <90 mmHg (n/%)	17/17.3	19/19.0	0.738	16/27.6	14/24.1	0.629	19/55.9	17/50.0	0.614
Trauma room RR <90 mmHg (n/%)	10/10.2	5/5.0	0.166	9/15.5	10/17.2	0.834	11/32.4	8/23.5	0.417
Blood transfusion >10 units (n/%)	0	0	---	4/6.9	2/3.4	0.679	10/29.4	6/17.6	0.253
AIS-Head ≥ 3 (n/%)	41/41.8	44/44.0	0.758	43/74.1	46/79.3	0.51	27/79.4	29/85.3	0.525
AIS-Thorax ≥ 3 (n/%)	56/57.1	66/66.0	0.2	33/56.9	34/58.6	0.851	15/44.1	21/61.8	0.145
AIS-Abdomen ≥ 3 (n/%)	21/21.4	15/15.0	0.241	12/20.7	7/12.1	0.21	16/47.1	9/26.5	0.078
AIS-Extremities ≥ 3 (n/%)	42/42.9	41/41.0	0.791	17/29.3	28/48.3	0.036	15/44.1	17/50.0	0.627
Number of diagnoses (n ± SD)	7.6 (± 3.8)	8.8 (± 3.9)	0.03	8.6 (± 3.9)	9.9 (± 3.9)	0.033	9.3 (± 5.1)	10.6 (± 5.8)	0.354
Number of surgeries(n ± SD)	5.1 (± 5.3)	5.1 (± 4.3)	0.532	5.2 (± 5.5)	6.9 (± 6.3)	0.136	5.9 (± 5.6)	6.7 (± 5.8)	0.597

Note: *indicates statistical significance

Abbreviations: ISS: Injury Severity Score; NISS: New Injury Severity Score; RISC: Revised Injury Severity Classification; CPR: Cardiopulmonary Resuscitation; AIS: Abbreviated Injury Scale

Table 2: Frequency and length of trauma room phases, Multislice-CT and total length of trauma room care.

	RISC-group 1 Exp. mortality [0-5%] n=198			RISC-group 2 Exp. mortality]5-50%] n = 116			RISC-group 3 Exp. mortality]50-100%] n = 68		p
Trauma room phase I (n/min ± SD)	198/25.3 (± 8.4)			116/26.1 (± 10.3)			68/26.0 (± 10.6)		0.832
Multislice-CT (n/min ± SD)	193/8.1 (± 4.5)			115/7.7 (± 4.3)			60/8.1 (± 4.9)		0.762
Trauma room phase II (n/min ± SD)	167/37.5 (± 26.3)			94/42.7 (± 26.0)			45/37.2 (± 30.5)		0.061
Total length of trauma room care (n/min ± SD)	198/66.7 (± 28.2)			116/69.1 (± 29.1)			68/58.0 (± 32.2)*		0.006
	SHORT-group n = 98	LONG-group n = 100	p	SHORT-group n = 58	LONG-group n = 58	p	SHORT-group n = 34	LONG-group n = 34	p
Trauma room phase I (n/min ± SD)	98/22.7 (± 6.2)	100/27.7 (± 9.5)	<0.001	58/24.5 (± 8.2)	58/27.6 (± 11.9)	0.144	34/22.3 (± 8.5)	34/29.7 (± 11.3)	0.003
Multislice-CT (n/min ± SD)	95/7.6 (± 4.0)	98/8.6 (± 4.9)	0.182	57/7.9 (± 4.7)	58/7.5 (± 3.8)	0.804	26/7.7 (± 4.0)	34/8.3 (± 5.6)	0.628
Trauma room phase II (n/min ± SD)	72/18.8 (± 8.7)	95/51.6 (± 26.5)	<0.001	38/26.8 (± 20.6)	56/53.5 (± 23.9)	<0.001	14/14.6 (± 19.5)	31/47.4 (± 29.3)	<0.001
Total length of trauma room care (n/min ± SD)	98/45.9 (± 10.4)	100/87.1 (± 25.1)	<0.001	58/48.0 (± 11.8)	58/90.2 (± 25.7)	<0.001	34/34.2 (± 10.8)	34/81.9 (± 28.6)	<0.001

Note: *indicates statistical significance

SHORT-sub-group: Duration of trauma room time < median trauma room time in study sample

LONG-sub-group: Duration of trauma room time ≥ median trauma room time in study sample

In-hospital death was defined as the primary outcome. In order to substantiate this parameter the Standardized Mortality Ratio (SMR) was calculated as the ratio of observed letality and expected letality (per RISC).

