

Treatment management and outcome of polytraumatized patients in a German certified trauma center – comparing standard versus maximum care

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German hospitals are classified as basic, standard and maximum care facilities within the German trauma networks. The Municipal Hospital Dessau was upgraded in 2015 as a maximum care provider. The aim of this study is to investigate whether a change in treatment management and outcome of polytraumatized patients has occurred afterwards. The study compared polytraumatized patients, treated in the Dessau Municipal Clinic as a standard care facility (DessauStandard) from 2012-2014 vs. those treated in the Dessau Municipal Clinic as a maximum care facility (DessauMax) from 2016-2017. Data of the German Trauma Register were analysed using the chi-square test, t-test and odds ratios with 95% confidence intervals. In DessauMax (238 patients; Ø 54 years, SD 22.3; ♂ 160, ♀ 78), the shock room time with 40.7 min (SD 21.4) was shorter than in DessauStandard (206 patients; Ø 56.1 years, SD 22.1; ♂ 133, ♀ 73) with 49 min (SD 25.1) ($p=0.001$). The transfer rate of 1.3% ($n=3$) to another hospital was lower in DessauMax ($p=0.01$). DessauStandard had 9 (4%) thromboembolic events and DessauMax 3 (1.3%) ($p=0.7$). Multiorgan failure was more common in DessauStandard, (16%) than in DessauMax (1.3%; $p=0.001$). DessauStandard showed a mortality of 13.1% ($n=27$), and DessauMax 9.2% ($n=22$) ($p=0.22$; OR=0.67, 95% CI, 0.37-1.23). The GOS in DessauMax (4.5, SD 1.2) was higher than in DessauStandard (4.1, SD 1.3) ($p=0.002$). The Dessau Municipal Clinic as a maximum care facility has achieved improved shock room time, fewer complications, lower mortality and an improved outcome.

Keywords : German Trauma society, trauma network, maximum care provider, and polytraumatized patients.

INTRODUCTION

The distribution and quality of trauma centers, which are used for the preclinical and clinical care of polytrauma patients, vary across the German federal states¹. The strong regional differences in survival probabilities led to the launch of the trauma network of the German Trauma Society (DGU[®]) in 2004. As basic objectives, the same chances of survival and the best possible quality of life under standardized quality standards should be guaranteed around the clock for every serious injury at any location in Germany². Moreover, the continuous common objective of the trauma network system remains to improve the quality of care. The DGU's White Book contains recommendations on the structure, organization, equipment, and the promotion of quality and safety in care for seriously injured patients in Germany. Similar

to the American trauma system, a ranking of trauma facilities was introduced, and all participating hospitals were classified as basic ("Lokales Traumazentrum", comparable to US level III), standard ("Regionales Traumazentrum", comparable to US level II), or maximum ("Überregionales Traumazentrum", comparable to US level I) care facilities³. The necessary disciplines and staffing of the shock room of the respective care level can be seen in Table I. Ultimately, a maximum care facility must be able to receive and care two seriously injured persons at the same time, in accordance with the requirements of the DGU. However, the primary goal in the care of polytrauma patients in the shock room remains to diagnose the injuries as quickly as possible and to initiate therapeutic measures if necessary. Management or time errors in the shock room can be accounted for 64% of treatment deficiencies in polytraumatized patients⁴.

Table I. — Necessary medical disciplines and shock room requirements of basic, standard, and maximum care facilities.

