

Review Article



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The Significance of Multidisciplinary Approach to Comprehensive Trauma Management

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Abstract

At a national level, efforts have been made to enhance patient care and decrease mortality rates in trauma management. The adoption of a multidisciplinary team approach in decision making has led to positive patient outcomes, facilitated by a variety of intricate modifications. Although significant progress has been made in establishing an efficient multidisciplinary trauma service, there is still room for further enhancements. This article examines the evolution of trauma care in the United States and evaluates the influence of multidisciplinary teams on the treatment of patients with multiple injuries with focus on orthopedics and anesthesiology.

Introduction

In the United States, traumatic injury ranks as the fifth leading cause of death, while globally it stands as the sixth leading cause of mortality. Traumatic injuries contribute to roughly 10% of total global deaths [1-3]. Trauma is the primary cause of mortality in individuals who are younger than 45 years old [1-3]. Polytrauma, which refers to the simultaneous occurrence of multiple traumatic injuries in a single individual, is observed in up to 40% of cases involving trauma admissions [4, 5]. Polytrauma frequently affects young and productive individuals, posing a significant burden on society in terms of both financial and human

aspects [6]. When multiple injuries occur simultaneously, they can result in considerable disability, reducing the likelihood of individuals returning to productive work. Consequently, this leads to significant economic costs [6].

Trauma victims with the most severe conditions often exhibit injury patterns that involve multiple anatomically distant areas, hemodynamic dysfunction, and the dysfunction of multiple organ systems. Treating such cases requires the expertise of both general traumatologists and specialized physicians from various subspecialties. Orthopedic trauma, in particular, is frequently observed among these injuries and serves as a prime example of

the significance of a multidisciplinary approach. This approach has been instrumental in reducing post-injury morbidity and mortality rates [7].

Global Perspective

The effective management of trauma, particularly in cases involving multiple injuries, necessitates the collective expertise of a medical team. Addressing severe trauma typically requires the collaboration of diverse medical specialists such as neurosurgeons, thoracic surgeons, abdominal surgeons, orthopedic surgeons, and maxillofacial surgeons. Given the intricate nature of this condition, the advancement of diagnostic techniques, the diversification of medical approaches, and the treatment of severe trauma present significant challenges [8]. The concept of the multidisciplinary team (MDT) model has garnered considerable attention due to its inherent benefits of fostering collaboration among various disciplines and facilitating personalized treatment approaches [9]. The concept of the MDT was initially introduced by the United States and subsequently recognized for its significance by other countries such as the United Kingdom, Australia, Japan, and more [10]. It has gained traction and been widely adopted as a standard approach to medical treatment in various healthcare institutions [11]. In China, the implementation of multidisciplinary diagnosis and treatment started in 1990. Since then, numerous high-level general hospitals have actively explored the application of the MDT model for various clinical conditions. As a result, multidisciplinary expert teams have been established to enhance collaboration and decision-making in patient care [12]. The implementation of the MDT model in clinical practice has demonstrated its ability to facilitate the optimal allocation of medical resources. Furthermore, it has been shown to enhance the accuracy and rationality of disease diagnosis and treatment. Importantly, the MDT model effectively addresses the societal challenges associated with complex medical treatments [13].

The American Trauma System

The American trauma system has been structured to offer a systematic approach in addressing injuries. According to statistics from the Center for Disease Control, traumatic injuries account for 59% of fatalities among individuals aged 1 to 44 years in the United States [14]. The modern trauma system in the United States is built upon the valuable lessons learned from the wars of the early and mid-twentieth century. During the First and Second World Wars, a standardized approach emerged for transporting injured soldiers through different levels of medical care, starting from initial stabilization on the battlefield by personnel with basic medical training, to their transfer to aid stations or hospitals for comprehensive medical treatment. The primary focus at the onset was on controlling external bleeding, managing open fractures, and alleviating pain. Soldiers in need of further care were subsequently transported to hospitals located behind the frontlines, where

emergency surgery and additional medical attention were provided. The introduction of mechanization expedited the transportation process within this early trauma system, leading to improved outcomes. In the Second World War, resuscitation techniques and the treatment of shock were given greater emphasis, utilizing intravenous fluids and blood. The development of helicopters during the Korean and Vietnam Wars further revolutionized the system, enabling severely wounded individuals to be transported to fully equipped hospitals within a matter of minutes [15]. The need for patients to follow the sequential stages of progressive care described earlier was no longer necessary.

