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Integrated Clinical Pathways for Chest Injury involving EMS, Nursing Practice, Radiologic Assessment, Laboratory and Microbiological Testing, Dental Support Roles, and Nutrition Management

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Abstract

Background: Chest trauma is a frequent and high-risk presentation in emergency medical services (EMS), accounting for nearly a quarter of all trauma-related deaths. These injuries, resulting from blunt or penetrating mechanisms, can rapidly compromise ventilation, oxygenation, and circulation, making timely assessment and management critical for patient survival.
Aim: This article aims to outline the principles of prehospital evaluation and management for chest trauma, emphasizing the role of EMS in rapid recognition, stabilization, and expedited transport to definitive care. It seeks to synthesize the pathophysiology, clinical assessment, and specific interventions for life-threatening thoracic conditions within the constraints of the field environment.
Methods: The approach is based on a structured primary survey (Airway, Breathing, Circulation) aligned with Advanced Trauma Life Support (ATLS) principles. Methods include rapid clinical assessment, essential life-support interventions (e.g., oxygen administration, hemorrhage control), and specific invasive procedures like needle decompression for tension pneumothorax and occlusive dressing for open chest wounds.
Results: Effective prehospital care focuses on identifying critical conditions such as tension pneumothorax, flail chest, and massive hemothorax. Interventions are time-sensitive and aimed at bridging the patient to hospital-based definitive care. The "load and go" strategy, minimizing on-scene time, is consistently associated with improved outcomes.
Conclusion: The prognosis for chest trauma patients is significantly improved by efficient EMS systems that prioritize rapid assessment, immediate life-saving interventions, and coordinated transport to appropriate trauma centers.
Keywords: Chest Trauma, EMS, Prehospital Care, Tension Pneumothorax, Trauma Management, ATLS.

Introduction

Emergency medical services (EMS) personnel encounter chest trauma as a frequent and high-risk presentation within the prehospital setting. Thoracic injuries contribute to a substantial proportion of trauma-related deaths, estimated at nearly one quarter of all mortality from trauma, ranking second after injuries to the head and neck. This pattern underscores the importance of clinical and public health of efficient assessment and management of chest trauma in the early phases of care. Chest injuries arise from both penetrating mechanisms such as gunshot wounds, stabbings, lacerations, and puncture wounds, and blunt mechanisms such as motor vehicle collisions, falls from height, crush injuries, blast exposure, and thermal injury. These mechanisms often lead to life-threatening disruption of ventilation, oxygenation, and circulation, which demands rapid recognition and prompt stabilization in the field. Within this context, EMS systems aim to shorten the interval between the time of injury and the initiation of definitive medical interventions, with the overarching objective of improving survival and functional outcomes. Although specific clinical protocols differ across regions and agencies, most EMS systems adopt a broadly similar framework that aligns with the core

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concepts of the Advanced Trauma Life Support (ATLS) guidelines, which provide a structured, priority-based approach to trauma care [1][2]. The wide range of possible complications following chest trauma, including respiratory failure, hemorrhagic shock, cardiac injury, and associated multi-system trauma, emphasizes the need for timely transfer to a hospital capable of providing definitive care. Rapid transport represents a central strategic goal in prehospital chest trauma management. EMS clinicians often face the challenge of balancing immediate life-saving interventions with the imperative to avoid unnecessary delays on scene. Current evidence indicates that patient outcomes tend to improve when more invasive diagnostic and therapeutic procedures take place in the hospital environment rather than during the prehospital phase. This observation supports a model of care where EMS prioritizes early recognition of critical conditions, institution of essential stabilization, and expedited transport over extensive on-scene interventions, especially in time-sensitive thoracic emergencies.

In many systems, prehospital trauma care in the United States combines basic life support with ATLS-based principles to structure decision-making and interventions. Basic or essential life support includes a set of noninvasive measures that target airway, breathing, and circulation. These measures involve manual airway maneuvers, use of airway adjuncts, provision of oxygen, and support of ventilation, in addition to cardiopulmonary resuscitation and automated or manual defibrillation when indicated. Providers also focus on external hemorrhage control through direct pressure and hemostatic measures, immobilization of the spine when they suspect significant trauma to the vertebral column, and stabilization or splinting of limb fractures. These actions aim to prevent secondary injury, maintain perfusion, and preserve organ function during the prehospital interval. Advanced life support adds further capabilities such as advanced airway management, which may include endotracheal intubation or supraglottic airway devices when appropriate training and resources exist. EMS clinicians may administer selected medications, for example analgesics, antiarrhythmics, or drugs used during resuscitation. They may also perform continuous cardiac monitoring to detect arrhythmias or ischemic changes and to guide resuscitative decisions. In specific life-threatening chest conditions such as tension pneumothorax, appropriately trained providers may perform needle decompression as an emergency procedure to relieve intrathoracic pressure and restore effective ventilation and circulation. These advanced interventions require careful risk–benefit evaluation to avoid prolonging scene time or transport time in a way that could offset their potential advantage [3].