	basic care	standard care	maximum care
required medical disciplines	Orthopaedics/Trauma Surgery Special Trauma Surgery General Surgery Abdominal Surgery Anaesthesiology Radiology	plus Vascular Surgery Neurosurgery	plus ENT Thoracic Surgery Ophthalmology Urology Maxillofacial Surgery Cardiac Surgery optional Paediatrics/Paediatric Surgery Plastic/Hand Surgery Gynaecology
shock room staffing 24-hour duty	1 Specialist for Orthopedics and Trauma Surgery or Abdominal Surgery/General surgery** 1 Specialist for Anaesthesia 1 Nurse 1 Anaesthesia nurse 1 Medical-technical radiology assistant	plus 1 Assistant physician for Orthopedics and Trauma Surgery or Abdominal Surgery/General Surgery** 1 Nurse	
shock room extended team (to be present within 30 min)	1 Senior physician Orthopaedics/Trauma Surgery 1 Senior physician Abdominal Surgery/General Surgery 1 Senior physician Anaesthesiology 1 Senior physician Radiology	plus Senior physician Special Trauma Surgery 1 Specialist for Neurosurgery 1 Specialist for Vascular Surgery 2 Theatre nurses	plus Senior physician Neurosurgery Additional call-services for the treatment of severely injured patients
spatial demands	shockroom $\geq 25 \text{ m}^2$ with X-ray, ultrasound and CT within close proximity operating room for emergency treatment of hollow organs intensive care beds	plus shockroom $\geq 25 \text{ m}^2$ with the possibility to treat child emergencies operating room for emergency treatment of 1 severely injured patient intensive care beds for treatment of at least 1 severely injured patient	plus shockroom $\geq 50 \text{ m}^2$ or $2 \geq 25 \text{ m}^2$ with the possibility to treat child emergencies and interventional angiography operating room for simultaneous emergency treatment of 2 severely injured patients intensive care beds for treatment of at least 2 severely injured patients
** with completed ATLS- or European Trauma Course			

To ensure high quality, the treatment procedures are always optimized, and regular shock room exercises for the staff as part of the recertification process are necessary and carry out in the clinic. Thereby, the fluent processes and time of the diagnostic steps in the shock room play an essential role. But it is not clear whether a clinic has changes in treatment management

and outcome of polytraumatized patients after being upgraded to a maximum care center with the fulfilment of the prescribed criteria. A change in the ranking should not cause a breakdown in the quality of treatment and jeopardize the DGU's main goal of a nationwide high quality of care. As an important part of the Saxony-Anhalt South trauma network, the

Dessau Municipal Clinic was successfully certified as a maximum care provider in November 2015. Previously, it acted as a standard care facility since January 2012. The aim of this study is to investigate whether a change of the treatment management and the outcome of polytraumatized patients occurs after upgrading the Dessau Municipal Clinic from a standard to a maximum care facility.

MATERIALS AND METHODS

The retrospective single-center study compared two cohorts of polytraumatized patients, those treated in the Dessau Municipal Clinic as a standard care facility (DessauStandard) from January 2012 to December 2014 vs. those treated in the Dessau Municipal Clinic as a maximum care facility (DessauMax) from January 2016 to December 2017. For this purpose, the survey form of the German Trauma Register served as the basis for the data collection. The Trauma Register includes all patients admitted via the shock room with subsequent intensive care or IMC monitoring and all patients who reach the clinic with signs of life and die before admission to the intensive care unit. In the clinic, patient data were entered online after approval in the five-page questionnaire of the register. In addition to the patient's master data, various clinical, laboratory chemical and radiological parameters from the preclinical care phase to discharge were recorded. The following parameters were selected and analysed for the investigation:

1. patient metadata (gender, age)
2. accident mechanism, injury pattern, severity after the ISS (injury severity score)
3. treatment: surgical interventions in the shock room, duration of the shock room phase, total length of stay, transfer rate to another hospital (at any time of hospitalization)
4. outcome: rate of thromboembolic events, occurrence of multiorgan failure, mortality with time of death, and the condition of the patients at the time of discharge using the GOS (Glasgow Outcome Scale)

Patients who did not reach the shock room alive were excluded.

The statistical analysis was performed with SPSS version 22 (IBM Corp., Armonk, NY, USA) and included the chi-square test for categorical variables, the independent samples t-test for comparing the mean values, and odds ratios with 95% confidence intervals to assess mortality.

