The right team at the right time: Multidisciplinary approach to multi-trauma patient with orthopedic injuries

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ABSTRACT
Integrated, multidisciplinary team approach to the multiply injured patient can help optimize care, minimize morbidity and reduce mortality. It also provides a framework for accelerated post-injury rehabilitation course. The characteristics and potential benefits of this approach, including team dynamics and interactions, are discussed in this brief review. Emphasis is placed on synergies provided by specialty teams working together in the framework of care coordination, timing of surgical and non-surgical interventions, and injury/physiologic considerations.

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INTRODUCTION
Traumatic injury is the fifth leading cause of death in the United States and the sixth leading cause of death worldwide, accounting for approximately 10% of overall global mortality.1,3 Among younger (<45 years old) individuals, trauma is the leading cause of death.1,3 Polytrauma, or the co-existence of multiple traumatic injuries in the same victim, is present in as many as 40% of trauma admissions.4,5 Polytrauma often involves young, productive individuals and represents a substantial burden to the society, from both financial and human perspectives.6 The presence of multiple simultaneous injuries can lead to significant disability with decreased probability of return to productive work and thus significant economic costs.5

Observed injury patterns in the highest acuity trauma victims frequently feature concurrent involvement of anatomically distant areas, hemodynamic dysfunction, multiple organ systems, and require the attention of both generalist traumatologist as well as various sub-speciality physicians. Orthopedic trauma features dominantly on the list of commonly seen injuries, and lends itself as a perfect example of the importance of the multidisciplinary approach that has reduced post-injury morbidity and mortality at its core.7 This manuscript reviews key aspects of the multidisciplinary approach to the multiply injured patient with orthopedic trauma.

MULTI-DISCIPLINARY TEAMS
Effective diagnostic and therapeutic approaches to the multiply injured patient require the presence of well-functioning trauma systems and integrated specialty teams.8 The optimal approach to the multiply injured patient involves the involvement of anesthesiologists, trauma-trained surgeons, intensivists, orthopedic specialists, diagnostic and interventional radiologists, urologists, neurosurgeons, rehabilitation specialists, otolaryngologists, among many others.7,9 Fine-tuned team management, leadership, and communication skills are of critical importance. Excellent communication between physicians and teams, including awareness of important clinical pitfalls and constant vigilance on the part of all participating team members (i.e., presence of multiple cross-checks), as well as the need for centralized care planning (including multi-disciplinary patient care conferences) are crucial.10

Such multidisciplinary approach begins in the prehospital setting with early responders and emergency medical service (EMS) personnel. These prehospital teams initially assess, stabilize, and transport patients to the nearest institution that is capable of managing the patient. According to trauma designation from the American College of Surgeons and the regional trauma systems, patients requiring higher levels of care are transferred to trauma centers where the multiple specialties needed to deliver optimal post-injury care are available.11 Due to the large overall number of injured patients, appropriate triage is important since more than 90% are best served in local community hospitals.11 For the remaining 10% of patients who represent the severely injured requiring level I and II trauma centers, multidisciplinary approach is essential for improving outcomes.

TRAUMA CENTERS AND SYSTEMS
In the United States, specialized trauma centers receive most of the multiply injured patients with immediately life threatening conditions. In the Major Trauma Outcome Study, nearly half of all patients had one or more musculoskeletal injuries.12 According to another study, 72% of emergency evaluations following motorcycle crashes resulted in orthopedic consultation, with significant proportion of patients suffering from open fractures requiring emergent orthopedic surgical intervention.6

