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Klinik Çalışma

# Determination of predictors and risk factors in patients with multiple emergency surgical traumas

## Acil cerrahi gerektiren çoklu travmalı hastalarda prediktörlerin ve risk faktörlerinin belirlenmesi

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***BACKGROUND***

In the rescue and management of patients with multiple traumas, identifying and eliminating risk factors can guarantee a promising outcome.

***METHODS***

This was a prospective randomized cohort study in trauma patients in the Department of Surgery, Jundishapour University of Medical Sciences, covering 17 months. Based on the cause of mortality, complications and discharge, the patients were divided into groups as non-survivor and complicated and non-complicated groups. The results were compared for the risk factor extraction.

***RESULTS***

From 125 studied patients, 27 died, 19 cases were complicated and 79 injured patients were successfully treated and discharged. Three extracted classifications as main (real), moderate and predictive risk factors were determined. Referral delay, delay in diagnosis and treatment, decreased blood pressure on arrival, multiple intra-abdominal visceral injuries, and severe acidosis were identified as the main risk factors. Age, multiple surgery and pitfalls, intensive care unit admittance, electrolyte imbalance, and mismanagement during transfer were identified as moderate risk factors. Low hemoglobin, hypoxemia, observation in multiple services, and distance of more than 100 kilometers were identified as predictive factors.

***CONCLUSION***

Elimination of the main risk factors is a substantial issue to decrease inevitable mortalities. Thus, attempt to shorten the lethal chain of the risk factors can lengthen a patient's life and improve the prognosis.

***Key Words:*** Multiple traumas; predictive factors; risk factors.

***AMAÇ***

Çoklu travmalı hastaların kurtarılması ve tedavilerinin düzenlenmesine yönelik bulgu ve risk faktörlerinin yok edilmesi umut verici sonucu garanti edebilir.

***GEREÇ VE YÖNTEM***

Bu çalışma, Jundishapour Üniversitesi Tıp Fakültesi, Cerrahi Bölümü'nde travma hastaları üzerinde 17 ay boyunca sürdürülen prospektif randomize kohort çalışmadır. Mortalite nedeni, komplikasyonlar ve taburculuk esasına göre hastalar ölenler, komplike ve komplike olmayan gruplar şeklinde ayrılmıştır. Bulgular risk faktörünün belirlenmesi için karşılaştırılmıştır.

***BULGULAR***

Çalışılan 125 hastanın 27 tanesi ölmüş, 19 olguda komplikasyon gelişmiş ve 79 travmalı hasta başarılı bir şekilde tedavi edilerek taburcu edilmiştir. Asıl (gerçek), orta derece ve prediktif risk faktörleri şeklinde çıkartılmış üç adet sınıflama bulunmuştur. Başvuru gecikmesi, tanı ve tedavi ile ilgili gecikme, ulaşma sırasında düşmüş kan basıncı, çoklu karın içi viseral travmalar ve ciddi asidoz asıl risk faktörlerini oluşturmuştur. Yaş, çoklu cerrahi ve tehlikeler, yoğun bakım ünitesine yatırılma, elektrolit dengesizliği ve transfer sırasındaki kötü yönetim orta derece risk faktörlerini oluşturmuştur. Düşük hemoglobin, hipoksemi, birden fazla sayıda servis tarafından gözlem ve 100 kilometreden daha fazla uzaklık prediktif faktörleri oluşturmuştur.

***SONUÇ***

Asıl risk faktörlerinin elimine edilmesi şeklindeki çözüm, kaçınılamaz mortaliteleri azaltmaya yönelik önemli bir konudur. Böylelikle risk faktörlerinin ölümcül zincirini kırmaya yönelik girişim hastanın yaşamını uzatabilir ve prognozu düzeltebilir.