In the United States, civilian urban trauma centers adopted and modified the systems developed during wartime to address the types of accidental injuries commonly encountered during peacetime. Extensive research and training within these urban trauma centers contributed to notable advancements in trauma patient outcomes. However, outside of these specialized centers, trauma care in community hospitals remained basic and limited. In 1966, the Committee on Shock and the Committee on Trauma of the Division of Medical Sciences of the National Academy of Sciences/National Research Council published a report titled "Accidental Death and Disability: The Neglected Disease of Modern Society." This report advocated for strong government leadership in establishing standardized trauma care systems and emphasized the need for funding research and training to disseminate these systems nationwide [16]. Funding from the US Congress was made available through the National Highway Safety Act of 1966 with the aim of reducing fatalities and injuries resulting from motor vehicle accidents, which were the primary cause of traumatic injuries. Taking advantage of this funding, Illinois took a pioneering step in the early 1970s by utilizing it to establish the first comprehensive statewide trauma system. Building upon the principles and practices developed at Cook County Hospital in Chicago, one of the earliest dedicated trauma centers in the United States, Illinois extended these concepts to create a coordinated trauma care network throughout the state [17].

In 1976, the American College of Surgeons released a publication titled "Optimal Hospital Resources for Care of the Seriously Injured." This document introduced a set of criteria for classifying hospitals according to their capacity to deliver trauma care at different levels. These criteria aimed to establish a standardized framework for categorizing hospitals based on their ability to provide appropriate care for seriously injured patients [18]. Significant emphasis was placed on establishing trauma centers as integral components of regional trauma systems.

It is important to note that the American College of Surgeons (ACS) does not directly designate trauma centers. Instead, they offer verification and assessment of the resources and capabilities outlined in their regularly updated publication, "Resources for Optimal Care of the Injured Patient" [17].

The Indian Challenge

Trauma-care systems in India are still in their early stages of development. The country exhibits a diverse landscape, with industrialized cities, rural towns, and villages coexisting alongside a lack of organized trauma care infrastructure. There is a significant disparity in the availability of trauma services across different regions of the country. Rural areas, in particular, face challenges in providing efficient trauma care due to factors such as varied topography, financial limitations, and inadequate health infrastructure.

One notable issue is the absence of a national lead agency responsible for coordinating the various components of a trauma system. Furthermore, there is no established mechanism for accrediting trauma centers and professionals. Although education in trauma life-support skills has recently become available, there are significant deficiencies in the current trauma systems, as documented by a nationwide survey of various healthcare facilities.

While some initiatives have emerged to improve prehospital systems, the recognition of injury as a major public health problem by the government, medical community, and society as a whole is still lacking. Despite its impact on public health, the significance of addressing trauma as a significant challenge is yet to be fully acknowledged in India.

The Multidisciplinary Teams

Achieving effective diagnostic and therapeutic approaches for multiply injured patients necessitates the existence of well-operating trauma systems and integrated specialty teams [19]. The ideal approach for managing multiply injured patients involves the collaboration and involvement of various medical professionals. This includes anesthesiologists, trauma-trained surgeons, intensivists, orthopedic specialists, diagnostic and interventional radiologists, urologists, neurosurgeons, rehabilitation specialists, otolaryngologists, and many other specialists who contribute their expertise to ensure comprehensive care for the patient [7-20]. Refined team management, strong leadership, and effective communication skills play a vital role in the care of multiply injured patients. Excellent communication among physicians and healthcare teams is essential, encompassing a deep understanding of significant clinical challenges and the continuous vigilance of all team members through multiple cross-checks. Centralized care planning, including multidisciplinary patient care conferences, is crucial for ensuring comprehensive and coordinated treatment. These elements collectively contribute to the optimal management and outcome of multiply injured patients [21].