In the presence of polytrauma, it is important to prioritize injuries based on their acuity (i.e., combination of physiologic and anatomic urgency). Utilizing the multidisciplinary approach necessitates the involvement of various medical and surgical
specialists, as determined by the severity and urgency of each injury, in the context of the anticipated urgency and timeline of intervention(s). Most often, such approach also relies on the presence of the central coordinating "control point" consisting of the trauma and/or the surgical intensive care team, depending on institution. Despite its seemingly chaotic nature, such an approach requires excellent coordination of care and actively engages a multitude of medical and surgical specialists including anesthesiologists, trauma surgeons, radiologists (both diagnostic and interventional), orthopedic surgeons, oral maxillofacial surgeons, vascular and neurosurgeons, among many others. This approach has certain benefits in the overall care of severely injured patients. A hypothetical example of clinical collaboration between multiple specialty teams includes a hypotensive patient with a pulseless limb after an extremity fracture. In such a case, the emergency physician and the trauma surgeon must ensure that no ongoing internal or external bleeding is occurring, and if such bleeding is taking place, he or she must be ready to perform a hemostatic procedure (i.e., suture ligation of cutaneous hemorrhage, emergency laparotomy, placement of extremity tourniquet) at any time. Concurrently, a combined orthopedic and vascular surgery team needs to reestablish distal limb perfusion and perform a repair of the fracture, with the determination of whether to utilize definitive or temporary fixation depending on the injury pattern and patient physiology. In all of the intricate planning and execution of such clinical course of action, the anesthesiologist plays a crucial role. Postoperatively, the intensivist provides intensive care unit (ICU) care to the patient who most likely will require significant resuscitative efforts. This multidisciplinary approach not only involves the surgeons, but must intimately involve professional teams at multiple levels of the healthcare infrastructure. This includes (but is not limited to) nursing staff, transportation staff, midlevel providers, blood bank, case managers, social workers, specialty therapists, pharmacists, and resident/fellow physicians. In many cases, these individuals are the first to respond to the patient’s initial presentation or first to notice a subsequent change in clinical status. The importance of the team approach is exemplified by the fact that any delay in recognition of significant clinical events, and thus prolonged time to therapeutic intervention, may worsen outcomes. The overall outcome of severely injured patients depend on successful integration of medical, psychosocial, financial, educational, and vocational resources available across an array of specialties and various medical centers, programs, and organizations. In sections that follow, we will discuss the care of the trauma patient from a number of different specialty perspectives.

**EMERGENCY PHYSICIAN PERSPECTIVE**

The trauma resuscitation area is a unique arena within an emergency department where multiple individuals from various subspecialties come together to form a team with a common goal of providing care to the injured trauma patient. The approach to the multiply injured patient with orthopedic trauma begins similarly to any other trauma patient and starts with the primary survey assessment of the airway, breathing, circulatory and neurologic status (i.e., the Advanced Trauma Life Support or ATLS protocol). This evaluation constitutes a starting point in the care of an orthopedic trauma patient. The mangled extremity can be quickly assessed and temporized. Diminished or absent pulses in an injured extremity require immediate attention as early reduction and/or repositioning and immobilization can often restore blood flow and subsequently minimize disability and potentially avoid amputation. Specific injuries such as posterior knee dislocations and unstable pelvic fractures elevate concern in the emergency physician’s mind for concomitant vascular injury and may require further testing such as angiography. Once pulses are confirmed and/or restored and the patient’s neurologic status assessed, the patient is fully exposed to evaluate for any less obvious injuries. After completing the adjuncts to the primary survey, a secondary "head-to-toe" evaluation is performed. This includes palpation of all bony surfaces and joints for tenderness or deformity while identifying bruising, lacerations or other signs of tissue injury. A liberal approach to imaging is taken for the multiply injured trauma patient, especially when the patient has altered sensorium secondary to head injury, alcohol or drugs. This liberal approach stems from the fact that extremity fractures are the most commonly missed injuries in trauma patients even in the era of "pan-imaging". After the primary resuscitation is complete, the secondary management of gross deformities includes splinting the injured limb. Open injuries should be covered with betadine-soaked gauze and splinted while waiting for radiographs and a formal orthopedic consultation. Open wounds are classified as grade 1 (<1 cm), grade 2 (1-10 cm), and grade 3 (>10 cm). This classification system has some utility in predicting which patients are more likely to go to the operating room. Tetanus status should always be addressed and updated with traumatic open wounds. In addition to tetanus, all open fractures also should receive prophylactic antibiotics such as cefazolin or clindamycin. In addition to all these diagnostic and therapeutic interventions, the emergency traumatologists are also trained in prompt recognition of other limb-threatening phenomena such as the compartment syndrome.