***Anahtar Sözcükler:*** Çoklu travma; risk faktörleri; prediktif faktörler.

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Many reasons are usually identified to explain why a patient who has suffered multiple traumas may die before receiving effective treatment or even before any help. Any cause facilitating a condition towards a lethal outcome is usually recognized as a factor of danger or risk factor. The severity of injury that can be scored according to ISS (Injury Severity Score) is not only an overall foundation in these patients but it can also serve as a basic risk factor alone when the score is more than 24.[1,2] Although it has been postulated that ISS was found to be a strong predictor of morbidity, it did not influence mortality in some types of multiple traumas with flail chests.[3] Multivariable and single arguments analysis showed that systemic inflammatory response syndrome, pulmonary contusion, coexisting lung disease as chronic obstructive lung disease and pneumonia, moderate hemothorax and pneumothorax, duration of shock over 12 hours, age over 55 years, and ISS>24 were accepted as high risk factors.[2] Age is a well-known risk factor and predictor in trauma patients.[1,2,4,5] Age from 56 years and older showed a significant increase in mortality in patients who sustained multiple traumas, an increase that may be independent of the trauma severity.[6] Furthermore, it has been postulated that age, initial blood pressure, transfusion requirement as well as the severity of head, chest, spleen and liver injury as "independent parameters" are able to predict reduced survival rates.[4] According to traumatic complications, trunk and head injuries and also age were proven to be the risk factors for developing posttraumatic pneumonia.[5] However, type of trauma, injured organs, internal bleeding and hemorrhage, cerebral damage, delay in finding the victim, distance to the medical center, availability of an expert medical team, and a wide range of simple causes can be responsible as the risk factors for possible mortality. Due to 30% incidence of mortalities in the early minutes of injury accompanied by multiple interfering risky elements, identification of these dangerous factors seems to be necessary and substantial since these factors can either be incarnated as the rings of a destructive chain that lodge to prevent obtaining proper health or can be considered as the key for consequent healthy management of patients suffering from multiple traumas.

## MATERIALS AND METHODS

This is a prospective self-control cohort study including patients who were randomly placed in the research and followed as they were referred to our emergency section of the Surgical Department, Jundishapour University of Medical Sciences, due to multiple traumas during a 17-month period (September 2004 to February 2006). As the hospital is a target and referral site of trauma patients, especially vascular and neurosurgical types, in Khuzestan province, this study was considered as a pilot study in our territory. All the information was recorded on a full detailed questionnaire adjustable from the time of disaster until referral and then during treatment until the completion of therapy and discharge. Patients were categorized into three groups as G1=exitus (mortality group) and G2=complicated and G3=uncomplicated groups. All

**Table 1.** The parameters considered for determination of risk factors

| Clinical factors | Non-clinical factors |
|---|---|
| Normal vital signs (V/S) vs abnormal V/S | Car vs motorcycle accidents |
| Normal consciousness vs unconsciousness | Gunshot vs stab injuries |
| Routine laboratory tests | Site of trauma* |
| Concomitant injuries | Rural vs urban traumas |
| Quick direct vs delayed transfer to hospital | Type of transporting vehicle |
| Quick vs hesitated diagnosis and treatment | Age |
| Distance of trauma site to the medical center | Gender |
| ICU admittance | Transportation distance |
| Emergency or surgical ward admittance | |
| Observation in multiple services | |
| Acidosis | |
| Hypoxemia | |
| Hypotension | |
| Decreased hemoglobin | |
| Degree of shock | |
| Unapproved surgical technique | |
| Mismanagement during transfer | |
| Multiple surgical procedures | |
| Intraoperative bleeding | |
| Multiple blood transfusions | |
| Multiple visceral injuries | |

*Abdominal ± thoracic injuries, abdominal + cerebral trauma, abdominal + retroperitoneal trauma.