The multidisciplinary approach to trauma care begins in the prehospital setting, involving early responders and emergency medical service personnel. These teams are responsible for conducting initial assessments, providing stabilization measures,

and transporting patients to the closest appropriate healthcare facility capable of managing their condition. Based on the trauma designation guidelines established by the American College of Surgeons and regional trauma systems, patients in need of advanced levels of care are transferred to designated trauma centers. These trauma centers are equipped with the necessary resources and specialized healthcare professionals from various disciplines who can deliver optimal post-injury care to these patients [22]. Given the high volume of injured patients, appropriate triage is crucial as the majority, over 90%, are effectively treated in local community hospitals [22]. For the remaining 10% of patients who are severely injured and require the specialized capabilities of Level I and II trauma centers, a multidisciplinary approach is essential to enhance outcomes.

Specialized Trauma Systems

In the United States, the majority of multiply injured patients with immediately life-threatening conditions are directed to specialized trauma centers. These centers are equipped to handle complex cases and provide the necessary resources for optimal trauma care. According to the Major Trauma Outcome Study, nearly half of all patients involved in the study had one or more musculoskeletal injuries, emphasizing the significant prevalence of such injuries among trauma patients [23]. Another study revealed that following motorcycle crashes, 72% of emergency evaluations resulted in orthopedic consultation. A substantial number of these patients experienced open fractures, which necessitated immediate orthopedic surgical intervention. This highlights the high incidence of orthopedic injuries and the critical need for prompt orthopedic care in the context of motorcycle accidents [6].

When dealing with polytrauma, it is crucial to prioritize injuries based on their level of urgency, considering both physiological and anatomical factors. The multidisciplinary approach plays a vital role in this process, involving various medical and surgical specialists. The severity and urgency of each injury determine the specific specialists required and the timing of interventions. Typically, a central coordinating “control point” comprising the trauma or surgical intensive care team is established within the institution. Despite appearing chaotic, this approach relies on effective care coordination and actively involves numerous medical and surgical specialists, such as anesthesiologists, trauma surgeons, diagnostic and interventional radiologists, orthopedic surgeons, oral maxillofacial surgeons, vascular surgeons, neurosurgeons, and many others [7-20].

This approach offers several advantages in the overall management of severely injured patients. To illustrate the collaborative nature of this approach, let's consider a hypothetical scenario involving a patient who is hypotensive and has a pulseless limb due to an extremity fracture. In this case, the emergency physician and trauma surgeon work together to assess and address

any internal or external bleeding promptly. If bleeding is present, they must be prepared to perform a hemostatic procedure, such as suturing cutaneous hemorrhage, emergency laparotomy, or applying an extremity tourniquet, as needed. Simultaneously, an orthopedic and vascular surgery team collaborates to restore distal limb perfusion and repair the fracture. The decision on whether to use definitive or temporary fixation depends on the nature of the injury and the patient's physiological condition. Throughout this intricate planning and execution, the anesthesiologist plays a critical role in ensuring optimal patient care. Following the procedure, the intensivist provides intensive care in the ICU, as the patient will likely require significant resuscitative efforts.

The multidisciplinary approach goes beyond the involvement of surgeons and necessitates the active participation of various professional teams at different levels of the healthcare system. This includes, but is not limited to, nursing staff, transportation staff, midlevel providers, blood bank personnel, case managers, social workers, specialty therapists, pharmacists, and resident/fellow physicians. Often, these individuals are the first responders to the patient's initial presentation or the ones who notice subsequent changes in the patient's clinical condition. The team approach is crucial because any delay in recognizing significant clinical events, leading to a prolonged time to therapeutic intervention, can have a negative impact on patient outcomes [24]. The successful integration of available medical, psychosocial, financial, educational, and vocational resources from different specialties, medical centers, programs, and organizations is crucial in determining the overall outcome of severely injured patients [25].

Multidisciplinary approach in orthopedics

Skeletal injuries are commonly observed in the majority of polytrauma patients. The advantages of surgical stabilization for these injuries are clearly defined, but the timing of such procedures has been a subject of controversy and ongoing development. Therefore, the provision of care in a multi-disciplinary, team-oriented manner is essential in order to maximize patient outcomes.