The organization of EMS and the structure of referral pathways differ across urban, suburban, and rural environments, which affects both the availability of transport modalities and the capabilities of receiving facilities. Some systems rely on ground ambulances alone, while others integrate air medical transport to mitigate long distances or challenging terrain. Receiving hospitals also differ in the range of services they can provide, such as dedicated trauma teams, cardiac surgery, interventional radiology, or thoracic surgery. EMS providers must therefore adapt their management plans to the realities of local resources. They need to select an appropriate destination that matches the anticipated needs of the chest trauma patient, while continuing to apply ATLS-based priorities during transport. This adaptive, system-aware approach aims to ensure that patients with thoracic injuries receive timely, coordinated, and resource-appropriate care beginning in the prehospital phase and continuing through hospital-based definitive management [3].

Etiology

Traumatic injury to the chest arises from two primary mechanisms, penetrating and blunt trauma. Penetrating mechanisms include gunshot wounds, stab injuries, lacerations, and other forms of puncture injury. Blunt mechanisms include motor vehicle collisions, falls from height or standing, crush events, blast injuries, and thermal insults such as burns. In most clinical series, blunt trauma accounts for the majority of chest injury presentations, reflecting road traffic crashes and falls as major contributors to overall trauma burden. The mechanism of injury shapes the energy transfer to thoracic structures and affects both the pattern and severity of internal damage. High-energy blunt forces often cause complex multi-system trauma, while penetrating mechanisms produce localized but potentially devastating disruption to specific organs and vascular structures. Both penetrating and blunt thoracic trauma can produce a wide range of acute complications that directly threaten life. These complications include tension pneumothorax, which compromises ventilation and venous return, open pneumothorax with ineffective ventilation through a chest wall defect, and hemothorax with significant intrathoracic blood loss. Structural compromise of the chest wall, such as flail chest, leads to impaired respiratory mechanics and ventilatory failure. Injury may also involve the heart and great vessels, with pericardial effusion and cardiac tamponade causing obstructive shock, and aortic rupture producing rapid exsanguination or contained hematoma with high risk of sudden deterioration. Disruption of hollow or conducting thoracic structures, such as esophageal rupture or rupture of the trachea or bronchial tree, further impairs ventilation and can introduce mediastinal contamination. Myocardial contusion and pulmonary contusion alter cardiac function and gas exchange and increase susceptibility to arrhythmia, hypoxia, and secondary complications. Diaphragmatic rupture allows abdominal viscera to herniate into the thoracic cavity, compromising respiratory function and sometimes delaying diagnosis. These diverse sequelae reflect the complex interplay between mechanism of injury, energy transfer, and the anatomic vulnerability of thoracic structures in traumatic events [4].

Epidemiology

Chest trauma represents a major component of the global trauma burden and is a significant contributor to preventable morbidity and mortality. Epidemiological data indicate that chest injuries occur in a substantial proportion of both blunt and penetrating trauma presentations, being reported in approximately 14% of all blunt trauma cases and 12% of all penetrating trauma cases [4]. When these proportions are considered against the overall volume of trauma presentations, thoracic injury emerges as a key determinant of outcome in emergency and critical care settings. Importantly, these injuries are not only frequent but also disproportionately lethal, being implicated in roughly one quarter of all trauma-related deaths, which underscores their clinical significance and the need for optimized systems of care [4]. From a population perspective, chest trauma frequently affects individuals in younger and middle-aged groups, who are typically the most economically and socially active segments of society. This age distribution amplifies the societal and economic impact of thoracic injuries, as deaths and long-term disability in this cohort translate into substantial loss of productivity and increased demand on health and social support systems. The predominance of high-energy mechanisms, particularly road traffic collisions and occupational or domestic falls, further reflects broader public health and injury-prevention challenges. In many regions, the epidemiology of chest trauma parallels trends in motorization, urbanization, and industrial activity, with higher incidence in settings where road safety measures, enforcement, and workplace protections are suboptimal.

The relative contribution of blunt versus penetrating mechanisms has important epidemiological implications. Blunt trauma forms the majority of thoracic injuries in most series, aligning with the dominance of motor vehicle accidents, falls, and crush mechanisms in overall trauma patterns [4]. Blunt chest trauma is frequently associated with multiple injuries and polytrauma, including concomitant head, abdominal, and musculoskeletal injuries, which complicates both diagnosis and management and further elevates mortality risk. Penetrating thoracic trauma, while less frequent in many settings, is often linked to interpersonal violence and firearm or stab injuries and may exhibit distinct demographic patterns, frequently involving young males and urban populations. Despite lower incidence in some regions, penetrating injuries can carry high case-fatality rates, particularly when major vascular or cardiac structures are involved. The lethality of chest trauma is closely connected to the spectrum of life-threatening complications that can develop rapidly after injury. Conditions such as tension pneumothorax, massive hemothorax, flail chest, cardiac tamponade, and major vascular injury may progress within minutes to respiratory failure, shock, or cardiac arrest if not promptly recognized and treated. These time-critical pathologies explain why chest injuries account for approximately 25% of trauma-related mortality and highlight the central role of prehospital systems, rapid transport, and early hospital-based resuscitation in determining outcomes [4]. The high mortality burden also reflects the frequent coexistence of chest injury with head and neck trauma, which together constitute the leading causes of death in severely injured patients [4].