In summary, the approach to orthopedic injuries begins with the prehospital recognition of a fracture and/or dislocation and appropriate temporary splinting. On arrival in the trauma resuscitation area, the splints are kept in place until the secondary survey is completed and the injuries are evaluated and imaged appropriately. In addition to immobilization, reduction, tetanus administration and antibiotics (if indicated), pain control with short-acting analgesics like fentanyl can be used until definitive treatment is decided upon. Occasionally the emergency traumatologist may utilize conscious sedation in the appropriately monitored patient during interventions involving severe fractures or dislocations in need of anatomical re-alignment. More recently, comprehensive ultrasound-based trauma assessment and triage protocols that incorporate musculoskeletal elements were proposed in order to increase both the efficiency and the completeness of the initial clinical evaluation of the multiply injured patient.

**ORTHOPEDIC SURGEON PERSPECTIVE**

As mentioned previously, majority of polytrauma patients will suffer skeletal injuries. The benefit of surgical stabilization of these injuries is well defined, but the timing has been controversial and continues to evolve. Thus, care in a multi-disciplinary, team-oriented fashion is crucial for optimizing patient outcomes.
Approximately a decade ago, the concept of "damage-control orthopedics" was introduced, and has been associated with improved outcomes for the multi-trauma patient.\textsuperscript{27,28} For many years, the concept of "early total care" was employed with early, emergent stabilization of all long bone fractures.\textsuperscript{26,29} The concept of "damage-control" arose from the observation that in the subgroup of patients with multiple injuries and/or thoracic trauma, early fixation was associated with a higher rate of complications and mortality. In this group of patients at high risk of complications, the approach is for early temporary stabilization (controlling hemorrhage, managing soft tissue injury, and often external fixation of long bone fractures) followed by delayed definitive fixation after the risk of systemic complications decreases and overall physiologic picture improves.\textsuperscript{28} The goal is to avoid a "second hit" and thus worsening of the patient's overall condition. Identifying patients who may benefit the most from the switch from "early total care" to "damage control" requires open communication and multidisciplinary approach. Multiple scoring systems have attempted to identify these patients, but there is no single score that reliably assists in decision-making during the acute resuscitation phase.\textsuperscript{50}

Patients can be generally divided into 4 groups: stable, borderline, unstable, and \textit{in extremis}.\textsuperscript{28} Stable patients can be treated with immediate fixation, and unstable/\textit{in extremis} patients should be treated with damage control. The borderline patient is the most difficult one to define and identify, but also exemplifies the situation in which the decision regarding the optimal course of action is most critical and the consequences of the "incorrect" decision are profound. In general, the borderline patient has multiple thoracic and abdominal injuries and is suffering from hemorrhagic shock or sequelae thereof. Such patient is probably best treated with damage control.

A few scenarios deserve special mention. Femoral fractures are generally treated with immediate fixation using an intramedullary device, but this differs in the multi-trauma population. Embolic fat from the instrumentation is known to provoke an inflammatory response in the lung, which can serve as the "second hit" in these patients.\textsuperscript{31} Thus consideration for external fixation, especially in the setting of bilateral femur fractures in the multiply injured patient, should be discussed. The second unique scenario is the patient with a pelvic ring injury and associated hemorrhage. Rapid clinical decisions must be made with regards to the appropriate skeletal and/or hemodynamic stabilization procedure(s) for the patient, and may include a variety of clinical approaches from pelvic binder/external fixation, to therapeutic angiography, to emergent open pelvic packing.\textsuperscript{32,34} These patients also require a specialized team approach to optimize outcomes.

