Total-body CT scanning in trauma patients: Benefits and boundaries
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A CASE-MATCHED SERIES OF IMMEDIATE TOTAL-BODY CT SCANNING VERSUS THE STANDARD RADIOLOGICAL WORK-UP IN TRAUMA PATIENTS

JC Sierink, TP Saltzherr, LFM Beenen, MJAM Russchen, JSK Luitse, MGW Dijkgraaf, JC Goslings

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ABSTRACT

Objective In recent years Computed Tomography (CT) has become faster and more available in the acute trauma care setting. The aim of the present study was to compare injured patients who underwent immediate total-body CT scanning with patients who underwent the standard radiological work-up with respect to 30-day mortality.

Methods Between January 2009 and April 2011, 152 consecutive patients underwent immediate total-body CT scanning as part of a prospective pilot study. These patients were case-matched by age, gender and Injury Severity Score category with control patients from a historical cohort (July 2006 – November 2007) who underwent X-rays and FAST followed by selective CT scanning.

Results Despite comparable demographics, TBCT patients had a lower median Glasgow Coma Score than controls (10 vs. 15, P<0.001) and on-scene endotracheal intubation was performed more often (33% vs. 19%, P=0.004). Thirty day mortality was 13% in the TBCT patient group vs. 13% in the control group (P=1.000). A generalized linear mixed model analysis showed that a higher in-hospital Glasgow Coma Score (Odds Ratio (OR) 0.8, 95% confidence interval (CI) 0.745-0.86; P<0.001) and immediate total body CT scanning (OR 0.46, 95%CI 0.236-0.895; P=0.022) were associated with decreased 30-day mortality, while a higher Injury Severity Score (OR 1.054, 95%CI 1.028-1.08; P<0.001) was associated with increased 30-day mortality.

Conclusion Trauma patients who underwent immediate total body CT scanning had similar absolute 30-day mortality rates compared to patients who underwent conventional imaging and selective CT scanning. However, immediate TBCT scanning was associated with a decreased 30-day mortality after correction for the impact of differences in raw ISS and in-hospital GCS.
INTRODUCTION

Traumatic injuries are an important cause of death among people 15-60 years of age, and the effects on the lives of those who survive may be devastating. Safe, accurate and rapid diagnostic procedures make sure that treatment can be planned and carried out as soon as possible. If we can speed up the diagnostic work-up in injured patients, this may help to prevent deaths.

In recent years Computed Tomography (CT) has become faster, more detailed and more available in the acute trauma care setting. Hence, the standard radiological work-up (X-rays and Focused Assessment with Sonography for Trauma (FAST) followed by selective CT scanning) may no longer be the optimal choice of primary diagnostics. One area in particular that has gained interest in trauma care is an immediate total-body CT scan without previous conventional imaging.

Previous cohort studies have shown that immediate total-body CT scanning provides faster diagnosis in injured patients than the standard radiological workup. In the largest retrospective study performed on this topic, patients who underwent immediate total-body CT-scanning were found to have an increased probability of survival compared to patients who underwent the standard radiological work-up. This survival benefit is, however, not confirmed in absolute mortality numbers in other studies. Wurmb and colleagues depicted their triage scheme but all other studies collected data of patients with an Injury Severity Score (ISS) of at least 16 who underwent a total-body CT scan. For daily practice it is of major importance to know what the selection criteria were for a patient to undergo a total-body CT and to make sure that those patients are comparable to patients who underwent the standard work-up.

The aim of the present study was to compare severely injured patients who underwent immediate total-body CT scanning according to predefined criteria with matched controls who underwent the standard radiological work-up with respect to thirty-day mortality.

PATIENTS AND METHODS

Immediate Total-Body CT scanning: TBCT patients

Between January 2009 and April 2011 patients in whom severe injury was suspected, based on predefined vital signs and clinically suspicious diagnoses, underwent immediate total-body CT scanning as a pilot study for the REACT-2 trial. In- and exclusion criteria for this pilot study are given in Table 1.
This study was approved by the Institutional Review Board with a waiver of informed consent for including 50 patients. After the inclusion of 50 patients, total-body CT scanning in patients fulfilling the inclusion criteria became routine in our level-1 trauma center. All consecutive injured patients who received total-body CT scanning in this period according to the criteria defined in Table 1 were therefore included in this study and will be described as ‘TBCT patients’.

