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Effect of the localisation of the CT scanner during trauma resuscitation on survival—A retrospective, multicentre study

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ABSTRACT

Introduction: Whole-body computed tomography (WBCT) is increasingly becoming the standard diagnostic technique during the resuscitation of severely injured patients. However, little is known about the ideal localisation of the CT scanner within the emergency setting. We intended to analyse the potential effect of the localisation of the CT scanner on outcome.

Patients and methods: In a retrospective multicentre cohort study involving 8004 adult blunt major trauma patients out of 312 hospitals, we analysed the effect of the distance of the trauma room to the CT scanner on the outcome. Three groups were built: 1. CT in the trauma room 2. CT equal or less than 50 m away and 3. CT more than 50 m away. Using data derived from the 2007–2011 version of TraumaRegister DGU® and the structure data bank of the TraumaNetzwerk DGU® (trauma network, TNW; German Trauma Society, DGU) we determined the observed and predicted mortality and calculated the standardised mortality ratio (SMR) as well as logistic regressions.

Results: $n = 8004$ patients fulfilled the inclusion criteria: their mean age was 46.4 ± 21.0 years. 72.8% of them were male and the mean injury severity score (ISS) was 28.6 ± 11.8. The overall mortality rate was 16.0%. The mean time from hospital admission to whole-body CT was 17.1 ± 12.3 min for group 1, 22.7 ± 15.5 min for group 2 and 27.7 ± 17.1 min for group 3, $p < 0.001$. Risk adjusted SMR was 0.74 (CI 95% 0.67–0.81) in group 1, 0.81 (CI 95% 0.76–0.87) in group 2, and 0.88 (CI 95% 0.79–0.98) in group 3. SMR group 1 vs. SMR group 2: $p = 0.130$. SMR group 2 vs. SMR group 3: $p = 0.170$. SMR group 1 vs. SMR group 3: $p = 0.016$. SMR groups 1 + 2 vs. SMR group 3: $p = 0.046$. Comparable data were found for the subgroup analysis of Level-I trauma centres only.

Logistic regression confirmed the positive effect of a close localisation of the CT to the trauma room. The odds ratio (OR) was lowest for the localisation of the CT in the trauma room (OR 0.68, CI 95% 0.54–0.86, $p < 0.001$).

Conclusions: It was proven for the first time that a close distance of the CT scanner to the trauma room has a significant positive effect on the probability of survival of severely injured patients. The closer the CT is located to the trauma room, the better the probability of survival. Distances of more than 50 m had a significant negative effect on the outcome. If new emergency departments are planned or rebuilt, the CT scanner should be placed less than 50 m away from or preferably in the trauma room.

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Introduction

Trauma is one of today's most relevant health issues. In 2010, a total of 180,811 deaths were classified as injury-related in the US [1]. Accidents (unintentional injuries) were the 5th leading cause of death in the US [1]. Besides preclinical therapy and transportation, operative and intensive care unit treatment, early in-hospital trauma management is of paramount importance for the survival of major trauma patients [2]. Therefore, an early, comprehensive and rational diagnostic workup is necessary. Whole-body computed tomography (WBCT) can be part of such a workup. Its feasibility, speed and accuracy have been proven in several studies during the last decade [3–21].

It could also be demonstrated that integration of WBCT into early trauma care significantly increased the survival rate of severely injured patients [22–33]. Recently, it could be shown that even haemodynamically unstable trauma patients benefit from this kind of diagnostic technique [28]. However, some professionals warn about CT as a "tunnel-to-death" [34], in contrast others talk about the "circle of life".

Little is known about the effect of the ideal localisation of the CT scanner within the emergency setting [6,35–37]. Is it better to put the CT scanner in, close to or far away from the trauma room?

Best evidence so far comes from the REACT 1 trial [38]. This randomised trial compared the effect of locating a CT scanner in the trauma room versus the radiology department in two Dutch trauma hospitals ($n = 1124$). Saltzherr and colleagues found that the time from arrival to the first CT imaging was 13 min shorter in the group in which the scanner was located in the trauma room. Patient transfers and transports were also reduced by more than half in this group. Differences in mortality and out-of-hospital days favoured the group in which the CT was located in the trauma room, but were not statistically significant due to the small sample size in the subgroups. Mean injury severity score (ISS) was 6.5 for the total trial population. The mean ISS of the subgroup of the 265 multiply injured patients was 23.9 [38].

