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Principles of major trauma and damage control orthopedics

Mauro Argiolas, Iacopo Ciampolini, Mario Manca

UOC Orthopedics and Traumatology, Versilia Hospital, Lido di Camaiore (LU), Italy

Summary

Polytrauma by definition represents a complex clinical scenario characterized by an evolving pattern of life-threatening injuries. In the last decades, different systems were created to classify polytrauma patients and to evaluate the probability of survival, and act as a guide to the decision-making process in the management of the individual patient. The overall management of the polytrauma patient must take many factors into account that influence the timing of surgical procedures. The management of a seriously injured patient with fractures has changed in recent decades. Any worsening of the patient's clinical condition or physiological parameters requires rapid re-evaluation and a change in therapeutic strategy. The analysis of the parameters obtained in the resuscitation stage is essential to stratify patients into the appropriate category. The evaluation and treatment of the polytrauma patient, together with the resuscitative endpoints, allows customization of the therapeutic and surgical strategy for each case.

Key words: polytrauma, damage control, early total care, early appropriate care, injuries

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Correspondence
Mauro Argiolas
UOC Orthopedics and Traumatology, Versilia Hospital, Lido di Camaiore (LU), Italy
E-mail: mauroargiolas@gmail.com

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A "multiple trauma patient" is defined as one in whom injuries affect different systems or organs, with at least two lesions of a degree greater than or equal to 3 on the Abbreviated Injury Scale" (AIS); and one or more of the following conditions:

- hypotension (systolic blood pressure < 90 mm Hg);
- loss of consciousness (GCS score 8);
- acidosis (base deficiency < 6.0, lactate level > 2.5 mmol/l);
- coagulopathy (PTT ≥ 50 seconds or INR ≥ 1.4);
- age (≥ 70 years) [1].

While individual lesions by themselves may not be life-threatening, the combination of orthopedic injuries, head injuries, and thoracic or abdominal injuries increases the risk of a fatal outcomes.

Polytrauma by definition represents a complex clinical scenario characterized by an evolving pattern of life-threatening injuries. The primary injury and the secondary injury are closely interrelated to the diagnostic-therapeutic path, the timing of treatment, the decision-making process, and the available resources.

In the last decades, different systems were created to classify polytrauma patients and to evaluate the probability of survival, and act as a guide to the decision-making process in the management of the individual patient.

The overall management of the polytrauma patient must take many factors into account, which influence the timing of surgical procedures.

In the pre-hospital emergency setting, the polytrauma patient mainly presents problems of acute bleeding, usually secondary to severe musculoskeletal injury or abdominopelvic trauma. In the first hours after admission, the main problems are represented by hypovolemic shock due to prolonged bleeding and severe brain damage. Given the variability