Thoracic aortic injury represents a particularly important, although relatively infrequent, subset of chest trauma. These injuries are strongly linked to high-energy deceleration mechanisms, such as high-speed motor vehicle collisions and falls from significant height. Epidemiologically, thoracic aortic injuries are notable for their poor prognosis, with a substantial proportion of patients dying at the scene or shortly after arrival at hospital. Even among those who reach definitive care, the risk of rapid deterioration remains high due to the potential for sudden rupture and massive hemorrhage. The association of thoracic aortic injury with poor outcomes reinforces the need for high clinical suspicion in appropriate mechanisms, timely imaging, and rapid access to definitive surgical or endovascular intervention. Within the broader epidemiological landscape of chest trauma, this entity exemplifies how relatively uncommon injuries can contribute disproportionately to mortality and shape the priorities of trauma systems and clinical protocols. Overall, the epidemiology of chest injuries illustrates a pattern of relatively high incidence, strong association with high-energy mechanisms, concentration in younger age groups, and a considerable contribution to trauma-related mortality. These features collectively emphasize the importance of prevention strategies, including road safety measures, workplace protection, and injury-control policies, alongside ongoing efforts to refine prehospital care, hospital-based resuscitation, and definitive management pathways for thoracic trauma [4].

Pathophysiology

The pathophysiological consequences of chest trauma arise mainly from impairment of respiratory mechanics and disruption of hemodynamic stability. Damage to the chest wall, lungs, pleura, mediastinum, heart, and great vessels alters normal gas exchange and circulatory function. One of the classic examples is flail chest, defined as fractures of at least three consecutive ribs with each rib broken in two or more locations. This pattern creates an unstable segment of the thoracic cage that moves independently from the intact chest wall. The paradoxical motion that occurs during inspiration and expiration reduces ventilatory efficiency, increases the work of breathing, and is often accompanied by underlying pulmonary contusion, which further compromises oxygenation and predisposes to respiratory failure. Air can also dissect into anatomic compartments not normally containing free gas. Pneumomediastinum develops when air collects within the mediastinum, while pneumopericardium occurs when air enters the pericardial sac. Both conditions may follow blunt or penetrating chest trauma and often result from alveolar rupture, airway disruption, or direct violation of mediastinal structures. Pneumopericardium can progress to tension pneumopericardium in which rising intrapericardial pressure restricts cardiac filling and produces hemodynamic compromise similar to cardiac tamponade. Pneumomediastinum may be associated with esophageal, tracheal, or bronchial injury and can signal significant underlying structural damage [1][2][3].

Complex chest trauma may involve combined injuries affecting multiple systems. Tracheobronchial or esophageal disruption leads to air leakage into the mediastinum or pleural space and potential contamination with gastrointestinal contents, increasing the risk of severe mediastinitis and sepsis. Pneumothorax accompanied by pericardial disruption allows communication between the pleural and pericardial spaces, which can modify pressure relationships around the heart and lungs and complicate both diagnosis and management [3][4]. The Macklin effect describes a specific sequence that often follows blunt thoracic trauma. High intra-alveolar pressures or shearing forces produce microscopic ruptures in the alveolar walls or damage to the basement membrane. Air then escapes from the alveoli into the interstitial space, resulting in interstitial emphysema. From there, the air tracks along the bronchovascular sheaths toward the lung hilum and accumulates within the mediastinum. This mechanism explains many cases of post-traumatic pneumomediastinum in the absence of overt tracheobronchial or esophageal perforation. Recognition of this process is important because it highlights how substantial mediastinal air can arise without a large central airway tear, influencing the diagnostic approach and the interpretation of imaging findings [3][4].

History and Physical

In prehospital trauma care, the information available to emergency medical services (EMS) personnel is often limited and may be unreliable. Dispatch data can be incomplete, delayed, or based on unverified reports from bystanders, which constrains the accuracy of the initial situational assessment. Once on scene, the extent to which EMS providers can collect additional history depends on several factors, including the clinical stability of the patient, the need for urgent life-saving interventions, environmental hazards, and overall scene safety. Under ideal conditions, EMS clinicians aim to obtain a concise account of the mechanism of injury, the sequence of events from the time of trauma to first medical contact, and any immediately relevant medical history, while simultaneously conducting a focused physical assessment [4][5]. When patients are unable to provide information because of reduced consciousness, respiratory distress, shock, or concurrent injuries, collateral histories from relatives, companions, or other witnesses become particularly valuable. Information about the mechanism and severity of injury can refine risk stratification and guide early management. Important details include the observed or estimated volume of blood loss in cases involving gunshot wounds, stab injuries, or limb amputations, as well as the duration and complexity of extrication from motor vehicle wreckage or collapsed structures. These elements provide insight into the magnitude of forces involved and the likelihood of occult injuries. Observations made during transport, such as deterioration in mental status, onset of dyspnea, declining blood pressure, changes in heart rate, or increasing oxygen requirement, are also critical. Transmission of this information to the receiving emergency department team at the time of handover enhances continuity of care and supports rapid decision-making regarding investigations and interventions [4][5].