Roughly ten years ago, the concept of "damage-control orthopedics" was introduced, and it has since been linked to enhanced outcomes for patients with multiple traumas [26]. For an extended period, the approach of "early total care" was utilized, involving the prompt and emergent stabilization of all long bone fractures [26]. The concept of "damage-control" emerged due to the recognition that in certain subgroups of patients with multiple injuries and/or thoracic trauma, early fixation was linked to increased rates of complications and mortality. In these high-risk patients prone to complications, the approach involves initial temporary stabilization, focusing on controlling hemorrhage, managing soft tissue injury, and often utilizing external fixation

for long bone fractures. Subsequently, definitive fixation is postponed until the risk of systemic complications decreases and the overall physiological condition of the patient improves [26]. The objective is to prevent a "second hit" and further deterioration of the patient's overall condition. Identifying patients who would benefit most from transitioning from "early total care" to "damage control" necessitates open communication and a multidisciplinary approach. Various scoring systems have been developed to identify such patients, but no single score can consistently assist in decision-making during the initial resuscitation phase [27].

Patients can be broadly categorized into four groups: stable, borderline, unstable, and in extremis [28]. Stable patients can receive immediate fixation as a treatment approach, while unstable or in extremis patients should undergo damage control measures. The borderline patient, although challenging to define and identify, represents a situation where the decision regarding the optimal course of action is crucial, and the consequences of an "incorrect" decision can be significant. Typically, the borderline patient presents with multiple thoracic and abdominal injuries and is experiencing hemorrhagic shock or its consequences. In such cases, the preferred treatment approach is likely damage control.

There are certain situations that require special attention. Typically, femoral fractures are promptly addressed by employing an intramedullary device for stabilization. However, this approach varies when dealing with individuals who have multiple injuries. The use of instrumentation can release fatty emboli, which may trigger an inflammatory reaction in the lungs, acting as an additional detrimental factor for these patients [29]. Therefore, it is important to consider the possibility of using external fixation, particularly when dealing with patients who have multiple injuries and bilateral femur fractures. Another distinctive scenario involves patients who have a pelvic ring injury accompanied by bleeding. In such cases, prompt clinical judgments are necessary to determine the most suitable skeletal and/or hemodynamic stabilization procedures. These approaches can range from applying a pelvic binder or external fixation to performing therapeutic angiography or urgently employing open pelvic packing [30, 31]. Optimizing outcomes for these patients necessitates a specialized team approach.

The decision regarding the timing of definitive fixation for secondary injuries or transitioning from external fixation to definitive fixation is critical. While most patients who undergo damage control techniques can be definitively stabilized within a week, the specific timeline may vary based on the patient's overall physiological condition. It is important to note that the period from days 2 to 4 following the injury is characterized by the highest systemic inflammation. Therefore, it is advisable to avoid any additional unnecessary surgeries during this period [32].

Multidisciplinary Approach in Anesthesiology

During the perioperative care of trauma patients, the involvement of an anesthesiologist or anesthesiology team is crucial at various critical points. The initial and significant aspect of anesthesia care involves managing the patient's airway. In addition to trauma-related considerations, it is important to note that over 35% of the population in the United States is obese [33], making difficult intubations a concern in more than 10% of nonoperative cases [34]. Furthermore, approximately 20% of critical incidents in the intensive care unit (ICU) are related to airway issues. These statistics emphasize the utmost importance of careful and appropriate planning, securing, and maintaining the patient's airway in order to ensure patient safety [35].

Furthermore, trauma can result in the loss of consciousness in a patient and may be accompanied by cervical spine injuries or facial fractures. Additionally, it is not uncommon for trauma cases to involve blood or vomit in the airway. The presence of these factors highlights the importance of anesthesiology expertise and the significant role of an anesthesiologist within the multidisciplinary trauma team. Their expertise becomes crucial in effectively managing and addressing these complex situations to ensure patient safety and optimal outcomes.

Establishing appropriate vascular access for the administration of intravenous fluids, blood products, medications, and for hemodynamic monitoring is highly crucial in trauma care. Although surgeons also possess this expertise, the involvement and assistance of anesthesiologists in this aspect can be particularly beneficial. This allows surgeons to concentrate on the operative management of traumatic injuries while anesthesiologists handle vascular access tasks. Many anesthesiologists are proficient in procedures such as arterial line placement, thoracostomy, and nasogastric tube insertion, further contributing to their valuable role in trauma care.