Trauma room management at the study hospital

Trauma room phase I is defined as the period from admission to the trauma room until completion of the primary survey and associated basic diagnostics/procedures. Following trauma room phase I, MSCT was performed (mostly whole-body-MSCT). The scanner is located next door to the trauma room. If necessary, a trauma room phase II was instituted after completion of MSCT in order to complete or extend emergency diagnostics or procedures. Following MSCT or trauma room phase II, all patients were transferred to either the Operating Room (OR) or the Intensive Care Unit (ICU).

The study hospital's trauma room algorithm follows the ATLS® principles and is compliant with the recommendations published in the S3-guidelines of the German Trauma Society. In rare cases, the routine trauma room algorithm was deviated due to need for emergency surgery.

Statistical analysis

The results are presented as absolute and relative frequencies and as mean value ± Standard Deviation (SD) where appropriate. In cases of n=1 no frequencies are revealed. The SMR is shown as ratio plus 95% confidence interval (95%-CI). Normal distribution was tested with the Kolmogorov-Smirnov test. Nominal variables were tested for significance by the chi-squared and Fisher's exact test where appropriate. T-test and Mann-Whitney U test were used for ordinal/metric variables where suitable. To test more than 2 groups at once for significant discrepancy in ordinal/metric variables, the Kruskal-Wallis test with paired post hoc test was applied. P-values of ≤ 0.05 were considered statistically significant. All results were calculated with the IBM SPSS Statistics 21.0 software package.

Results

Basic demographics of the study sample (n=382; male n=273/71.5%; blunt trauma n=370/96.9%; mean age 39.2 ± 20.9 years) are comparable to ISS >16 samples originating from the TraumaRegister DGU® [9,33].

Table 1 demonstrates a comparable distribution of sex and injury mechanism in each of the RISC-groups. As expected (and due to the calculation matrix of the RISC-score), the mean age, ISS, NISS and RISC are increasing from RISC-group 1 to 3. Likewise, the percentage of pre-hospital interventions (e.g. intubation or chest tube) increases from RISC-group 1 to 3 (prehospital airway: RG1 55.1%, RG2 75.9%, RG3 91.2%, p<0.001; prehospital chest tube: RG1 11.1%, RG2 19.0%, RG3 22.1%, p=0.047).

On the contrary, there was no difference in gender-, age-, trauma-type-, ISS-, NISS- and RISC-allocation between the SHORT- and LONG-sub-groups (p ≥ 0.076). Moreover, the percentage of pre-hospital interventions (e.g. intubation or chest tube) was similar in the SHORT- and LONG-sub-groups. Interestingly, prehospital time tends to be longer in the three sub-groups with long trauma room time (LONG-sub-groups), however missing statistical significance (p ≥ 0.06).Compared to the prehospital data set, the rate of shock (RR_{sys} <90 mmHg) at trauma room admission decreased in all RISC-groups. Despite this finding, there was no difference in the rate of shock in the SHORT and LONG-sub-groups (p ≥ 0.166).

While ISS and NISS within the three RISC-groups were comparable between the sub-groups (p ≥ 0.177), serious head-, chest-, and extremity-injuries (AIS ≥ 3) tended to be more frequent in the LONG-sub-groups (p ≥ 0.036). On the other hand, serious abdominal injuries (AIS ≥ 3) were more frequent in the SHORT-sub-groups, whereas severe bleeding (indicated per transfusion of > 10 blood units) was comparable in the SHORT- and LONG-sub-groups. In general, long trauma room times were associated with a higher number of diagnoses (Table 1).

The shortest total trauma room time was documented for the RISC-group 3 (highest fatality rate prognosis), which goes along with higher rates of trauma room care breaks and emergency surgeries. Considering the SHORT- and LONG-sub-groups, trauma room phases I and II were (with exception for RG2) significantly longer in the LONG-sub-groups (p ≤ 0.003), while the isolated MSCT time was not significantly different (p ≥ 0.182). Details are shown in Table 2.

Decision for a second trauma room phase following MSCT was found to be the leading cause for an increased total trauma room time. This is consistent with the finding of higher mean numbers of interventions (intubation, chest tube, arterial and central lines) in cases with longer trauma room times. Moreover, the time needed

Table 3: Frequency and time of trauma room interventions.