On hospital arrival, a more comprehensive history and physical examination by in-hospital providers are central to definitive evaluation and triage. The hospital team builds on prehospital information but often must reconstruct the clinical picture from limited or second-hand details, especially when the patient remains unable to communicate. A structured trauma history, when feasible, seeks to clarify the exact mechanism of injury, the use of safety devices such as seat belts or helmets, pre-existing cardiopulmonary or coagulation disorders, current medications including anticoagulants or antiplatelet agents, and any history of prior thoracic surgery or lung disease that may influence both risk and management [3][4][5]. Despite the importance of historical data, the physical examination carries particular weight in thoracic trauma, especially in patients who cannot provide a reliable account. A systematic, head-to-toe assessment grounded in advanced trauma life support principles allows early recognition of life-threatening conditions such as airway compromise, tension pneumothorax, open pneumothorax, flail chest, massive hemothorax, cardiac tamponade, and shock. Visual inspection, palpation, percussion, and auscultation of the chest can reveal deformity, paradoxical motion, extensive bruising, crepitus, diminished or absent breath sounds, and muffled heart tones. Concomitant assessment of vital signs, level of consciousness, skin perfusion, and peripheral pulses contributes to an integrated view of respiratory and hemodynamic status. In practice, the relative priority of history-taking and physical examination is dictated by the urgency of the clinical situation. In unstable patients, the initial focus must be on rapid identification and treatment of immediately reversible threats, with more detailed history deferred until stabilization. Nonetheless, all available information from EMS personnel, witnesses, and prior medical records should be synthesized with the findings of the physical examination to guide imaging choices, laboratory investigations, and decisions regarding operative or interventional management [3][4][5].

Evaluation

The prehospital evaluation of the trauma patient is a time critical process in which emergency medical services providers undertake three core responsibilities, namely rapid clinical assessment with early recognition of injuries, physiological stabilization, and expedited transportation to an appropriate trauma center or hospital. Within this framework, providers apply a structured primary survey that follows the airway, breathing, and circulation sequence, often referred to as the ABC approach. This sequence reflects the priority of correcting immediately life threatening disturbances in oxygenation, ventilation, and perfusion before attention shifts to less urgent problems. Even when patients exhibit obvious or distracting injuries, such as open fractures or significant external wounds, EMS personnel must first ensure that the airway is patent, breathing is adequate, and circulatory status is compatible with short term survival. Throughout this process, they also monitor vital signs and level of consciousness at frequent intervals to detect early physiological deterioration and to guide ongoing interventions. In practice, prehospital care focuses on control of severe hemorrhage, maintenance of the airway, and prompt recognition of life threatening thoracic conditions that require urgent management or rapid transport. Airway assessment and stabilization represent the initial step in the ABC sequence for trauma care. EMS clinicians form an early impression of airway patency from the patient’s general appearance, ability to speak, and respiratory effort. Patients who can speak in full sentences usually have an adequate airway at that moment, although their status may change. Conversely, confusion, agitation, obtundation, or overt head and neck trauma can compromise airway protection and clearance. For this reason, EMS personnel maintain a low threshold for suspecting cervical spine injury. They implement cervical spine precautions if there is any suggestion of significant blunt trauma to the head or neck, high energy mechanisms, or altered mental status. These precautions often include manual in line stabilization followed by placement of a cervical collar as soon as feasible [4][5][6].

Basic airway interventions in the field include manual maneuvers such as the jaw thrust technique that help to open the upper airway without excessive cervical spine movement. When appropriate, oropharyngeal or nasopharyngeal adjuncts support airway patency in patients with decreased consciousness who do not have a gag reflex or basal skull fracture respectively. Suctioning is used to clear blood, secretions, or vomitus that might obstruct airflow. Supplemental oxygen is delivered via nasal cannula or non rebreather facemask depending on the degree of respiratory compromise and oxygen saturation. In some patients, these measures are insufficient, and more advanced techniques are required. Supraglottic airway devices can provide temporizing control of ventilation when endotracheal intubation is not immediately possible. Endotracheal intubation constitutes a definitive airway intervention in the prehospital environment and may be considered for patients with actual or anticipated airway compromise, inadequate ventilation, or severe traumatic brain injury, provided that providers have the necessary training, equipment, and system support. Assessment of breathing and ventilation follows directly after airway evaluation and is often conducted in parallel. EMS providers appraise respiratory status using respiratory rate, pattern of breathing, chest wall movement, and auscultatory findings when conditions permit. They pay close attention to the symmetry of chest expansion, the presence or absence of breath sounds bilaterally, and the use of accessory muscles. Pulse oximetry offers a continuous, noninvasive indicator of oxygenation and aids in gauging the response to interventions. The goal is to rapidly identify conditions such as tension pneumothorax, open pneumothorax, massive hemothorax, and flail chest, all of which can cause rapid deterioration if they remain untreated. Visual inspection may reveal open chest wounds, paradoxical movement of a flail segment, or extensive bruising, while palpation may detect crepitus from subcutaneous emphysema or rib fractures. Where findings suggest tension pneumothorax, immediate decompression may be lifesaving and usually precedes definitive imaging [4][5][6].