RESULTS

In DessauStandard, 206 patients (age \bar{O} 56.1 years, SD 22.1; ♂ 133, ♀ 73) with a mean ISS of 18.4 (SD 11.5) were treated from January 2012 until December 2014. In DessauMax, 238 patients (age \bar{O} 54 years, SD 22.3; ♂ 160, ♀ 78) with a mean ISS of 15.3 (SD 11.6) were treated from January 2016 until December 2017. In both care levels, the age structure was quite similar. Accident mechanisms, injury patterns, surgical interventions in the shock room, and outcome of the patients are seen in Table II. In DessauStandard, the average care in the shock room lasted 49 minutes (SD 25.1). In comparison, in DessauMax, the shock room time was 40.7 minutes (SD 21.4) and significantly shorter ($p=0.001$). In DessauStandard, the total length of care of the polytraumatized patients was on average 15 days (SD 12.1). In comparison, the average total length of hospitalization in DessauMax showed no significant difference, with 13.6 days (SD 14.1) ($p=0.28$). The transfer rate of 1.3% ($n=3$) to another hospital was significantly lower in DessauMax ($p=0.01$). In DessauStandard, 6% of patients ($n=12$) were transferred to another clinic for further treatment, whereby all 3 patients of DessauMax were transferred to hospitals close to home without any medical need. A thromboembolic event occurred in 4% ($n=9$) of DessauStandard cases and 1.3% ($n=3$) of DessauMax cases without a statistically relevant difference ($p=0.7$). However, multiorgan failure was more common in DessauStandard, with 16% ($n=33$), than in DessauMax, with 1.3% of cases ($n=3$) ($p=0.001$). DessauStandard showed a mortality of 13.1% ($n=27$), with the mortality of DessauMax being 9.2% ($n=22$) ($p=0.22$) (Figure 1). In DessauStandard, 89% ($n=24$) of the deceased patients were seriously injured and had an ISS of ≥ 16 , in DessauMax it was 95% ($n=21$) of the deceased. Statistical analysis revealed a lower risk for mortality in DessauMax, with an odds ratio of 0.67 (OR=0.67, 95% CI, 0.37-1.23). In DessauStandard, 7 patients (3.4%) died after <24 h in the hospital, 4 (1.9%) after >24 h, 4 (1.9%) after >48 h, 6 (2.9%) after > 1 week, and also 6 (2.9%) after > 2 weeks. In DessauMax, 7 (2.9%) died after <24 h in the hospital, 4 (1.7%) after >24 h, 5 (2.1%) after >48 h, 1 (0.4%) after > 1 week, and 5 (2.1%) after > 2 weeks. Regarding the condition of the patients at the time of discharge, it was found that most patients were discharged "good and recovered" at both care levels (Figure 2). However, the mean value of GOS in DessauMax was 4.5 (SD 1.2), which was significantly higher than the mean GOS in DessauStandard (4.1, SD 1.3) ($p=0.002$).

Table II. — Accident mechanisms, injury patterns, surgical interventions in the shock room, and outcome of the patients in DessauStandard and DessauMax.

	Dessau Standard	Dessau Max
Patients	206	238
female	73	78
male	133	166
Age Ø	56.1 years (SD 22.1)	54 years (SD 22.3)
Accident mechanism		
Traffic: car/truck occupant	51 (24.8%)	60 (25.2%)
Traffic: motorcyclist	13 (6.3%)	15 (6.3%)
Traffic: cyclist	25 (12.1%)	19 (8%)
Traffic: Pedestrian	6 (2.9%)	3 (1.3%)
Traffic: other (ship, train)	0	1 (0.4%)
Fall - > 3m height	49 (23.8%)	36 (15.1%)
Fall - < 3m height	49 (23.8%)	83 (34.9%)
Other: Stab, Blow	7 (3.4%)	17 (7.1%)
Miscellaneous	6 (2.9%)	4 (1.7%)
Severity after the ISS Ø	18.4 (SD 11.5)	15.3 (SD 11.6)
Injury pattern (multiple answers possible)		
Traumatic brain injury	142 (69%)	155 (65%)
Thoracic injuries	99 (48%)	102 (43%)
Abdominal injuries	31 (15%)	36 (15%)
Pelvic and extremity injuries	39 (19%)	38 (16%)
Shock room - Surgical interventions		
Application of a thoracic suction drainage	52 (25%)	58 (24%)
Stopping of massive bleeding	18 (8.7%)	21 (8.8%)
Relief of a pericardial tamponade	0	0
Emergency thoracotomy	0	2 (0.84%)
Emergency laparotomy	0	3 (1.3%)
Application of an external pelvic fixator	1 (0.04%)	2 (0.84%)
Duration of the shock room phase Ø	49 min, SD 25.1	40.7 min, SD 21.4
Outcome		
Thromboembolic event	9 (4%)	3 (1.3%)
Multiorgan failure	33 (16%)	3 (1.3%)
Mortality	27 (13.1%)	22 (9.2%)
GOS (Glasgow outcome Scale) Ø	4.1 (SD 1.3)	4.5 (SD 1.2)

