

Practical real time predictors of multiple organ dysfunction syndrome following trauma

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SUMMARY

The ability to predict which trauma patients need special attention and care to prevent complications and to support organ dysfunctions permits the efficient allocation of personnel and other resources. Subtle biologic markers predictive of MODS can be detected. While these biologic phenomena occur early, analysis requires time and sophisticated techniques. Readily available clinical indices can accurately identify within 12 hours most patients at risk for MODS.

Key words: Trauma. Time predictors. Multiple organ dysfunction syndrome.

Ancient Greek medical training stressed prognosis as the most important skill for physicians to master. This may have been due in part to the limited effective therapeutic interventions known to them. Nonetheless, modern physicians and their patients remain very interested in the prognosis of a given illness. Those who administer the financing of health care are especially interested.

Multiple organ dysfunction syndrome (MODS) accounts for a major portion of the deaths in critical care units. MODS following injury produces more than half of the late mortality following trauma. survivors of MODS consume tremendous resources both in the acute ICU phase of hospitalization and in the rehabilitation and convalescent period. While most trauma patients recover from the life-threatening aspects of their injuries, patients who recover from MODS are incapacitated for months and even years. The opportunity to reduce mortality from MODS and to manage health care resources effectively especially in the intensive care setting requires the ability to accurately and promptly identify patients at risk for MODS.

Table 1
Inflammatory Predictors of MODS after Trauma

Nast-Kolb	Dunham
Neutrophil elastase	Cholesterol
Lactate	C-reactive protein
Anti-thrombin III	Transferrin

Table 2
Predictors of Multiple Organ Dysfunction Syndrome after Trauma

	Sauia	Dunham
Age	> 55 yrs	> 50 yrs
ISS	> 24	> 24
Rbc	> 6 units	> 1 liter
Base deficit	yes	yes
Lactate	yes	yes

Platelets	yes ^a	
Hypotension		yes
Chronic illness	± ^b	yes

a. 1997

b. APACHE III, 1997

The past three decades have seen the birth of many systems designed to predict which patients will develop complications. No perfect system exists but key elements for predicting MODS following trauma have emerged. This discussion will review several different approaches to predict organ failure after injury and it will focus on practical timely clinical and laboratory data which identify patients at risk for organ dysfunction.

Elements for prediction

There are several categories of data elements for predicting MODS. Injury severity is an intuitively obvious one. The more damaged the patient, the more likely to develop MODS. Systems of categorization which quantify anatomic injury include the injury severity score and the AIS. In these system injuries in each body region are scored for severity on a numerical scale. More recently the American Association for the Surgery of Trauma has sponsored the development of a comprehensive injury severity scoring system organized by body region. The ISS has recently been updated and a new injury severity system based on ICD codes has been developed. The obvious weakness in this approach is that it only addresses anatomy.

R Adams Cowley founded the Shock Trauma Center on the premise that shock which is not treated within a finite period of time ("the Golden Hour") will produce irreversible injury and death. Single laboratory measurements of physiologically significant shock predict the development of MODS with some accuracy. These data include serum lactate, base deficit and acidosis. Blood pressure and capillary refilling time, two clinical indicators of shock, are commonly used in practice although these observations are neither sensitive nor specific. Dynamic observations such as lactate clearance over a period of time have substantial strength for predicting outcome from trauma. considerable debate still persists around the significance of more elaborate observations of oxygen debt and the hyperdynamic cardiovascular recovery from shock. The SAPS score was developed to quantify the influence of physiology on the outcome of critical illness. It is a popular index of severity especially in Europe.

Two categories of characteristics of host factors influence the outcome from injury. Age, while not in itself necessarily a risk factor, can be a surrogate for chronic illness. Chronic diseases such as diabetes mellitus, emphysema, cardiac disease and cirrhosis all negatively influence the outcome from injury. The various generations of the APACHE score (I, II, III) were developed to measure acute physiology and chronic illness risk to the patient. Apache II does not do well in predicting the outcome from trauma^{10,11}. Nevertheless the APACHE system has become quite popular.

The vigor of a patient's immune system also influences the development of MODS and mortality. MODS has been characterized as the result of the immune response gone wild. Hemorrhage and trauma on the other hand are immunosuppressive. The complex interaction of elements of the immune response continue to be the subject of active investigation. Measures of the inflammatory response are accurate predictors of adverse outcome from trauma but have the disadvantage of requiring laboratory analysis. Test results are not available immediately. Risk assignment is therefore delayed until these results are known^{12,13}. Clinical decision making may require less precise but more current data.

The combination of several predictive factors has more prognostic accuracy than any individual factors. Siegel *et al.*¹⁴ identified Glasgow Coma Score and base deficit as the two factors most likely to predict death after blunt liver injury. They validated the accuracy of the two data elements on a separate population of patients

with pelvic fractures. GCS and base deficit indicate the two causes of early mortality after trauma: brain injury and hemorrhage¹⁴.

Patients who develop MODS must survive long enough in hospital to develop organ dysfunction. GCS is a good marker for brain injury but does not predict multiple organ dysfunction well. Sauia and Dunham, working independently, used multiple regression analysis to identify the major risk factors for the development of multiple organ dysfunction after injury^{15,16}.

Sauia highlighted age >55 years, ISS > 24 and transfusion of more than six units of red blood cells in twelve hours after injury as the main risk factors for MODS. Base deficit and serum lactate, two additional indices of shock, improved the accuracy of prediction.

Dunham *et al.*¹⁷ examined 3,611 patient records from the trauma registry of the R Adams Cowley Shock Trauma Center. They developed a predictive model for MODS based on one set of patients and validated on a set of separate patients. The most predictive factors for the development of MODS were pre-existing serious chronic illness, hypotension, acidosis, loss of more than one liter of blood, age > 50 years, major base deficit and ISS. The four measured of hemorrhagic shock (blood, acidosis, base deficit and hypotension) were individually significant in the analysis.

More exact predictions can be made when other data are considered. Dunham for example examined markers of the systemic response and found them to be superior indicators of adverse outcome than injury severity. The specific markers studied included cholesterol, transferrin, C-reactive protein and nitrogen balance. All these tests require laboratory analysis and are not immediately available for timely clinical decisions¹⁷.

Sauia has recently reported that multiple organ failure can be accurately predicted as early as twelve hours after injury. The relevant data for analysis were ISS, platelets and age in all their models. Transfusion, serum lactate and the need for inotropic support of the cardiovascular system emerged as important factors in different time frames. The APACHE III score added minimal improvement in prediction only in 48 hour model¹⁸.

RESUMEN

La habilidad para predecir cuáles pacientes trauma-tizados necesitan atención y manejo especial para prevenir complicaciones y para dar soporte a la disfunción de órganos, permite la destinación eficiente tanto de personal como de otros recursos. Se pueden encontrar marcadores biológicos predictores de disfunción múltiple de órganos. Sin embargo, estos fenómenos ocurren en forma temprana, y el análisis requiere tiempo y técnicas sofisticadas. Existen índices clínicos fáciles y rápidamente disponibles que pueden identificar con precisión en el término de 12 horas a la mayoría de los pacientes con riesgo de disfunción múltiple de órganos.

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