Circulatory assessment is particularly critical in thoracic trauma, because intrathoracic hemorrhage, cardiac injury, or vascular disruption can cause abrupt and profound hemodynamic compromise. The circulation component of the primary survey includes rapid appraisal of skin color, temperature, and capillary refill, along with measurement of heart rate and blood pressure. Providers evaluate distal pulses in all extremities to identify asymmetry that may signal vascular injury or evolving shock. Recognizing external hemorrhage is essential, since early control of blood loss can significantly influence outcomes. Direct pressure with dressings, pressure bandages, and when appropriate, tourniquets to control bleeding from extremities form a central element of the circulatory phase of assessment. EMS clinicians simultaneously consider the possibility of non compressible internal bleeding, including intrathoracic hemorrhage, which may present with signs of shock in the absence of obvious external blood loss. Cardiac monitoring often commences early in the prehospital phase for chest trauma patients, as arrhythmias, ischemic changes, or signs of cardiac contusion may be detectable. In some systems, a twelve lead electrocardiogram can be obtained during transport and transmitted to the receiving facility, offering additional information about cardiac function and guiding early decision making [5]. However, EMS protocols emphasize that neither initiation of monitoring nor acquisition of an electrocardiogram should delay transport, especially in unstable patients. Intravenous or intraosseous access is frequently established en route to allow administration of fluid boluses or medications when indicated. Even so, EMS personnel aim to avoid prolonged on scene times for the sake of securing access, since rapid delivery to a facility capable of definitive hemorrhage control and advanced resuscitation remains a priority [5].

Beyond the direct clinical assessment, prehospital evaluation must incorporate several operational considerations specific to the EMS environment. One of the earliest and most fundamental tasks is the assessment and maintenance of scene safety. EMS teams work in diverse and sometimes hostile settings, including confined residential spaces, roadways, industrial sites, and large scale disaster areas. Each environment presents distinct hazards such as ongoing traffic, structural instability, fire, chemical exposure, or potential violence. Providers must recognize that their own safety and that of their colleagues is a prerequisite for effective patient care. Consequently, they implement early precautions such as staging at a safe distance, using protective equipment, and coordinating with fire, police, or other responders. As scenes evolve, they periodically reassess safety, since conditions may deteriorate rapidly due to weather, crowd behavior, or structural changes [3]. A structured framework such as the SAFE approach supports this process in prehospital care [6]. In this model, the provider first calls for help to ensure adequate resources are available, then assesses the general scene to gain an overview of hazards, access routes, and the number of casualties. The provider determines whether the environment is free from immediate danger or whether additional controls are needed before direct patient contact. Only after this situational appraisal does the provider move to evaluate the casualty in detail. This sequence helps to balance the instinctive urge to rush to the patient against the need for controlled, safe, and sustainable operations [6].

Prehospital evaluation becomes more complex when EMS providers face incidents with multiple injured individuals. Under such circumstances, they must rely heavily on rapid clinical assessment and established triage criteria to allocate limited resources, prioritize patients for treatment and transport, and select appropriate destinations. Triage systems differ between jurisdictions and are regularly updated in light of emerging evidence and operational experience. They typically incorporate physiological parameters, anatomic injury patterns, and mechanism of injury to stratify patients by urgency. The aim is to ensure that patients with the greatest need for immediate advanced care are transported first to suitable facilities, without neglecting the needs of others. Effective triage during mass casualty events or multi patient incidents can significantly influence overall survival and system performance. One important challenge in the prehospital evaluation of chest injuries is that classic clinical signs may be subtle or absent in the field. For example, paradoxical chest wall motion, which is characteristic of flail chest, may not be evident in a patient who is splinting or breathing shallowly due to pain. Likewise, detecting reduced breath sounds or heart tones with a stethoscope is often difficult in noisy environments, during helicopter transport, or on busy roadways. Clothing, limited lighting, and space restrictions inside ambulances can further obscure physical findings. As a result, EMS personnel must maintain a high index of suspicion for significant underlying thoracic pathology when mechanisms of injury or associated findings suggest major trauma, even if overt signs have not yet appeared. This cautious stance supports early decision making regarding rapid transport, advanced notification to the receiving facility, and the need for immediate imaging and surgical consultation upon arrival [5][6][7].

The potential role of ultrasound in prehospital trauma evaluation has gained increasing interest in some European systems and selected regions of the United States, though its routine use is not yet widespread [7]. Portable ultrasound devices enable point of care imaging at the scene or during transport, which may enhance diagnostic accuracy for specific conditions. In the context of chest trauma, prehospital ultrasound can aid in the detection of pneumothorax by demonstrating absence of lung sliding, in the identification of pericardial effusion that may indicate impending cardiac tamponade, and in the evaluation of pleural collections. Focused protocols such as extended focused assessment with sonography for trauma can be adapted to the prehospital context to provide rapid, noninvasive information that supports decisions about triage, the need for urgent intervention, and selection of the most appropriate receiving hospital [7]. Despite these advantages, the impact of prehospital ultrasound on hard clinical outcomes such as mortality and long term morbidity remains under investigation. Limitations include device availability, the need for specific training and ongoing competency, time constraints during critical resuscitation, and the risk that imaging might distract from essential interventions or delay transport. Current evidence suggests that ultrasound can refine clinical judgment and improve confidence in decision making, yet robust data linking its prehospital use to improved survival are still limited. Consequently, further research is necessary to determine the optimal indications, training requirements, and integration of ultrasound into diverse EMS systems [7]. In summary, evaluation of the chest trauma patient in the prehospital setting is a dynamic process that integrates structured clinical assessment, targeted interventions, and continuous operational judgment. EMS providers apply the ABC based primary survey to stabilize airway, breathing, and circulation, while also managing hemorrhage and monitoring physiological trends. They operate within complex and variable environments that demand attention to scene safety, resource management, and triage principles. Emerging tools such as portable ultrasound hold promise for enhancing diagnostic capability, but they must be incorporated in ways that complement rather than impede the core priorities of rapid recognition, stabilization, and timely transport to definitive care [6][7].