DISCUSSION

The aim of this investigation was to determine whether upgrading from standard care to a maximum care facility leads to changes in treatment management and outcome of polytraumatized patients. The certification process for a maximum care facility is work intensive and fee based. It includes a regular audit that examines the personnel, equipment, and structural resources of the clinic. The study included 206 patients in the standard care center and 238 patients treated in the maximum care center of the Dessau Municipal Hospital. Within 2 years, more polytraumatized people were treated in DessauMax than in 3 years in DessauStandard. This can be explained by an increase in treatment capacity in DessauMax. Moreover, the rate of secondary transfer after initial treatment

to the surrounding clinics decreased from 6% in DessauStandard to 1.3% in DessauMax. By increasing the treatment capacity after upgrading, a higher number of patients could be transferred directly to the shock room of the Municipal Hospital Dessau, especially in the case of traffic accidents, which are often accompanied by several serious injuries. Biewener et al. demonstrated in their study that the time factor and primary transport to a suitable clinic play a decisive role in polytrauma care and lead to a reduction in the lethality of polytraumatized patients⁵. But it is not uncommon for complications after polytrauma to occur, not only directly due to the trauma itself but also by indirect causes such as tissue ischaemia, SIRS or organ failure. Tilney et al. first described multiorgan failure in 1973⁶. This is one of the most common causes of death in severe polytrauma⁷. While multiorgan

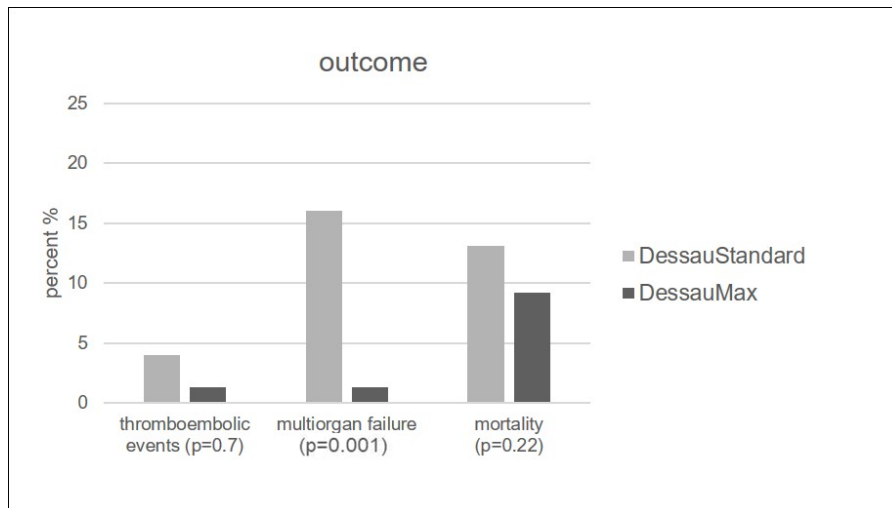


Fig. 1 — Rate of thromboembolic events, multiorgan failure and mortality in DessauStandard and DessauMax.