**Table 2.** The obtained risk factors and results in the three study groups

| | Risk factors | Group 1 | Group 2 | Group 3 |
|---|---|---|---|---|
| Main Risk Factors | Decreased consciousness level | 37.03% | 26.3% | 17.72% |
| | Hypotension on arrival | 70.3% | 36.8% | 17.7% |
| | Delay in transfer | 81.5% | 57.8% | 10.1% |
| | Delay in diagnosis - therapy | 63% | 21% | 2.5% |
| | Intraoperative hemorrhage | 11.11% | 0 | 0 |
| | Multiple visceral injuries | | | |
| | (± hepatic-splenic injury) | 100% | | |
| | HV+Hep* | 73.7% | | |
| | HV+Hep+Spl | 31.6% | | |
| | Spl (+/-) HV | | | |
| | Multiple blood transfusions | 100% | 94.7% | 63% |
| | Acidosis (mean pH) | 7.04 - 48% | 7.24 - 10.5% | 7.2 - 8.8% |
| Moderate Risk Factors | Age, range (mean) (years) | 13-62 (35.2) | 14 - 60 (29) | 3 - 85 (29) |
| | Unapproved surgical technique | 7.4% | 21% | 0 |
| | Electrolyte imbalance | 14.81% | 26.3% | 12.65% |
| | Multiple surgical procedures | 11.11% | 21% | 0 |
| | ICU admittance | 77.77% | 73.68% | 72.15% |
| | Mismanagement in transfer | 29.6% | 26.3% | 0 |
| Predictor Factors | Decreased hemoglobin | 11% | 16% | 3.5% |
| | Observation in multiple services | 37.1% | 52% | 0 |
| | Hypoxemia | (n:1) 3.7% | 0 | 0 |
| | Distance of trauma site >100 km | (n: 21) 77.78% | (n: 3) 15.79% | (n: 9) 11.4% |

* HV: Hollow viscus; Hep: Hepatic; Spl: Splenic; n: Number.

the data were analyzed and compared for confirmation and P values through the SPSS, version 12 and S-Plus software by T test methods. We compared them with the other compatible data in the form of a self-control study between the classified groups of exitus and complicated patients, with the uncomplicated discharged patients as the control group. The main risk factors were extracted from mortality causes, moderate risk factors from complications and predictive factors from comorbidities. All the clinical and non-clinical factors substantially considered for determination of risk factors are shown in Table 1. The ISS was calculated in all groups.

## RESULTS

During the aforementioned period, 125 patients (103M, 22F) with multiple trauma were followed and allocated as Group 1 (G1)=27 cases (25M, 2F, mean age 35.2 years) with mortality (21.6%), Group 2 (G2)=19 cases (15M, 4F, mean age 29 years) of complicated patients (15.2%) and Group 3 (G3)=79 cases (63M, 16F, mean age 29 years) of uncomplicated and discharged patients (63.2%). Mean ISS was 30.4 (+14.6/-13.4) in G1, 30 (+8/-6) in G2 and 16.2 (+9.2/-11.8) in G3 (p=0.051 compared to G1/G2, p=0.023 compared to G1/G3). All the presenting identified risk factors that related to every specified group were obtained and defined as in Table 2 (T squared 95% simultaneous confidence intervals using the Sidak method). With respect to consciousness, acceptable Glasgow Coma Scale (GCS) score was ≥10, while scores <10 indicated consciousness disorder (unconsciousness), in which substantial defect was found between GCS scores of 6 to 10. Unconsciousness was detected as 37.03% in G1 due to severe unresponsive shock followed by bleeding and sustained hypotension in patients who needed to be intubated for an extended period postoperatively (compared with G3, p=0.00). Hypotension was seen as the main sign on admission in G1 (70.3%), compared to G2 (36.8%) and G3 (17.7%), respectively. The range was 0-60 mmHg (all detected by cuff). The most common cause was also bleeding at the site of trauma, during transfer and intraoperatively. Only 3 cases (11.11%) in G1 had severe bleeding during the operation above 2500 CC requiring massive transfusion; sepsis was also present in these cases (p=0.00). Other causes for hypotension in G1 and G2 were inappropriate replacement of liquid and transfusion mostly during transfer and inefficient intravenous lines. Delay in transfer was determined in 81.5% of patients in G1, i.e. ≥5 hours for G1 and G2 but <5 hours (mean: 2 hours) for G3 and generally for urban and rural injuries (distance of more than 100 kilometers) (p=0.00). While all the transfer vehicles were ambulances via roads, delayed diagnosis and treatment as an important main risk factor was prominent in G1 (n:

17, 63%) compared with G2 (n: 4, 21%) and G3 (n: 2, 2.5%). The undiagnosed period in cases with main traumatized organs (thoracic-intra-abdominal) was responsible for complications when the victim's arrival was after >3 hours (p=0.00). Delays were mainly due to collapsed computerized tomography (CT) machine, unavailability of sufficient isogroup blood and prolonged shift changes of staff. Important multiple visceral injury as hollow viscus, hepatic or splenic injury, separately or concomitantly, was detected in 100% of G1 patients, as mostly intestinal injuries, in 73.7% (n: 14) of G2 patients with dominant hepatic injury and in 31.6% (n: 25) of G3 patients with usually sporadic splenic injury (p=0.00). Massive blood transfusion in the form of packed blood cells, whole blood, and fresh frozen plasma (FFP) were employed in all types in all G1 patients (100%), in 94.7% of G2 and in 63% of G3, in the range of 3-17 (mean in G1: 14, G2: 7.5, G3: 4) units of blood and 9-24 units of FFP (50% of transfusion in first 3 hours). Disseminated intravascular coagulation (DIC) was seen in 2 cases in G1 with >6 units rapid blood transfusion in the first 2 hours and 11-14 units transfusion in the first 12 hours. There was no platelet usage in any of the groups. Acidosis defined as pH<7.3, as a serious resistant risk factor, was seen in 48% (n: 13, mean pH: 7.04) of G1 patients, mainly in those with severe shock, more than 7 units urgent blood transfusion, internal bleeding, hepatic injuries and >3 hours delay. In G2 and G3, these values were 10.5% with mean pH: 7.24 and 8.8% with mean pH=7.2, respectively. In G2-G3, acidosis was controlled uneventfully with replacement therapy. According to complications, age, multiple surgical procedures, intensive care unit (ICU) admittance, pitfalls in surgical techniques along with electrolyte imbalance that were affected by mismanagement during transport were determined as the moderate risk factors (Table 1). Approximately 70% of all three groups were admitted in the ICU, but the duration of admittance was 24-48 h for 100% of G3, average ≥5 days for >70% of G2 and between 18 h-7 days until mortality for G1. Incorrect handling of victims during transportation was found only in G1, at 29.6% (n=8) and in G2, at 26.3% (n: 5) (p=0.031). From all signs (clinical/paraclinical) and accompanying factors participating in comorbidity, the most important list was extracted as predictive or warning factors in multiple traumas. Approach to multiple medical services for treatment was detected in 37.1% of G1 and 52% of G2, mainly to orthopedics, neurosurgery and anesthesiology. Decreased hemoglobin at the time of admittance and its continuation during treatment, distance of trauma site from the target medical center and hypoxemia were also taken into account. Regarding non-clinical-related factors, motorcycle, gunshot injuries, rural traumas, and distance were crucial risk factors for the G2-G3 series, while age, car accidents, and the site of trauma were found to be the main risk factors in G1. Amputation, intra-abdominal abscess, sepsis, incision necrosis, and tracheostomy were common complications in patients (15.78% for each) in G2.

## DISCUSSION

The literature contains little pure information about the risk factors and their virtual correlations in multiple traumas. Advanced transporting facilities and programmed handling for management of patients suffering multiple traumas are established in developed countries; yet, the discrepancy in this context observed in developing countries can be interpreted as a missed cause of a wide range of mortalities. Thus, in order to find a direction, this pilot study was performed to identify previously unknown risk factors in geographic territories. Some main risk factors playing an important direct role in morbidity and even more in mortality were determined; for instance, delay in the transfer of patients, delay in diagnosis and treatment and multiple visceral injuries resulted in multiple transfusions and severe acidosis, respectively. A comparison between the groups showed a significant difference in delay as the primary major risk factor, since many of the mortalities were referral cases from remote rural territories with severe injuries and delays of as long as eight hours by land transportation. Hypotension on arrival, another main risk factor in the series, was mostly the result of inappropriate replacement of liquids and severe bleeding at the trauma site, confirming the importance of initial blood pressure for predicting reduced survival.[4] Criddle et al.[7] showed that arterial base deficit levels make a significant unique contribution to predicting survival in patients with multiple traumas who received massive transfusion (≥50 units of blood products in the first post-injury day). In their study, there was no significant difference among survivors and non-survivors with respect to age, sex, type of trauma, or amount of any blood components. Furthermore, other authors determined that the initial acid-base variables of pH, base deficit and anion gap, especially strong ion gap, discriminate survivors from non-survivors of major vascular surgery.[8] Overall, age in the study was not found as a major factor, but was identified as a moderate risk factor. Among visceral injuries, hepatic injuries caused by car accidents were the major risk factors for cause of bleeding and transfusion leading to severe acidosis and mortality. These results are supported by some researches that reported the importance of liver injury and its association with pelvic fractures[1,4] and lumbar vertebral transverse process fractures.[9] Among the risk factors studied, motor vehicle accident is the only notable risk factor substantially associated with severe pelvic fracture.[1] It was found that overall fractures

