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Comparison of Different Thoracic Trauma Scoring Systems in Regards to Prediction of Post-Traumatic Complications and Outcome in Blunt Chest Trauma

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Background. **As accurate assessment of thoracic injury severity in the early phase after trauma is difficult, we compared different thoracic trauma scores regarding their predictive ability for the development of post-traumatic complications and mortality.**

Materials and Methods. **Two hundred seventy-eight multiple trauma patients (ISS ≥ 16) age > 16 y with severe blunt chest trauma (AIS_{chest} ≥ 3) admitted between 2000 and 2009 to Level I Trauma center were included. Exclusion criteria were severe traumatic brain injury (AIS_{head} ≥ 3) and penetrating thoracic trauma. The association between AIS_{chest}, Pulmonary Contusion score (PCS), Wagner-score and Thoracic Trauma Severity score (TTS), and duration of ventilation, length of ICU stay, development of post-traumatic complications, and mortality was investigated. Statistical analysis was performed with χ^2-test, ANOVA, logistic regression, and receiver operating characteristic (ROC) curve.**

Results. **Patients' mean age was 42.7 ± 17.0 y, the mean injury severity score was 28.7 ± 9.3 points. Overall, 60 patients (21.6%) developed ARDS, 143 patients (51.4%) SIRS, 110 patients (39.6%) sepsis, and 36 patients (13.0%) MODS. Twenty-two patients (7.9%) died. Among the examined thoracic trauma scores only the TTS was an independent predictor of mortality. With the TTS showing the best prediction power, the TTS, PCS, and Wagner-score were independent predictors of ventilation time, length of ICU stay, and the development of post-traumatic ARDS and MODS.**

Conclusions. **Thoracic trauma scores combining anatomical and physiologic parameters like the TTS seem to be most suitable for severity assessment and prediction of outcome in multiple trauma patients with concomitant blunt chest trauma.**

Key Words: **multiple trauma; thoracic trauma; scoring systems; post-traumatic complications; association.**

INTRODUCTION

Eighty percent to 90% of patients with severe thoracic trauma have multiple additional injuries [1, 2]. The incidence of systemic inflammatory response syndrome (SIRS), infectious complications (e.g., pneumonia), adult respiratory distress syndrome (ARDS), and multiple organ dysfunction syndrome (MODS), is substantially higher in multiply injured patients with severe thoracic trauma [3–6]. Severe thoracic trauma also causes a significant increase in ventilation time and length of stay on the intensive care unit (ICU) in these patients [1]. Moreover, thoracic injuries are associated with a mortality of 30%–40% and trauma associated fatalities of 20%–25%; 50%–75% of deceased polytraumatized patients have a thoracic injury [3, 5, 7–12].

Early accurate grading of chest injury severity is decisive for the clinical course of multiple trauma patients [3, 7, 13]. The severity of chest trauma influences

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decision making in multiple trauma in terms of timing and priority of surgical interventions (early total care *versus* damage control) in order to avoid post-traumatic complications. Despite the development of different scoring systems, thoracic injury severity grading remains difficult, and current assessment standards vary widely. Global trauma scorings systems, such as the Revised Trauma score (RTS) [14], the Injury Severity score (ISS) [15], and the Trauma and Injury Severity score (TRISS) [16] include thoracic injuries as part of the overall injury severity. Chest-specific scoring systems based on isolated anatomical findings differentiate bony and parenchymal pulmonary lesions. As part of the ISS [15], the most common and clinically used chest-specific scoring system is the Abbreviated Injury scale (AIS_{chest}) giving a more trauma-related anatomical assessment of the thoracic trauma. The Pulmonary Contusion score (PCS) [17] and the CT-dependent Wagner-score [18] quantify the extent of pulmonary contusions. The Thoracic Trauma Severity score (TTS) [19] combines anatomical and physiological parameters.

The precision of the different scoring systems for predicting post-traumatic complications and outcome has not been elucidated fully. The aim of the present study was to evaluate the predictive value of four different trauma scoring systems in multiply traumatized patients with blunt chest trauma.

MATERIALS AND METHODS

Ethical Approval and Informed Consent

The present retrospective study has been approved by the local ethical committee. The need to obtain informed consent was waived by the local ethical committee.