During the primary survey the vital functions were checked and, when necessary, corrected. The necessary corrections and interventions during the primary survey consisted of intubation or performing a cricothyrotomy, chest tube drainage or pericardiocentesis and taking hemorrhage-controlling measurements such as applying a pelvic binder or external pressure. Furthermore, at least one working infusion system should be available and blood could be drawn for analysis before making the CT scan.

Total-body CT scanning consisted of a two-step whole-body acquisition (from vertex to pubic symphysis) starting with Head and Neck Non Enhanced CT (NECT) with arms alongside the body. For the second complementary scan a split-bolus intravenous contrast protocol was used directly after repositioning the arms alongside the head. This scan covered chest, abdomen and pelvis.

**Standard radiological work-up: control patients**

Patients admitted between July 2006 and November 2007 underwent the standard radiologic work-up. During this period, the REACT-1 trial was recruiting all blunt trauma patients who were admitted to our hospital. Standard radiological work-up consisted of chest X-ray, pelvic X-ray and FAST followed by selective CT scanning based on local imaging guidelines.

Conventional digital radiographs were made by a mobile X-ray machine and archived in the Picture Archiving and Communication System PACS (Impax 4.5, AGFA Gevaert, Mortsel, Belgium). Portable ultrasound was available to perform FAST. The trauma resuscitation room was further equipped with a sliding gantry CT-scanner (since 2008 a 64-slice CT scanner, before that period a 4-slice CT scanner was used) (Sensation 64, Siemens Medical Solutions, Forchheim, Germany) with a multifunctional, radiolucent trauma resuscitation table.
### Table 1 Criteria for immediate total-body CT-scanning in TBCT patients

**Trauma patients with the presence of one of the following vital parameters:**

- respiratory rate $>$29/min or $<$10/min;
- pulse $>$120/min;
- systolic blood pressure $<$ 100 mmHg;
- estimated exterior blood loss $>$ 500 ml;
- Glasgow Coma Score $\leq$ 13;
- abnormal pupillary reaction on site.

**OR patients with one of the following clinically suspicious diagnoses:**

- fractures from at least two long bones;
- flail chest, open chest or multiple rib fractures;
- pelvic fracture;
- unstable vertebral fractures;
- spinal cord compression.

**Trauma patients not receiving total-body CT scanning:**

- known age $<$18 years;
- known pregnancy;
- referred from another hospital;
- any patient who is judged to be too unstable to undergo a CT scan and requires (cardiopulmonary) resuscitation or immediate operation.

### Data collection and processing

Data concerning patient demographics, radiologic imaging, type of treatment and clinical outcome were prospectively registered in a database by a dedicated research nurse for the control patients and by a trained medical student under supervision of a physician for the TBCT patients. Pre-hospital parameters (hypotension defined as systolic blood pressure below 90 mmHg, on-scene Glasgow Coma Score and presence of endotracheal intubation) were registered as well. On-scene pre-hospital GCS was registered by the ambulance personnel. In case of on-scene intubation, in-hospital GCS was scored as 3.

Injury severity of every trauma patient was scored by trained trauma surgeons using the Abbreviated Injury Scale (AIS) per body region. Severity scores (1 to 6) within the AIS range from minor (code 1), moderate, serious, severe, critical to unsurvivable injury (code 6). AIS body regions head, chest, abdomen and extremities were described.

General practitioners and discharge locations were contacted for information concerning follow-up and hospital- and ICU days in case the patient was discharged to another hospital. In case of a deceased patient, predominant cause of death was abstracted from patient charts, computerized hospital databases and/or from information of general practitioners.
Outcome measure
Thirty-day mortality.

Matching
Each TBCT patient was matched 1:1 to a control patient with SPSS-syntax (from David Marso; SPSSX-L archives http://listserv.uga.edu/cgi-bin/wa?A2=ind1103&L=spssx-l&D=0&P=64620; March 30th, 2011), adapted for the following matching variables. Patients were matched by age within 5 years, gender and Injury Severity Score (ISS) category (according to the American College of Surgeons’ categories of ISS: 1-9, 10-15, 16-24, >24). Matching by ISS category rather than matching by raw ISS allowed for small measurement bias to occur that resulted from the different CT scanning protocols applied, with immediate total body CT scanning tending towards slightly higher ISS values.17

With this method, 139 patients of 156 could be matched. Four of the 17 non-matched patients had an ISS of 75. Three died shortly after admission and one unexpectedly survived a C3-fracture with a traumatic disc hernia. Hand-matching these patients with control patients who were non-comparable in age and sex would potentially have caused selection bias. These patients were therefore excluded.