Hemodynamic and fluid management, along with transfusion medicine, are essential components of an anesthesiologist's scope of practice. The presence of an anesthesiologist with expertise in these areas provides significant benefits to orthopedic trauma patients and complements the surgical team during the perioperative period. The anesthesiologist's knowledge and skill in utilizing blood products, colloid solutions, and crystalloid solutions, as well as their understanding of vasopressor, vasodilator, inotropic, and antiarrhythmic agents, greatly optimize and enhance the success of trauma interventions. This expertise ensures that the care provided to injured patients is tailored to their specific needs and contributes to improved outcomes in trauma management.

An essential and traditional role of the anesthesiologist is to carefully induce anesthesia and maintain clinical vigilance

during definitive surgical interventions. The choice between a regional approach, general anesthesia, or monitored anesthesia care is a critical decision that should be made in consultation with the surgical team prior to the procedure. Additionally, during the operative intervention, the anesthesiologist plays a vital role in hemodynamic monitoring and implementing appropriate physiological and pharmacological interventions. This highlights the necessity of competent and appropriate anesthesiology expertise to ensure the safety and success of the surgical procedure [34].

Summary

To summarize, adopting an interdisciplinary healthcare approach for multiply injured patients can lead to optimized care, reduced morbidity and mortality, and facilitate a faster rehabilitation process following the injury. The advantages of utilizing this approach for multi-trauma patients with orthopedic injuries are substantial, while the disadvantages are minimal. The authors highlight the importance of the synergistic collaboration among specialty teams, emphasizing the significance of care coordination, appropriate timing of surgical and nonsurgical interventions, and considering the patient's physiological factors. By working together, these teams can provide comprehensive and effective care for patients with multiple injuries.

References

1. Søreide K (2009) Epidemiology of major trauma. *Br J Surg* 96: 697-698.
2. National Center for Health Statistics (U.S.) National Hospital Discharge Survey. Hyattsville, MD: DHHS Publication, U.S. Department of Health and Human Services, Centers for Disease Control and Prevention; 2016.
3. Peters S, Nicolas V, Heyer CM (2010) Multidetector computed tomography-spectrum of blunt chest wall and lung injuries in polytraumatized patients. *Clin Radiol* 65: 333-338.
4. Marx JA, Hockberger RS, Walls RM, Adams J, Rosen P, et al. (2010) *Rosen's Emergency Medicine: Concepts and Clinical Practice*.
5. Bonatti H, Calland JF (2008) Trauma. *Emerg Med Clin North Am* 26: 625-48.
6. Amin NH, Jakoi A, Katsman A, Harding SP, Tom JA, et al. (2011) Incidence of orthopedic surgery intervention in a level I urban trauma center with motorcycle trauma. *J Trauma* 71: 948-951.
7. Wisler JR, Beery II PR, Steinberg SM, Stawicki SP, Stanislaw PA, et al. (2012) Competing priorities in the brain injured patient: Dealing with the unexpected. *Brain Injury - Pathogenesis, Monitoring, Recovery and Management* 341-54.
8. Powell HA, Baldwin DR (2014) Multidisciplinary team management in thoracic oncology: more than just a concept? *Eur Respir J* 43: 1776-1786.
9. El Saghir NS, Keating NL, Carlson RW, Khoury KE, Fallowfield L, et al. (2014) Tumor boards: optimizing the structure and improving efficiency of multidisciplinary management of patients with cancer worldwide. *Am Soc Clin Oncol Educ Book* e461-466.