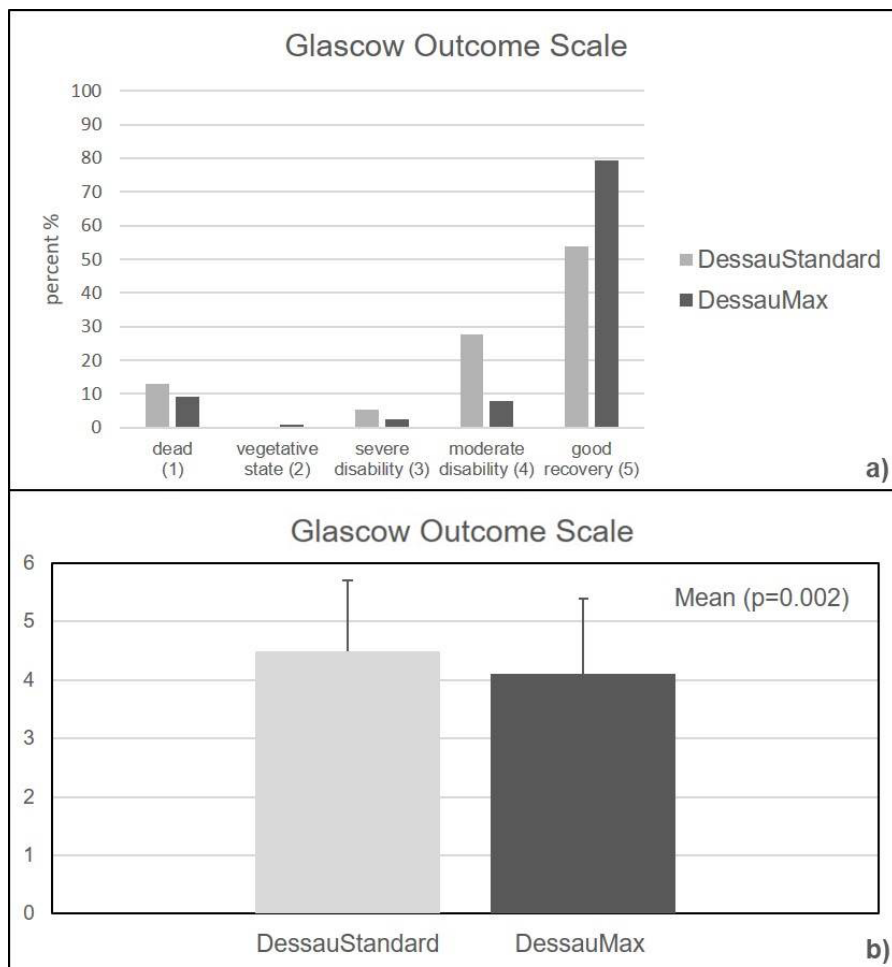


Fig. 2 — Glasgow Outcome Scale as a degree of recovery at time of discharge in DessauStandard and DessauMax: a) dismissal status in percent, b) mean value comparison.

failure occurred in 16% of cases in DessauStandard, the rate of multiorgan failure in DessauMax was 1.3%. The literature shows a relatively wide range of variations in the occurrence of multiorgan failure in polytrauma patients. Zörb described multiorgan failure in 5.5% of patients, and Grotz et al. described a rate of 26.1%^{8,9}. Thereby, in patients with multiple injuries the principles of fracture management play an important role. Thus, it could be shown that the method of “Early Total Care” in unstable polytraumatized patients may significantly increase the severity of the systemic inflammatory response and may lead to development of acute respiratory distress syndrome and multiorgan failure¹⁰⁻¹². The alternative with a significant reduction in the incidence of general systemic complications is the concept of the “Damage Control Surgery”¹³. This widely accepted procedure was rigorously pursued in DessauStandard as well as in DessauMax without any distinction. Consequently, the principles of fracture care are out of question for explaining the different occurrence of multiorgan failure in this work. Since, multiorgan failure is a predominant cause of death following the acute phase of polytrauma (> 1 week)¹⁴, the focus must rather be on the treatment following the shock room phase in the intensive care unit. Changes in treatment methods during the post-acute period have not been studied in more detail in this study. With recognition of this limitation, further analyses of the inpatient treatment phase are planned to clarify the cause of the significant difference in the occurrence of multiorgan failure of both care levels. Regarding mortality of polytraumatized patients, there is also high degree of variation in the literature. In 2019, Schill described a mortality below 10%, Bardenheuer in 2000 of 18.6% and Zörb 2005 a high mortality of 22.9%^{8,15,16}. While mortality at DessauStandard was 13.1%, it fell to 9.2% after being upgraded to a maximum care facility. The better average ISS score in DessauMax could evidently be discussed as a main cause. However, further analysis showed that almost all deceased were seriously injured and had an ISS of ≥ 16 and the proportion of these in DessauMax (95%) was even greater than in DessauStandard (89%). A correlation between better ISS score and low mortality in DessauMax can therefore not be seen. Luippold demonstrated a similar lethality rate in her study at the University Hospital of Tübingen in 2015¹⁷. Biewener et al. showed in their investigation about the quality of multiple trauma care with regard to the care level of the target hospital that mortality with the same degree of injury was 41% in a hospital with basic and standard care but 16% with maximum care⁵. However, a steady