Treatment / Management

Management of chest trauma in the prehospital setting centers on rapid recognition of time critical complications, immediate life saving intervention when indicated, and prompt transport to an appropriate facility capable of providing definitive care. Many thoracic injuries can deteriorate quickly, and any life threatening abnormality detected during the primary survey requires intervention before further evaluation proceeds. Certain conditions identified in the field mandate a "load and go" strategy, in which EMS personnel perform only essential noninvasive or limited invasive measures while prioritizing rapid transfer. Once initial stabilization is achieved, the principal goal becomes ensuring that each patient is delivered to the most suitable hospital with the necessary resources within the shortest feasible time. Because outcomes in chest trauma are strongly influenced by the interval between injury and definitive treatment, EMS providers form a crucial link in the overall trauma system. Their ability to identify critical pathology, support airway, breathing, and circulation, and trigger timely transport has a direct impact on survival and long term function. Tension pneumothorax represents one of the most important immediately reversible causes of preventable death in thoracic trauma and therefore requires a high index of suspicion and rapid treatment in the field. Pathophysiologically, tension pneumothorax results from progressive accumulation of air under positive pressure within the pleural space. This accumulation is usually driven by a one way valve mechanism, whereby air enters the pleural cavity during inspiration through a lung parenchymal tear, chest wall defect, or airway injury but cannot escape efficiently during expiration. As intrapleural pressure continues to rise, the ipsilateral lung progressively collapses, greatly impairing gas exchange. Simultaneously, increasing pressure compresses the contralateral lung and displaces mediastinal structures toward the opposite side. This shift kinks and compresses the great veins, particularly the superior and inferior vena cava, leading to reduced venous return, decreased cardiac output, and evolving obstructive shock. If uncorrected, even a relatively modest volume of trapped air can rapidly precipitate cardiovascular collapse and death [7][8].

Clinically, tension pneumothorax may present with acute respiratory distress, hypoxia, tachypnea, tachycardia, and hypotension. On examination, breath sounds on the affected side are typically diminished or absent, and percussion may reveal hyperresonance. The involved hemithorax may appear hyperexpanded with reduced chest wall excursion. In advanced cases, tracheal deviation away from the injured side and distended neck veins may be noted, although these classic signs are not always present, especially in hypovolemic states. Because delays in treatment can be fatal, EMS providers are trained to act on a syndromic pattern of respiratory compromise and hemodynamic instability in the context of chest trauma, rather than waiting for all textbook features to appear. When tension pneumothorax is strongly suspected and the patient shows signs of decompensation, prehospital needle decompression may be indicated as a temporizing measure. The commonly taught technique involves insertion of a large bore, typically 14 gauge, needle or angiocatheter into the second intercostal space at the midclavicular line on the affected side, taking care to remain above the rib to avoid the neurovascular bundle. This procedure allows accumulated air under pressure to escape from the pleural space into the external environment, thereby reducing intrathoracic pressure, improving venous return, and restoring ventilation to some degree. The clinical response, when successful, includes improvement in oxygenation, respiratory effort, and blood pressure. Nevertheless, success rates vary in practice because the catheter may be too short to traverse chest wall soft tissue, may kink, or may become obstructed by blood or tissue. Despite these limitations, needle thoracostomy can provide a vital bridge to definitive treatment, which typically consists of pigtail catheter insertion or tube thoracostomy performed in the hospital setting under controlled conditions [8][9].

Open pneumothorax, often referred to as a "sucking chest wound," occurs when a defect in the chest wall creates a direct communication between the external environment and the pleural space. With each inspiration, air is preferentially drawn through the low resistance chest wall opening rather than through the trachea, especially when the defect is large relative to the tracheal diameter. This dynamic results in impaired ventilation of the underlying lung and can allow the development of pneumothorax under atmospheric or positive pressure. During expiration, air may exit through the wound, but partial obstruction or tissue flaps can limit egress, allowing a progressive accumulation of intrapleural air that may evolve toward a tension physiology. Clinically, open pneumothorax shares many features with tension pneumothorax, including respiratory distress, hypoxia, reduced breath sounds, and hemodynamic compromise, and it may precede or coexist with a tension state. Immediate management of open pneumothorax in the prehospital phase is aimed at preventing further air entrainment while allowing trapped air to escape. EMS providers are trained to apply an occlusive dressing over the wound, using a non-permeable material such as a commercial chest seal or an improvised plastic barrier. The dressing is secured on three sides, leaving one edge unsealed to function as a flutter valve. This configuration restricts air inflow during inspiration while permitting air to vent during expiration, thereby reducing the risk of converting the lesion into a tension pneumothorax. This intervention is a temporary measure designed to stabilize the patient until definitive surgical or thoracic management can be undertaken in the hospital [10]. Continuous monitoring is essential, as changes in respiratory status may signal the need to adjust the dressing or consider additional interventions.