The timing of definitive fixation of secondary injuries or conversion from external fixation to definitive fixation is also a crucial decision. Most patients treated with damage control techniques can be definitively stabilized within one week, but this may depend on the overall physiologic state of the patient. Days 2-4 following the injury have been defined as the time of greatest systemic inflammation and any additional unnecessary surgery should be avoided during this period.\textsuperscript{35}

\textbf{ANESTHESIOLOGIST PERSPECTIVE}

In all of the intricate planning and execution of such a clinical course of action, the anesthesiologist plays a crucial role. In the provision of perioperative care for the orthopedic trauma patient the anesthesiologist/anesthesiology team intervenes at several important junctures. The first important aspect of anesthesia care is the airway. Trauma aside, the fact that greater than 35% of the United States population is obese \textsuperscript{36}, more than 10% of nonoperative intubations are difficult \textsuperscript{37}, and 20% of all critical incidents in the intensive care unit are airway related \textsuperscript{38,39} all combine to make appropriate and cautious planning, securing, and maintaining airway absolutely critical. Additionally, trauma could render a patient unconscious, may be associated with cervical spine injury or facial fractures, and is not infrequently complicated by blood and/or vomitus in the airway. The coexistence of these factors further corroborates the crucial nature of the anesthesiology expertise and prominent presence on the multi-disciplinary trauma team.

Adequate vascular access for infusion of intravenous fluids, blood products, medications, and for hemodynamic monitoring is of great importance. While this expertise is also shared with surgeons, the presence and assistance of anesthesiology in this area is very helpful, thereby freeing up the surgeons to focus on operative management of traumatic injuries. Most anesthesiologists are also well versed with procedures such as arterial line placement, thoracostomy and nasogastric tube insertion.

Hemodynamic and fluid management, as well as transfusion medicine are at the core of the anesthesiologist's scope of practice. The orthopedic trauma patient will benefit from, and the surgical team will be complemented by, this aspect of perioperative anesthesia expertise. The use of blood products, colloid solutions, and crystalloid solutions in the care of the injured, along with the knowledge of vasopressor, vasodilator, inotrope, and antiarrhythmic agents optimizes and adds to the success of trauma interventions.

Finally, the induction of an anesthetic with clinical vigilance during definitive surgical interventions is an important traditional role of the anesthesiologist. Choosing a regional approach, a general anesthetic, or monitored anesthesia care is an extremely important clinical decision, which should be done in consultation beforehand with the surgical colleagues. Furthermore, during the operative intervention, hemodynamic monitoring, with appropriate physiological and pharmacological interventions make competent, appropriate anesthesia expertise a true necessity.\textsuperscript{40}

\textbf{INTENSIVIST PERSPECTIVE}

Postoperatively, the intensivist provides critical care support to patients who are deemed to be most likely to require significant resuscitative efforts. In the United States, the intensivist role can be currently fulfilled by specialty trained anesthesiologists, surgeons, internists, and emergency physicians.\textsuperscript{41,42} They work closely with the trauma care team providing everything from consultative input to the primary provision of critical care services. The critical care team, working closely with the trauma team, is well positioned to cover all aspects of patient care except for the surgical care of the injury.
Manipulation of the ventilator, cardiopulmonary physiology and pharmacology, transfusion medicine, resuscitation, nutrition, wound care, infectious diseases/sepsis/antibiotic administration, renal support therapy, and other aspects of critical care all fall within the purview of the intensivist. In other words, care of the renal support therapy, and other aspects of critical care all fall within the purview of the intensivist. In other words, care of the renal support therapy, and other aspects of critical care all fall

CONCLUSIONS

In summary, interdisciplinary healthcare approach to the multiply injured patient can help optimize care, minimize morbidity and mortality, and ultimately provide a framework for accelerated post-injury rehabilitation course. Potential benefits of utilizing this approach when treating the multi-trauma patient with orthopedic injury are significant and disadvantages are few. The authors would like to emphasize the synergies provided by specialty teams working together in the context of care coordination, timing of surgical and non-surgical interventions, and physiologic considerations.

REFERENCES