Thirteen of the non-matched patients were hand-matched by age and ISS. Age was comparable in these patients with a mean difference of 7.6 years and a maximum difference of 23 years (between females of 84 and 61 years of age). ISS was similar in these patients with a maximum difference of 2 points except in 1 patient in which the difference was 12 points (ISS of 50 and 38 in males of 93 and 80 years of age respectively). In total 152 TBCT patients were matched with 152 control patients.

The study flowchart is depicted in Figure 1.
Figure 1 Study flow chart

Immediate total-body CT scanning
Jan 2009 – April 2011
n=156

Standard work-up
July 2006 – Nov 2007
n=1376

1:1 case-matching
on age, sex and ISS

Successful matching in
139 out of 156

4 pilot patients with an ISS of 75 were excluded

13 patients were hand-matched

Immediate total-body CT scanning
Jan 2009 – April 2011
n=152

Standard work-up
July 2006 – Nov 2007
n=152

Standard work-up: chest and pelvic X-ray, FAST, and selective CT. Abbreviations: CT, Computed Tomography; ISS, Injury Severity Score.

Statistical analysis

Data are presented as median and interquartile ranges for not normally distributed data and as mean ± standard deviation for normally distributed data. Considering the matching of TBCT with control patients, testing was done with the McNemar test for dichotomous variables, the McNemar-Bowker test or extended McNemar test for categorical variables and with the Wilcoxon signed ranks test for continuously but not normally distributed variables.

The Revised Trauma Score (RTS) was calculated following the formula described by Champion et al.18,19 The Trauma and Injury Severity Score (TRISS) method was used to calculate the probability of survival.20

Generalized linear mixed modelling was done to identify the independent predictive value of type of CT scanning for 30-day mortality, accounting for (1) TBCT patients being matched
with control patients, (2) potential confounders, and (3) multicollinearity in the predictor set. A backward stepwise approach was applied excluding predictors with the highest non-significant P-value one-by-one. A P-value below 0.05 was considered to indicate statistical significance. Statistical analyses were performed using SPSS (version 20.0.0.1; IBM Coorperation) and PEPI (version 1.11; Abramson/Gahlinger, Salt Lake City, USA, 2000-2004).

RESULTS

Patient characteristics are summarized in Table 2. TBCT patients were comparable to controls with respect to mechanism of injury and laboratory results. Pre- and inhospital median Glasgow Coma Scores (GCS) were lower, while on-scene endotracheal intubation too was performed more often in TBCT patients than in controls.

Table 2 Characteristics of injured patients in the matched cohorts.

<table>
<thead>
<tr>
<th></th>
<th>TBCT* n=152</th>
<th>Control† n=152</th>
<th>Missing‡</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age in years §</td>
<td>43.91 (19.67)</td>
<td>43.63 (18.61)</td>
<td>0</td>
<td>0.324</td>
</tr>
<tr>
<td>Men</td>
<td>107 (70.4%)</td>
<td>109 (71.7%)</td>
<td>0</td>
<td>0.687</td>
</tr>
<tr>
<td>Blunt trauma</td>
<td>147 (96.7%)</td>
<td>144 (94.7%)</td>
<td>0</td>
<td>0.581</td>
</tr>
<tr>
<td>Prehospital</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>hypotension(SBP&lt;90 mmHg)</td>
<td>4 (7.8%)</td>
<td>1 (2.0%)</td>
<td>101</td>
<td>0.375</td>
</tr>
<tr>
<td>intubation</td>
<td>48 (32.9%)</td>
<td>28 (19.2%)</td>
<td>6</td>
<td>0.004</td>
</tr>
<tr>
<td>GCS</td>
<td>12 (4-15)</td>
<td>15 (9-15)</td>
<td>17</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Trauma room</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>hypotension(SBP&lt;90 mmHg)</td>
<td>5 (3.4%)</td>
<td>7 (4.7%)</td>
<td>3</td>
<td>0.774</td>
</tr>
<tr>
<td>GCS</td>
<td>10 (3-15)</td>
<td>15 (7.3-15)</td>
<td>26</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Laboratory results on admission</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hemoglobin in g/dl §</td>
<td>12.50 (2.00)</td>
<td>12.52 (1.91)</td>
<td>3</td>
<td>0.911</td>
</tr>
<tr>
<td>Ph</td>
<td>7.36 (7.31-7.39)</td>
<td>7.37 (7.31-7.42)</td>
<td>6</td>
<td>0.471</td>
</tr>
<tr>
<td>base excess in mmol/L§</td>
<td>-2.81 (4.34)</td>
<td>-3.33 (4.97)</td>
<td>6</td>
<td>0.326</td>
</tr>
<tr>
<td>ISS (points)</td>
<td>18 (9-29)</td>
<td>18 (8-29)</td>
<td>0</td>
<td>0.528</td>
</tr>
<tr>
<td>ISS in matching categories</td>
<td>0</td>
<td>0</td>
<td>1.000</td>
<td></td>
</tr>
</tbody>
</table>