**Table 3.** The number of injuries in groups based on injury types

| Type of injury | G1 (n:27) | G2 (n:19) | G3 (n:79) |
|---|---|---|---|
| Head injury | 2 | 0 | 0 |
| Hemo-pneumothorax | 6 | 5 | 30 |
| Pulmonary contusion | 5 | 0 | 4 |
| Rib fracture | 6 | 4 | 11 |
| Cardiac tamponade | 2 | 1 | 0 |
| Arterial injury | 5** | 4** | 9** |
| Pelvic fracture | 5 | 1 | 0 |
| Splenic rupture | 2 | 2 | 19 |
| Hepatic rupture | 8 | 6 | 12 |
| IVC rupture | 2 | 0 | 0 |
| Hollow viscus injury | 9 | 5 | 7 |
| Renal injury | 2 | 1 | 3 |
| Retroperitoneal hematoma | 3 | 2 | 1 |
| Diaphragmatic rupture | 0 | 0 | 2 |
| Upper & lower extremity trauma | 5 | 6 | 15 |

IVC: Inferior vena cava; **Total 18, of which 15 cases were popliteal artery injuries (83.33%).

and head-thoracic injuries were exclusively caused by motorcycles with high-range associated morbidity; on the other hand, abdominal visceral injuries were mostly due to car accidents without significant differences in mortality with respect to the type of injury. Splenic injury in our series with or without other visceral trauma regardless of liver injuries was almost always safe with more confined intra-abdominal bleeding and mortality. According to ICU admittance due to required mechanical ventilation support or intensive care, although trunk and head injury and age are proven risk factors for developing posttraumatic pneumonia[5] and prolonged mechanical ventilation with continuous enteric feeding and associated craniotomy have been shown to be risk factors for nosocomial pneumonia,[10] in this study, there were no signs of pneumonia or related pulmonary disorders except for simple atelectasis in a few cases. Furthermore, no specific bacterial organisms were cultured from ventilator tube samples. [11] With more than 70% ICU admission in our cases, we fortunately observed no obvious sepsis or ventilation support complication in G2 and G3 patients, and no significant differences. Similar to reported data by Davidovic et al.,[12] popliteal artery and failed revascularization were the most significant independent risk factors for limb loss with or without associated injury. Secondary operation, arterial contusion and late reconstruction surgery in patients who underwent multiple surgical procedures were also noted. Considering moderate or predictive risk factors, between the non-survivors and complicated versus uncomplicated groups, we detected significant meaningful difference, except in ICU admittance. According to the mortality and the injuries depicted in Table 3, we believe that hemo-pneumothorax, rib fractures, isolated or sporadic splenic or hepatic hematomas (ruptured type), and accompanying extremity bone fractures can not be accounted as independent risk factors, vice versa in inferior vena cava rupture and cardiac tamponade. Close correlations were also observed between clinical and non-clinical factors in age, gender, motorcycle accidents, and type of transportation with respect to mortality. Meanwhile, we can also consider the distance from the site of trauma, synonymous with delay in transportation, for its importance as one of the highest risk factors in managing trauma patients apart from unavailability of air transport.

In conclusion, in spite of the expanded range of determination of risk factors, it seems crucial to extract and categorize both the main related factors that endanger victims and the conditions responsible for managing the patients toward health and safety. Identification and recognition of these factors and efforts to eliminate or reduce them will be beneficial in reducing mortality and then morbidity.

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