10. Yang B, Tan JJ, Wang P (2017) Application and practice of project management mode in multi-disciplinary collaborative diagnosis and treatment of hospitals. *J Milit Surg Southwest Chin* 19 :588–589.
11. Ryan J, Faragher I (2014) Not all patients need to be discussed in a colorectal cancer MDT meeting. *Colorectal Dis* 16: 520-526.
12. Zhang H, Han L, Liu Q (2018) Discussion on the Multidisciplinary collaborative diagnosis and treatment model in deepening hospital discipline construction. *Chin Hosp Manage* 38:29-30.
13. Ji J, Chen H, Gao B (2017) Implementation and management of multidisciplinary collaborative diagnosis and treatment in tuberculosis department. *Mod Hosp* 17: 1729-1731.
14. Centers for Disease Control and Prevention, National Center for Injury Prevention and Control. Web-based Injury Statistics Query and Reporting System (WISQARS) Fatal Injury Data2016.
15. Mullins RJ (1999) A historical perspective of trauma system development in the United States. *J Trauma* 47: S8-14.
16. National Academy of Sciences, National Research Committee on Trauma, National Academy of Sciences, National Research Council Committee on Shock. National Academies Press (US); Washington (DC): 1966. *Accidental Death and Disability: The Neglected Disease of Modern Society*.
17. Boyd DR (2010) Trauma systems origins in the United States. *J Trauma Nurs* 17:126-134.
18. Optimal hospital resources for care of the seriously injured. *Bull Am Coll Surg* 61:15-22.
19. Mirza A, Ellis T (2004) Initial management of pelvic and femoral fractures in the multiply injured patient. *Crit Care Clin* 20:159-170.
20. Stawicki SP (2007) Trends in nonoperative management of traumatic injuries: A synopsis. *Int J Crit Illn Inj Sci* 7:38-57.
21. Ruchholtz S, Waydhas C, Lewan U, Piepenbrink K, Stolke D, et al. (2002) A multidisciplinary quality management system for the early treatment of severely injured patients: implementation and results in two trauma centers. *Intensive Care Med* 28:1395-1404.
22. McSwain N, Rotondo M, Meade P, Duchesne J. A model for rural trauma care. *Br J Surg* 99: 309-314.
23. Browner BD, DeAngelis JP (2007) Emergency care of musculoskeletal injuries. In: Townsend CM, Beauchamp RD, Evers M, Mattox KL, editors. *Sabiston Textbook of Surgery*. Ch. 21. Philadelphia, PA: WB Saunders 521–558.
24. Stewart BT, Lee V, Danne PD (1994) Laparotomy for trauma in a regional centre: the effect of delay on outcome. *Aust N Z J Surg* 64: 484-487.
25. Strasser DC, Uomoto JM, Smits SJ (2008) The interdisciplinary team and polytrauma rehabilitation: prescription for partnership. *Arch Phys Med Rehabil* 89: 179-181.
26. Pape HC, Hildebrand F, Pertschy S, Zelle B, Garapati R, et al. (2002) Changes in the management of femoral shaft fractures in polytrauma patients: from early total care to damage control orthopedic surgery. *J Trauma* 53: 452-461.
27. Bosse MJ, MacKenzie EJ, Riemer BL, Brumback RJ, McCarthy ML, et al. (1997) Adult respiratory distress syndrome, pneumonia, and mortality following thoracic injury and a femoral fracture treated either with intramedullary nailing with reaming or with a plate. A comparative study. *J Bone Joint Surg Am* 79: 799-809.
28. Pape HC, Aufm'Kolk M, Paffrath T, Regel G, Sturm JA, et al. (1993) Primary intramedullary femur fixation in multiple trauma patients with associated lung contusion--a cause of posttraumatic ARDS? *J Trauma* 34: 540-547.
29. Pohlemann T, Culemann U, Gänsslen A, Tscherne H (1996) Die schwere Beckenverletzung mit pelviner Massenblutung: Ermittlung der Blutungsschwere und klinische Erfahrung mit der Notfallstabilisierung. *Unfallchirurg* 99: 734-743.
30. Gänsslen A, Giannoudis P, Pape HC (2003) Hemorrhage in pelvic fracture: who needs angiography. *Curr Opin Crit Care* 9: 515-523.
31. Pape HC, Schmidt RE, Rice J, Griensven MV, Gupta RD, et al. (2000) Biochemical changes after trauma and skeletal surgery of the lower extremity: quantification of the operative burden. *Crit Care Med* 28: 3441-3448.
32. Ogden CL, Carroll MD, Kit BK, Flegal KM (2012) Prevalence of obesity in the United States, 2009-2010. *NCHS Data Brief* 1-8.
33. Martin LD, Mhyre JM, Shanks AM, Tremper KK, Kheterpal S, et al. (2011) 3,423 emergency tracheal intubations at a university hospital: airway outcomes and complications. *Anesthesiology* 114: 42-48.
34. Beckmann U, Baldwin I, Durie M, Morrison A, Shaw L, et al. (1998) Problems associated with nursing staff shortage: an analysis of the first 3600 incident reports submitted to the Australian Incident Monitoring Study (AIMS-ICU). *Anaesth Intensive Care* 26: 396-400.
35. Stene JK, Grande CM (1990) General anesthesia: management considerations in the trauma patient. *Crit Care Clin* 6: 73-84.