Data are number (%) or median (interquartile range (IQR)) unless otherwise indicated. Abbreviations: CT, Computed Tomography; SBP, systolic blood pressure; GCS, Glasgow Coma Score; AIS, Abbreviated Injury Score; ISS, Injury Severity Score.

*Immediate total-body CT from head to pelvis. †Chest and pelvic X-ray, FAST and selective CT
‡Missing pairs, if no data were available for at least one patient in the matched pair.
§Mean (SD). ||Matching parameters.
Of the 152 patients in the control group, 132 patients (87%) underwent selective CT scanning of one or more body regions after conventional imaging. Twenty-two control patients (14%) underwent TBCT scanning after imaging with X-rays and FAST. Cranial CT scans were obtained in 73 patients (48%), cervical spine CT scans in 92 patients (61%), thoracic CT scans in 13 patients (9%), abdominal CT scans in 18 patients (12%), pelvic CT scans in 3 patients (2%) and thoracic or lumbar spine CT scans in 29 patients (19%).

Figure 2 shows the prevalence of severe injuries (AIS ≥3) per body region in both study groups. The TBCT patients had serious head injuries more often than the control patients did (63% vs. 37%, P<0.001). The prevalence of severe injuries to the chest, abdomen and extremities was comparable between TBCT and control patients.

Figure 2 Presence of severe injuries (AIS≥3) in the matched cohorts

* Immediate total-body CT from head to pelvis. † Chest and pelvic X-ray, FAST and selective CT.

**Main results**

Outcome parameters are listed in Table 3. The crude thirty-day mortality rates were 13% for both TBCT and control patients (P=1.000). Cause of death differed significantly between TBCT patients and controls (P=0.002). Five control patients who died from hemorrhage were hemodynamically unstable on admission and died at the operating room due to uncontrolled traumatic bleeding; 2 patients had no cardiac output on admission. The last patient was a drowning victim who underwent cardiopulmonary resuscitation on-scene. He was admitted to the hospital with a marked decrease in hemoglobin level with a radiologically occult bleeding
site other than subcutaneously. Other causes of death in TBCT patients were hypoxia after drowning (n=1), hypoxia after a suicide attempt by hanging (n=1), septic shock (n=1) and unexpected asystole most likely due to fat embolism (n=1). In control patients, other causes of death were out-of-hospital cardiac arrest after drowning (n=1), traumatic spinal cord lesion with complete paraplegia (n=1), fall from height while recovering from a cerebral contusion (n=1), respiratory insufficiency in combination with marginal neurologic function (n=1) and traumatic hemorrhagic complications due to anticoagulant treatment (n=1).

Type of treatment did not differ between TBCT and control patients (P=0.422). Median hospital stay was 9 days in TBCT as well as control patients (9 (IQR=3-25) vs. 9 (IQR=1-23), P=0.358).

Table 3 Outcome parameters of injured patients in the matched cohorts.