Flail chest represents another serious consequence of blunt thoracic trauma and is characterized by multiple rib fractures that create a free segment of the chest wall. Specifically, at least two fractures in each of multiple adjacent ribs result in a section of the rib cage that becomes mechanically disconnected from the surrounding thoracic framework. During inspiration, negative intrathoracic pressure draws the flail segment inward, whereas during expiration, positive pressure pushes it outward. This paradoxical motion impairs effective ventilation and increases the work of breathing. Flail chest is frequently associated with significant underlying pulmonary contusion, as the same high energy impact that fractured multiple ribs also transmits force to the lung parenchyma. Pulmonary contusion leads to interalveolar hemorrhage, edema, and loss of functional lung units, contributing to hypoxemia and increasing the risk of respiratory failure. However, contusions may not be clinically obvious in the prehospital phase and may only become apparent on imaging or as respiratory status deteriorates. In the field, EMS management of flail chest focuses on maintaining adequate oxygenation, reducing pain related hypoventilation, and limiting paradoxical motion. While advanced ventilatory strategies, analgesia, and surgical fixation fall within hospital based care, prehospital providers can manually stabilize the flail segment by applying firm, gentle pressure or by using supportive dressings during transport. This measure helps to improve chest wall mechanics, decrease discomfort, and prevent further respiratory compromise 11. Oxygen therapy, careful positioning, and readiness to support ventilation with bag valve mask devices are also important. Patients with suspected flail chest are considered high risk and generally require rapid transport to a facility with critical care and surgical capabilities [8][9][10].

Besides these specific entities, chest trauma encompasses a spectrum of other injuries ranging from relatively minor conditions to life threatening emergencies. Severe pathologies such as pericardial tamponade, massive hemothorax, traumatic aortic rupture, diaphragmatic tears, and esophageal injury are major causes of morbidity and mortality but are often difficult to diagnose and manage definitively in the prehospital setting. At present, most EMS systems do not support field procedures for pericardiocentesis, thoracotomy, or operative control of intrathoracic hemorrhage for such conditions. Consequently, prehospital protocols emphasize meticulous attention to airway, breathing, and circulation, aggressive management of shock when possible, and a “load and go” strategy once immediate life threatening complications amenable to field intervention have been addressed [12][13]. Early hospital notification and transport to centers with cardiothoracic surgery, interventional radiology, and advanced critical care are key elements of this approach. In summary, treatment and management of chest trauma in the prehospital environment rely on early identification of critical thoracic conditions, focused interventions such as needle decompression and occlusive dressings when clearly indicated, and rapid coordination of transport to definitive care. EMS providers operate within time and resource constraints yet play a pivotal role in preventing secondary injury, supporting vital functions, and improving the likelihood that patients reach specialized facilities in a condition that permits definitive, lifesaving treatment [12][13].

Differential Diagnosis

When evaluating a patient with chest trauma, the prehospital and hospital care teams must consider a wide range of potential injuries, each of which carries distinct physiological consequences and implications for immediate management. Tension pneumothorax is a critical diagnosis in which accumulating intrapleural air leads to mediastinal shift, compromised venous return, and obstructive shock. Recognition relies on the combination of clinical signs such as hypotension, tachycardia, hypoxia, diminished or absent breath sounds, and tracheal deviation, while treatment requires emergent decompression to prevent cardiovascular collapse [8]9. Open pneumothorax presents differently but can progress to a tension physiology if untreated; it is identified by a visible chest wall defect that allows inspiratory air entry with inadequate expiratory escape, often producing a “sucking” wound. Application of an occlusive dressing and rapid transport remain the cornerstones of initial management [10]. Hemothorax, the accumulation of blood within the pleural space, can arise from blunt trauma, penetrating injuries, or vascular compromise, and may present with hypotension, tachycardia, diminished breath sounds, dullness to percussion, and respiratory distress. Immediate recognition and rapid transport are critical, as significant hemothorax may necessitate operative intervention to control hemorrhage. Flail chest is defined by multiple consecutive rib fractures creating a free-floating segment of the thoracic wall, producing paradoxical chest wall motion. It often coexists with pulmonary contusions, which are frequently occult yet contribute substantially to hypoxemia and respiratory compromise [11]. Pericardial effusion and cardiac tamponade represent intrathoracic complications that can produce hypotension, jugular venous distension, and muffled heart sounds. While EMS personnel cannot definitively treat tamponade in the field, recognition of shock physiology prompts rapid transport and hospital-based intervention. Aortic rupture is frequently fatal at the scene, yet patients with contained injuries may present with hypotension, chest pain, and radiographic findings indicative of mediastinal widening. Tracheal or bronchial tree injury, myocardial contusion, pulmonary contusion, diaphragmatic rupture, and esophageal perforation constitute additional differential considerations. Many of these injuries are initially occult, requiring high suspicion based on mechanism of injury, clinical deterioration, and subsequent imaging for confirmation. Prompt recognition of these pathologies ensures that EMS interventions prioritize life-saving measures and rapid transport to definitive care, minimizing the risk of secondary injury [10][11].