	SHORT-group n=98	LONG-group n=100	p	SHORT-group n=58	LONG-group n=58	p	SHORT-group n=34	LONG-group n=34	p
Trauma room phase II (n/%)	62/63.3	95/95.0	<0.001	32/55.2	55/94.8	<0.001	6/17.6	31/91.2	<0.001
Intubation (n/%)	4/4.1	18/18.0	0.003	5/8.6	8/13.8	0.377	1/2.9	3/8.8	0.614
Chest tube (n/%)	4/4.1	22/22.0	<0.001	3/5.2	16/27.6	0.002	3/8.8	12/35.3	0.017
Arterial line (n/%)	61/62.2	68/68.0	0.395	39/67.2	50/86.2	0.016	26/76.5	28/82.4	0.549
Central venous line (n/%)	13/13.3	39/39.0	<0.001	14/24.1	36/62.1	<0.001	12/35.3	27/79.4	<0.001
Multislice-CT (n/%)	95/96.9	99/99.0	0.366	57/98.3	58/100	1	26/76.5	34/100	0.005
Trauma room care break (n/%)	4/4.1	0	0.058	1/1.7	1/1.7	1	11/32.4	2/5.9	0.011
Referral to OR (n/%)	57/58.2	40/40.0	0.011	30/51.7	22/37.9	0.135	25/73.5	16/47.1	0.026
Intubation (n/min ± SD)	2/1.5 (± 0.7)	15/4.5 (± 2.4)	0.117	5/1.8 (± 0.8)	8/3.5 (± 1.8)	0.041	n = 1	3/2.7 (± 1.2)	---
Chesttube (n/min ± SD)	4/11.3 (± 6.2)	21/11.6 (± 7.3)	0.935	3/10.0 (± 7.0)	16/13.4 (± 7.7)	0.482	3/3.7 (± 1.2)	12/10.7 (± 6.3)	0.003
Arterial line (n/min ± SD)	60/4.6 (± 3.1)	64/6.0 (± 3.9)	0.048	38/5.1 (± 4.0)	49/4.8 (± 3.0)	0.876	25/3.1 (± 2.1)	27/5.3 (± 5.2)	0.059
Central venous line (n/min ± SD)	13/7.4 (± 3.6)	35/10.7 (± 5.6)	0.056	13/7.5 (± 5.8)	33/11.0 (± 7.4)	0.135	12/5.3 (± 3.2)	26/9.0 (± 5.7)	0.045

Table 4: Outcome indicators.

	SHORT-group n=98	LONG-group n=100	p	SHORT-group n=58	LONG-group n=58	p	SHORT-group n=34	LONG-group n=34	p
Length of stay in hospital (n/days ± SD)	98/19.9 (± 13.2)	100/20.0 (± 11.3)	0.41	58/23.0 (± 14.7)	58/28.8 (± 17.1)	0.054	34/13.2 (± 18.5)	34/18.6 (± 20.6)	0.069
Length of stay on ICU (n/days ± SD)	98/6.7 (± 7.0)	100/8.2 (± 7.9)	0.067	58/13.3 (± 12.4)	58/18.6 (± 12.6)	0.025	33/9.6 (± 15.6)	34/16.3 (± 18.8)	0.028
Length of intubation (n/days ± SD)	98/3.6 (± 6.2)	100/4.1 (± 5.5)	0.125	58/8.4 (± 8.9)	58/12.8 (± 11.4)	0.01	34/7.3 (± 13.3)	34/11.8 (± 10.8)	0.012
Multi-organ failure (MOF) (n/%)	14/14.3	19/19.0	0.373	22/37.9	25/43.1	0.623	16/47.1	24/70.6	0.143
Organ failure lungs (n/%)	10/10.2	13/13.0	0.505	15/25.9	18/31.0	0.576	10/29.4	14/41.2	0.531
Hemodialysis (n/%)	1/1.0	0	0.495	2/3.4	4/6.9	0.679	2/5.9	3/8.8	1
Glasgow Outcome Scale ≥ 4 (n/%)	88/89.8	96/96.0	0.049	35/60.3	36/62.1	0.849	5/14.7	7/20.6	0.525
Mortality (n/%)	1/1.0	0	0.495	6/10.3	5/8.6	0.751	22/64.7	18/52.9	0.324
Time from admission to exitus (n/days ± SD)	n=1	0	---	6/5.5 (± 8.2)	5/8.2 (± 7.1)	0.578	22/1.9 (± 3.0)	18/3.9 (± 4.5)	0.054
Standardized Mortality Ratio (SMR)	0.46	0		0.47	0.42		0.8	0.7	
95 % CI	-0.44 – 1.37	---		0.11 – 0.83	0.07 – 0.77		0.60 – 1.00	0.48 – 0.93	

to perform this intervention tended to be longer in the LONG-sub-groups.

MSCT was performed in at least 96% of RISC-groups 1 and 2. Interestingly cases from RISC-group 3 (SHORT-sub-group) have significantly lower rates of MSCT (p=0.005), which goes along with higher rates of trauma room breaks and emergency surgeries.

As a key result of the present study, we detected no significant difference regarding the primary outcome of hospital fatality rate between trauma room time SHORT- and LONG sub-groups (p ≥ 0.324). Regarding secondary outcome indicators, the LONG-sub-groups were characterized by a longer hospital stay, with longer ICU stay and longer intubation time. Moreover, Multi-Organ Failure (MOF) rates were higher in these sub-groups. The rate of cases with no or slight outcome disability (Glasgow Outcome Scale, GOS > 4) was equal within the SHORT and LONG-sub-groups. Table 4 shows the SMR of the trauma room time sub-groups. To conclude, the study data showed no association of trauma room time and various outcome indicators, such as fatality rates, SMR, and GOS.