<table>
<thead>
<tr>
<th></th>
<th>TBCT* n=152</th>
<th>Controls† n=152</th>
<th>Missing‡</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>no intervention</td>
<td>71 (47.3%)</td>
<td>75 (50.0%)</td>
<td>2</td>
<td>0.422</td>
</tr>
<tr>
<td>operative</td>
<td>74 (49.3%)</td>
<td>67 (44.7%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>interventional radiology</td>
<td>5 (3.3%)</td>
<td>8 (5.3%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospital stay (days)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>overall</td>
<td>9 (3-25)</td>
<td>8.5 (1-22.8)</td>
<td>0</td>
<td>0.358</td>
</tr>
<tr>
<td>ICU stay</td>
<td>2 (0-6)</td>
<td>1 (0-5)</td>
<td>0</td>
<td>0.022</td>
</tr>
<tr>
<td>ventilation time</td>
<td>1 (0-3)</td>
<td>0 (0-1.3)</td>
<td>10</td>
<td>0.134</td>
</tr>
<tr>
<td>Discharge location</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>home</td>
<td>76 (50.0%)</td>
<td>88 (57.9%)</td>
<td>0</td>
<td>0.605</td>
</tr>
<tr>
<td>other hospital</td>
<td>22 (14.5%)</td>
<td>18 (11.8%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>rehabilitation center</td>
<td>14 (9.2%)</td>
<td>17 (11.2%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>nursing home</td>
<td>11 (7.2%)</td>
<td>9 (5.9%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>other</td>
<td>29 (19.1%)</td>
<td>20 (13.2%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mortality</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24h</td>
<td>11 (7.25)</td>
<td>10 (6.6%)</td>
<td>0</td>
<td>1.000</td>
</tr>
<tr>
<td>30-day</td>
<td>20 (13.2%)</td>
<td>20 (13.2%)</td>
<td></td>
<td>1.000</td>
</tr>
<tr>
<td>Predominant cause of death</td>
<td></td>
<td></td>
<td></td>
<td>0.002</td>
</tr>
<tr>
<td>no death</td>
<td>128 (84.2%)</td>
<td>129 (84.9%)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>TBI</td>
<td>17 (11.2%)</td>
<td>8 (5.3%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>haemorrhage</td>
<td>0 (0%)</td>
<td>8 (5.3%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>other</td>
<td>7 (4.6%)</td>
<td>7 (4.6%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Data are number (%) or median (interquartile range (IQR)) unless otherwise indicated. Abbreviations: CT, Computed Tomography; SBP, systolic blood pressure; GCS, Glasgow Coma Score.
*Immediate total-body CT from head to pelvis.
†Chest and pelvic X-ray, FAST and selective CT.
‡Missing pairs, if no data were available for at least one patient in the matched pair.
A generalized linear mixed model analysis was applied to assess the predictive value of type of CT scanning for 30-day mortality. Pre-hospital intubation, pre-hospital and in-hospital GCS, and raw ISS were identified as potential confounders (see Table 2). With pre-hospital and in-hospital GCS being highly correlated (Spearman’s rho: 0.87), only in-hospital GCS was included in the multivariable model. Further, pre-hospital intubation was associated with higher ISS values and was dropped during the backward stepwise approach. Table 4 shows the final model, indicating that immediate total body CT scanning was associated with a lower 30-day mortality (OR 0.46, 95%CI 0.236-0.895; P=0.022) after correction for the impact of differences in raw ISS (OR 1.054, 95%CI 1.028-1.08) P<0.001) and in-hospital GCS (OR 0.8, 95%CI 0.745-0.86; P<0.001).

**Table 4 Independent predictors of 30-day mortality (N=278) with GLMM**

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Odds ratio</th>
<th>95% CI</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total-body CT scanning</td>
<td>0.46</td>
<td>0.236-0.895</td>
<td>0.022</td>
</tr>
<tr>
<td>Trauma room GCS</td>
<td>0.80</td>
<td>0.745-0.860</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>ISS</td>
<td>1.054</td>
<td>1.028-1.080</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Abbreviations: GLMM, generalized linear mixed model; CI, Confidence Interval; CT, Computed Tomography; GCS, Glasgow Coma Score; ISS, Injury Severity Score.

**DISCUSSION**

This case-matched series shows that patients who underwent immediate total-body CT scanning had similar absolute 30-day mortality rates as patients who underwent conventional imaging and selective CT scanning. Patients were comparable in important prognostic factors for mortality such as age and ISS category. To correct for any non-comparable pre-hospital characteristics, a generalized linear mixed model was used, and this analysis showed that immediate TBCT was associated with decreased 30-day mortality.