decline in the mortality of polytraumatized patients can be observed in recent years and decades¹⁸⁻²⁰. The analysis of trauma mortality and its temporal distribution is important for further development and progress in the care of severely injured patients. In both care levels of the Dessau Municipal Clinic, the temporal distribution did not show the trimodal distribution published by Trunkey and Blaisdell in 1988²¹. Although preclinical accidental deaths could not be considered in this work, as they are not recorded in the German Trauma Register, the typical third peak of this distribution, a high mortality after several days or weeks after trauma, cannot be detected. Several studies with the analysis of trauma mortality in the recent past were also unable to demonstrate trimodal distribution, but rather a bi- or unimodally sloping pattern²²⁻²⁶. The reason for the change in the temporal mortality distribution is the continuous improvement of intensive care therapy as well as advances in the preclinical and clinical acute care of severely injured patients^{19,20}. Another noticeable difference between the two care levels was the duration of the shock room phase. The evaluation showed a significant improvement in DessauMax with an average duration of 40.7 minutes (SD 21.4), while the average time in DessauStandard was 49 minutes (SD 25.1). The primary goal in the care of polytrauma patients in the shock room is to diagnose the injuries as quickly as possible and to initiate therapeutic measures if necessary. In example, in a multicenter retrospective analysis, Huber-Wagner et al. proved that a whole-body CT scan, carried out as early as possible (ideally in the shock room), is associated with a significant increase in the probability of survival of polytraumatized patients²⁷. Since the beginning of the certification process for DessauStandard, clinical diagnostics in the shock room have therefore been constantly improved. This includes the establishment of FAST (focused assessment with sonography for trauma), CT examination in the shock room, consistent implementation of volume therapy, use of modern ventilation strategies and, most recently, the implementation of standardized therapy algorithms, such as ATLS (Advanced Trauma Life Support) in particular. But not only the refinement of the clinical diagnostics and implementation of ATLS, which were realised in both care levels, can be seen as the cause of the improvement in DessauMax. In the opinion of the authors, especially the increasing number of polytraumatized patients in DessauMax and the necessary regular shock room exercises for the staff as part of the recertification process have led to a routine that indeed allows targeted and rapid action in the

shock room and finally a medical management with fewer complications. In summary, the shorter duration of the shock room phase in DessauMax as result of the certification process and as a sign of faster diagnosis, have had a positive effect on the decrease in multiorgan failure and mortality.

At the time of discharge the GOS covered in the DGU questionnaire was used to assess the condition of the patients. The fact that most patients in both centers have been discharged “well recovered” underlines the good medical treatment before and after the upgrade of the center within the trauma network. However, the mean value comparison of the GOS provides a significantly better result for DessauMax for the outcome of polytraumatized patients.

CONCLUSION

A maximum care facility must be able to receive and care two seriously injured persons at the same time, in accordance with the requirements of the DGU. The promotion of the Dessau Municipal Clinic to a maximum care provider has achieved improved treatment time in the shock room, fewer complications, lower mortality, and an improved outcome despite a clear increased number of polytraumatized patients to be cared for. In the authors opinion, not only the implementation of modern standardized therapy algorithms leads to an improvement of trauma care. But the high number of cases and increasing treatment routine as well as the necessary regular shock room exercises for the staff as part of the recertification process are indeed important factors for an improved treatment management and finally lead to a good outcome of polytraumatized patients in maximum care facility.

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