Discussion

Time management is an essential component of trauma management. Ruchholtz et al. as well as Bernhard et al. demonstrated that the quality of trauma care is improved by implementation of a structured trauma room algorithm [29,30]. The "Whitebook Medical Care of the Severely Injured" of the German Trauma Society demands such algorithms for all German Trauma Centers based on the body of evidence indicating the positive effect on trauma outcomes [7].

To the best knowledge of the authors, this is the first study that demonstrates that there is no association of length of trauma room care and hospital fatality rates in the given setting. The study hospital is a certified Level I trauma center in the German trauma network. It operates based on a structured and priority-based trauma room algorithm appropriate to the ATLS® principles and compliant with the recommendations published in the S3-guidelines of the German Trauma Society.

During the 64-months study period, a mean of 183 trauma room patients were admitted to the trauma room every year. The SMR of the study sample (SMR=0.63; 95%-CI: 0.47-0.79) is significantly lower than the mean SMR (0.85; KI: 0.81–0.89) of the trauma centers in the trauma registry of the German Trauma Society in 2012 [14].

Clarke et al. report a 1% increase of fatality rate in emergency laparotomy cases due to intra abdominal bleeding with each three minutes delay to surgery [18]. This underlines the significance of early decision making and surgery. On the other hand, whole-body CT was reported an effective diagnostic measure to reduce fatality rate, even in haemodynamically unstable patients [34,35]. For this reason, the simple and vague definition of optimized time management as "most rapid diagnostic and therapy within seconds or at least few minutes" has to be re-evaluated. In fact, every patient requires individual interventions and an individual time management, which represents key result of this study. This underlines and even expands the famous statement of D. Trunkey with regard to pre-hospital trauma care: "[…] get the right patient to the right hospital at the right time" [36].

This investigation found the shortest trauma room time in the group with the highest RISC-prognosis for fatal outcome (RG 3), which is due to emergency surgical procedures and trauma room care breaks. All sub-groups with trauma room times equal or longer than the median time (LONG-sub-groups) revealed significantly higher rates of a second trauma room phase. This represents an expected result, and the analysis of associated outcome parameters reveals the significance of this finding.

First of all, the total pre-hospital rescue time is slightly longer in all LONG-sub-groups compared to the SHORT-sub-groups. Moreover, there is a higher rate of serious chest injuries (AIS Thorax > 3), and a larger number of diagnoses. Furthermore, more invasive interventions are performed in cases from all LONG-sub-groups, and these interventions took longer to be performed as in the SHORT-sub-groups. In addition, more ICU days, higher rates of MOF, and a higher number of diagnoses in these cases pinpoint a critical fact: despite similar injury severity scores and RISC-prognosis, diagnostics and initial care in cases with longer trauma room times are more challenging compared to the SHORT-sub-group. Therefore, trauma room time is the reflexion of the complexity of trauma management, rather than an indicator for time lost. This is supported by the fact that not only the number of interventions, but also the time for these interventions is higher in the LONG-sub-groups. Again, trauma room time at level I trauma centers appears to reflect the complexity of individual procedures that in the end add up to a longer total trauma room time.

To conclude, the authors are convinced that the injury severity and prognostic scores used in this study allow for an objective and valid categorization of the study sample, while the broad spectrum of outcome indicators (e.g. length of stay, organ failure) were affected by secondary factors that were supposedly not documented in this study. The authors therefore believe that trauma room time is a primary indicator for the complexity of trauma management and not a function of (isolated) fatality risk or (isolated) injury severity scores. Institution of life-saving procedures must not be refrained from in order to produce shorter trauma room times.

Limitations

The study hospital routinely collects a broad spectrum of trauma room and associated data prospectively. Nevertheless, the data-analysis of the present study was performed in a retrospective manner in a single center. This causes well-known limitations: The sub-groups are comparably small and the results may not be representative, or rather they are not transferable for all trauma centers.

Conclusion

Identifying life-threatening conditions ("deadly dozen") and instituting appropriate measures are the primary tasks of the trauma room team [37]. This includes coordination of the complex chain of care and its individual diagnostic and therapeutic components. Assuming that high-class trauma care is provided, referred to the actual guidelines and care algorithms, this study contradicts the assumption that trauma room time is a marker for quality in trauma care. For this purpose, there is no association between time in trauma room and viability. Therefore, patient survival or other relevant outcome benefits in consequence of limited diagnostics or therapeutic procedures to reduce trauma room time is not supported by this study.

To proof the findings of the current study, further research should be carried out as multicenter-trials. Other levels of trauma care should be addressed to find potential criteria that may indicate resource demands in trauma care and outcome of patients with similar injury severity and fatality risk.

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