The advantages of TBCT scanning in the clinical setting seem clear: TBCT scanning saves time. A rapid overview of all threatened body regions can be obtained in 15 minutes, which leads to rapid decision making in treatment. As a result of goal-directed and earlier start of treatment, mortality could be reduced. Previous studies were too focussed on TBCT scanning and mortality in injured patients, but whether this scan was ‘immediate’, as was the case in the present study, that fact was not described routinely. Differences in overall, 24h of 30-day mortality in favor of immediate TBCT have been described previously, but there is no reproducible level 1 scientific evidence.

All these studies compared two different cohorts of patients, and did not match the patients on age, gender and ISS. Furthermore, patients in the standard radiological work-up group
in these studies were not described in detail. The present study showed however, that these patients underwent total-body CT scanning after conventional imaging in 14% of the cases. In these patients, only time is a factor of importance when comparing them to patients in the immediate TBCT group. All available evidence suggests that total-body CT scanning in injured patients leads to fast and accurate diagnosis and treatment. Previous studies showed that diagnostic work-up time was significantly longer in patients who underwent the standard radiological work-up. However, the clinical relevance of speeding up the diagnostic process cannot be described based on these retrospective series.

RTS and TRISS could be calculated in 39 TBCT patients (26%) and 35 control patients (23%). RTS differed significantly between TBCT and control patients (7.55 vs. 7.84, P=0.008) as well as TRISS (0.98 vs. 0.99, P=0.017). However, patients in whom TRISS could not be calculated were more severely injured than patients in whom TRISS could be calculated. This was reflected by a higher on-scene endotracheal intubation rate (30% vs. 16%, P=0.025), a lower median GCS pre-hospital (13 vs. 15, P=0.036) and a higher median ISS (20 vs. 16, P=0.009). Age, sex, mechanism of injury, pre- and in hospital hypotension rates and in-hospital GCS were comparable between patients in whom TRISS could not be calculated and patients in whom TRISS could be calculated.

The major limitation of our study is that patients were compared retrospectively. Although matching parameters were carefully chosen and ISS is strongly related to mortality, there were differences in pre-hospital parameters and the incidence of serious head injuries between the groups. Preferably, we would have selected control patients based on the same inclusion criteria as TBCT patients. However, these data could not be retrieved retrospectively in a reliable manner. We therefore used matching to select a cohort of control patients that is more comparable to the patients selected in the TBCT group than would have been the case when using all control patients admitted between 2006 and 2007. This would have yielded more control patients who were not comparable to TBCT patients, for example with a lower ISS and a lower prevalence of mortality. Although it would have made the logistic regression analysis easier, there would have been more ‘noise’ that had to be explained by the prediction model. Furthermore, fewer variables could have been used in the prediction model since the prevalence of mortality will be lower when using all control patients. By matching, the number of confounding variables in our prediction model was reduced. This was done in other studies as well, although in those studies retrospective selection of patients was used to create groups with an ISS of 16 and higher or patients who were admitted to the ICU. In several studies on this topic similar differences in characteristics between study groups were found and statistical methods were used to correct for these differences. Obviously, matching possibly only partially compensates for the difference in selection methods of TBCT patients and the subsequent regression analysis has been restricted to a limited number of predictors. Consequently, residual confounding may remain like in most observational studies.
Another limitation of the present study is that the ISS in the TBCT patients might be influenced by the more extensive classification that is made possible by the total-body CT scan. This phenomenon has been described in patients with occult pulmonary contusions, in whom the median ISS was increased without significant consequences for complication rate and mortality. Because the majority of control patients had a considerable number of CT scans after conventional imaging as well, we think that this effect is marginal.

To investigate the causal relationship between initial imaging and mortality in injured patients, a multicenter randomized clinical study is underway. This randomized trial does not only focus on clinical outcome, but will analyse radiation dose and cost-effectiveness as well. An analysis of all these factors together is required to provide a complete overview of the advantages and disadvantages of using immediate total-body CT in the initial evaluation of injured patients.

CONCLUSION

In conclusion, this case-matched series showed that patients who underwent immediate total body CT scanning had comparable absolute mortality rates when compared with trauma patients who underwent conventional imaging and selective CT scanning. After correction for confounders, a decrease in 30-day mortality in TBCT patients was apparent.
REFERENCES