The disadvantages for patients that are scanned far away from the trauma room are that it could be difficult to escalate care in many CT rooms where access to the patient is poor, lighting is bad, resuscitation equipment is less available, and it requires transporting patients to other parts of the hospital. Clearly, these risks depend on local protocols and practice patterns. The advantages of performing WBCT close to or in the trauma room are earlier diagnosis and an earlier initiation of targeted, priority-oriented treatment.

To the best of our knowledge, however, there is so far no evidence whether the localisation of the CT scanner has any significant negative or positive effect on the outcome of severely injured patients. Therefore, we hypothesised that a close localisation of the CT scanner has a positive effect on the survival of major trauma patients.

Methods

Data collection

We acquired our data from the TraumaRegister DGU® which was started in 1993 (DGU: German Trauma Society). It comprises data of major trauma patients of trauma centres mainly from German-speaking countries (Germany, Austria, Switzerland, but also the Netherlands, Belgium, and Slovenia)[1]. It is a prospective, multicentric, standardised and anonymised database. The inclusion criterion is admission to hospital via emergency room with subsequent ICU/ICM care or reach the hospital with vital signs and die before admission to ICU. Data are continuously entered into a web-based data server that is hosted by AUC – Academy for Trauma Surgery, a company affiliated to the German Trauma Society. Irreversible data anonymity is guaranteed both for the individual patients and the participating hospitals. The registry comprises epidemiologic, physiologic, laboratory, diagnostic, operative, interventional and intensive care medical data as well as scoring and outcome data [39].

Additionally, we acquired our data from the Structure Data Bank of the TraumaNetzwerk DGU® (trauma network, TNW). This data bank comprises structural data of every hospital participating in the German system of trauma network hospitals. Aim of the TraumaNetzwerk DGU® is the improvement of the quality of trauma care of severely injured patients. The participating hospitals have to fulfil high quality standards including consistent structural, organisational and staff requirements. Based on a transparent external audit, hospitals are classified into level 1 (supraregional), level 2 (regional) and level 3 (local) trauma centres. During the external certification process, many structural data of the hospitals are recorded and transferred to the structure data bank of the TraumaNetzwerk DGU®. This data bank is hosted by the working group "Arbeitskreis Umsetzung Weissbuch/TraumaNetzwerk DGU®" (AKUT) and is located in Marburg.

Besides many other data, this data bank contains the information of the distance from the CT to the trauma room (in metres). This information is measured and collected by external personnel during the certification process of the referring hospital (Certification company DIOcert GmbH, Hindenburgplatz 1, 55118 Mainz, Germany). Every hospital participating in the TraumaNetzwerk DGU® is committed to take part and record data for the TraumaRegister DGU®. Data from the TraumaRegister DGU® and the structure data bank of the TraumaNetzwerk DGU® can be safely aggregated via a unique, anonymised hospital identification code (ID).

In 2011, 457 hospitals in 26 networks have already been successfully certified. As the trauma network initiative started in 2007, we analysed the years 2007–2011.

Inclusion criteria were blunt trauma patients, ISS $\geq$ 16, available information about the Revised Injury Severity Classification (RISC) score and WBCT during trauma room treatment. Only those patients were included who were admitted directly from the incident scene and not transferred from other hospitals. As the TraumaNetzwerk DGU® exists only in Germany, the trauma registry data of non-German hospitals have been excluded.

We analysed the TraumaRegister DGU® patient data $\pm$1 year around the audit date from the certification process. This was done to minimise potential changes of the CT distance to the trauma room due to potential building measures within the hospitals.

This study has received the full approval of the ethics committee of the medical faculty of Technical University Munich (TUM), Germany (Project number 5813/13). There was no funding for this study.

Furthermore the present study is in line with the publication guidelines of the TraumaRegister DGU® and registered as TR-DGU project ID 2012-065.

Three groups were built:

1. The CT scanner is located *in* the trauma room (*in* TR).
2. The CT scanner is $\leq$50 metres (m) away from the trauma room (*close* to TR).
3. The CT scanner is >50 m away from the trauma room (*far away* from TR).

WBCT is defined as unenhanced CT of the head followed by contrast-enhanced CT of the chest, abdomen, and pelvis, including

[1] Participating hospitals (in alphabetic order) accessible at: www.traumaregister.de.