Inclusion and Exclusion Criteria

Polytraumatized patients (ISS $\geq$ 16) age $>$ 16 y treated at our Level 1 trauma center with a severe thoracic trauma ($AIS_{chest} \geq 3$) between January 2000 and December 2009 were included in the present study. Further inclusion criteria were performance of computed tomography and plain chest radiography at admission, plain chest radiography 24 h after admission, documentation of all required parameters for calculation of the trauma scores (TTS, MODS, ARDS), primary admission to our hospital within 6 h after injury, and survival of more than 48 h after admission. Exclusion criteria were severe traumatic brain injury ($AIS_{head} \geq 3$) due to its marked impact on post-traumatic complications and outcome, penetrating trauma, steroidal and non-steroidal anti-inflammatory medication, hormone therapy, vascular obstruction (cardiac coronary disease, renal dysfunction, diabetes), malignancy or chronic diseases of the liver, kidneys, or lung (Table 1).

Radiographic Examination

In general, all multiply injured patients admitted to our trauma center received a standardized examination including plain radiography (chest, pelvis, cervical spine), abdominal ultrasound (focused assessment with sonography for trauma, FAST), and computerized tomography of head, spine, chest, abdomen and pelvis. As part of the routine, plain radiography of the chest was taken after admission on ICU, 24 h after admission in the emergency department, and at least once daily during the time of mechanical ventilation.

Classification of Thoracic Plain Radiology and Computer Tomography

The retrospective examination of all chest images (plain radiography, computer tomography) and the classification according to the different scoring systems was performed by a consultant of the Institute of Diagnostic Radiology, Hannover Medical School (JW). The radiologist was blinded to the clinical course.

Clinical Parameters and Outcome Evaluation

Clinical data including demographics, mechanism of injury, duration of intensive care, and mechanical ventilation as well as mortality were recorded. Laboratory, hemodynamic and respiratory parameters as well as the transfusion of blood products (packed red blood cells [PRBC], plasma [FFP], and platelets [PLT]) were documented. The results of clinical examination and blood chemistry were recorded up to 14 d after admission.

Definitions

MODS was defined according to Marshall *et al.* [20]. According to the literature, manifest MODS was considered at a Marshall score $>$ 8 points on at least 1 d during the observation period [20, 21]. Diagnosis of SIRS was related to the criteria of the Consensus Conference of the American College of Chest Physicians and Society of Critical Care Medicine [ACCP/SCCM] on at least two consecutive days [22]. The diagnosis of ARDS was made according to the criteria of the American-European Consensus Conference on ARDS [23].

Scoring Systems

The Abbreviated Injury Scale (AIS) is a prognostic scoring system allocating a severity score to every injury of the different body regions (head, face, neck, chest, abdomen, spine, upper extremity, lower extremity). The score value ranges from 0 to 6 and high severity scores are associated with a lower probability of survival.

In 1999, Tyburski *et al.* developed the Pulmonary Contusion Score (PCS) based on plain radiograph of the chest at the time of admission and 24 h after trauma [17]. After classification of the lung in an upper, middle, and lower third, the pulmonary contusion in every third is assessed by a value of 1 to 3 and added afterwards. A score value of 1–2 is classified as mild, a value of 3–9 as moderate and a value of 10–18 as severe pulmonary contusion.

Wagner and Jamieson developed a thoracic trauma score based on CT-scan [18]. Depending on the extension of pulmonary lesions the severity of thoracic trauma is divided into different sections. Pulmonary lesions $<$ 19% of total air space are classified as grade 1, 19%–27% as grade 2, and $\geq$28% as grade 3.

The Thoracic Trauma Severity Score (TTS) is based on five anatomical and physiologic parameters: PO_2/FiO_2, rib fractures, pulmonary contusion, pleural lesion, and age [19]. Each parameter is assigned to a value of 0–5 and subsequently added. The TTS score ranges from 0 to 25. With increasing score values, a more severe thoracic trauma could be assumed, but the authors of the TTS have not recommended a specific cutoff.

Statistical Analysis

Receiver operating characteristic (ROC) curves were constructed to display sensitivity and specificity of the different scores for mortality,