of different situations and injuries that need to be addressed in the polytrauma patient, the concept of Trauma Team was created.
The Trauma Team manages the critically ill patient and has the survival of the patient as its first objective. A critically ill patient with ongoing severe bleeding can rapidly deteriorate, initiating a chain of events that can lead to death. The "Lethal Triad" is defined as the onset of hypothermia, acidosis, and coagulopathy that all too often resulting in the patient's death. Therefore, the first action relates to control of hemorrhage [2].
Bleeding is indeed the most common cause of preventable death after trauma. Resuscitation protocols emphasize that early control of bleeding is essential for the survival of the patient. It is of fundamental importance for the attending physician to clinically assess the extent of the hemorrhage resulting from major trauma on the basis of the patient's physiological response, of the nature of the lesions, the dynamics of the accident, and the patient's response to initial resuscitation.
It has been estimated that over 50% of polytrauma patients require blood transfusion, and more than 15% require multiple transfusions.
A patient in hemorrhagic shock due to an unidentified bleeding site should undergo immediate evaluation of the chest, abdominal cavity and pelvic ring, which represent the main occult sites of blood loss in trauma.
The priority is therefore represented by vital organ perfusion of the traumatized patient and stabilization of the hemodynamic picture. The presence of multiple limb injuries can complicate the management of priorities [3].
The orthopedic management of long bone injuries is in turn dependent on the management of internal organ injuries. The management of bleeding, both for internal organs and for fractures of large segments is actioned immediately. Survival of the patient is dependent on the rapid application of surgical techniques that fulfill this function.
The management of the seriously injured patient with fractures has changed in recent decades. In the early 1970s long bone fractures were mainly stabilized with skeletal traction. This method was associated with numerous complications such as pneumonia, atrophy of the musculature, and thromboembolic complications due to prolonged immobilization.
In later years, the arrival of Early Total Care (ETC) was associated with fewer complications, lower mortality, and reduced length of stay in intensive care units and hospital. Early fracture fixation resulted in early mobilization, was associated with a lower risk of malnutrition and long-term drug therapy, and resulted in a reduced risk of wound infections. ETC became standard practice in polytrauma in the 1980s and early 1990s, and was further stimulated by advances in osteosynthesis techniques during these decades.
However, it was noticed that early internal fixation of fractures can be harmful for many patient groups. This method of combined surgical procedures can lead to the development of an additional life-threatening secondary inflammatory reaction known as the "Second Hit". ETC in polytrauma patients can significantly increase the severity of their systemic inflammatory response (SIRS) and can lead to the development of acute respiratory distress syndrome (ARDS) and multiorgan failure (MOF), leading to a relatively high incidence of morbidity and mortality.
It subsequently became evident that definitive stabilization of all fractures in all seriously injured patients was inadequate and the management of major fractures was modified to a method called "Damage Control Orthopedics" (DCO) [4].
While in the past one tried to identify patients who could tolerate prolonged surgical interventions, nowadays the DCO strategy is widely accepted in the treatment of seriously injured unstable patients. The principles of DCO include initial stabilization of life-threatening conditions related to the injury and provisional fixation of fractures of long bones using modular external fixators and minimally invasive techniques. Definitive internal fixation of fractures is then carried out at a later stage, between 5-10 days after the initial trauma.
Recently, the concept of "Early Appropriate Care" (EAC) was introduced to emphasize that definitive fixation of fractures can be performed after the initial resuscitation as soon as the patient is fully stabilized with restoration of normal vital parameters.
EAC includes the internal fixation of unstable fractures of the pelvis and fractures of the spine after the initial phase of stabilization of the patient.
Therefore, it is now accepted that the ETC and the DCO are complementary to each other and used for different types of patients (3).
Following completion of the initial assessment and acute interventions, patients should be stratified according to their physiological condition into one of four categories:

- stable;
- borderline;
- unstable;
- critical (end of life).

This will guide the subsequent strategy for their management. Any worsening of the patient's clinical condition or physiological parameters requires rapid re-evaluation and a change in therapeutic strategy [1].
The analysis of the parameters obtained in the resuscitation stage is essential to stratify patients into the appropriate category.
The "end points" of resuscitation include:

- restoration of normal hemodynamics;
- restoration of optimal oxygen saturation;
- lactate levels below 2 mmol/L;
- no coagulation impairment;
- normal temperature;
- urine output greater than 1 ml/kg per hour;
- no requirement for inotropes.;
- the presence of thoracic, abdominal, vertebral, and cranial injuries [3].

In conclusion, the evaluation and treatment of the polytrauma patient, together with the resuscitative endpoints, allows

customization of the therapeutic and surgical strategy for each case. Teamwork among specialists of different disciplines allows prioritization in the management of each injury. On this basis, it is possible to decide the most appropriate strategy for the patient, choosing between ETC, EAC or DCO.
The main goal is stabilization of major fractures as early as is physiologically safe; The concept of "Safe Definitive Surgery" (SDS) has been introduced, which is a dynamic synthesis of both strategies – Early Total Care (ETC) and Damage Control Orthopedics (DCO). This concept does not rule out the use of ETC or DCO, but rather puts it in perspective of the clinical situation considering the dynamics of the clinical course. Due to repeated reevaluation and assessment of the patients regarding their physiology, dynamic classification and adaptation of the treatment strategy is possible.

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