Prognosis

The prognosis of chest trauma patients is determined by a combination of injury severity, comorbid conditions, and the timeliness and quality of prehospital and in-hospital interventions. Chest injuries account for substantial morbidity and mortality, particularly when associated with high-energy blunt trauma or penetrating mechanisms involving major thoracic structures. The majority of patients sustaining blunt traumatic aortic injury do not survive to reach a hospital, emphasizing the importance of rapid identification and transport for those with potentially survivable injuries. Early assessment and stabilization, including airway management, hemorrhage control, and recognition of life-threatening thoracic complications, significantly enhance survival rates [12][13]. Patient age is another critical factor influencing prognosis. Advanced age is associated with decreased physiological reserve, higher likelihood of comorbidities, and reduced tolerance for hypoxia and hypotension. Similarly, the presence of underlying cardiopulmonary disease, coagulopathies, or previous thoracic surgery can complicate both the natural course of injury and therapeutic interventions. Patients with multi-system trauma, in which chest injuries are compounded by abdominal, cranial, or extremity injuries, demonstrate poorer outcomes due to the cumulative effects of shock, hypoxemia, and systemic inflammatory responses. Prehospital interventions that emphasize rapid recognition and mitigation of life-threatening conditions, coupled with efficient triage and transportation to appropriately equipped trauma centers, contribute to improved outcomes. Studies consistently demonstrate that patients who receive timely and targeted prehospital care, including airway stabilization, oxygen supplementation, hemorrhage control, and immobilization, have higher survival rates and reduced incidence of complications than those with delayed or inadequate intervention. Moreover, early coordination with receiving hospitals enables the rapid initiation of definitive care such as surgical repair, advanced ventilatory support, or interventional radiology, further improving prognosis [12][13].

Complications

Chest trauma can precipitate a range of complications affecting multiple organ systems within the thoracic cavity. Tension pneumothorax remains among the most critical, as rapid accumulation of air can lead to obstructive shock and cardiovascular collapse if not promptly decompressed. Pulmonary complications following blunt or penetrating trauma are frequent and contribute substantially to morbidity. Pulmonary contusions reduce effective alveolar ventilation, impair gas exchange, and increase the risk of hypoxemia, acute respiratory distress syndrome, and secondary infections. Patients with flail chest experience paradoxical movement of the thoracic segment, which exacerbates ventilatory compromise and may precipitate respiratory failure if uncorrected. Hemothorax may progress to hypovolemic shock if intrathoracic bleeding is not recognized and controlled, and pericardial effusion can evolve into cardiac tamponade, further compromising circulation. Other potential complications include diaphragmatic rupture with subsequent visceral herniation, tracheobronchial tears causing airway obstruction, esophageal rupture with mediastinitis, and myocardial contusions that can precipitate arrhythmias. Many of these injuries may not manifest obvious signs in the prehospital setting, necessitating careful monitoring of hemodynamic and respiratory parameters, high suspicion based on mechanism of injury, and rapid transport to hospital facilities capable of advanced diagnostic and surgical interventions. Imaging, including chest radiography, computed tomography, and echocardiography, often becomes essential to confirm these injuries and guide definitive management [11][12][13].

Consultations

Prehospital guidance from medical command or online consultation is crucial when managing patients with severe thoracic trauma. EMS providers frequently operate in environments where rapid decisions are required, and access to experienced physicians or trauma coordinators via radio or telemedicine enhances patient safety and clinical decision-making. Remote consultation allows field personnel to confirm procedural indications, discuss transport priorities, and coordinate the use of specialized resources at receiving facilities. It also facilitates early hospital notification, allowing the trauma team to prepare for high acuity patients and mobilize necessary surgical or critical care resources in advance [13].

Patient Education

Prevention strategies play a significant role in reducing the incidence of chest trauma. Public education campaigns highlighting the importance of seatbelt use, helmet protection, fall prevention, and workplace safety measures can decrease the occurrence of high-energy thoracic injuries. Bystanders are critical first responders who can initiate lifesaving measures such as calling EMS promptly, providing basic airway support, controlling external bleeding, and preventing further harm at the scene. Community awareness and training programs improve outcomes by ensuring that these initial interventions occur before professional responders arrive [12][13].

Other Issues

Rapid recognition of life-threatening thoracic injuries is central to prehospital management. Interventions must be guided by clinical assessment, with priority given to airway, breathing, and circulation. For patients with multiple injuries, assessment of potential thoracic compromise should take precedence, with IV fluid administration initiated during transport to avoid delaying definitive care. Classic signs of flail chest, including paradoxical motion, may not be immediately evident, and open chest wounds require appropriate occlusive dressings to prevent progression to tension physiology. Prompt stabilization and transfer to a trauma center equipped for definitive intervention are consistently associated with improved patient outcomes [12].

Enhancing Healthcare Team Outcomes

EMS providers often serve as the initial point of professional contact for trauma patients, and their assessments inform subsequent decisions by physicians, nurses, and allied healthcare personnel. Effective communication during handover, clear documentation of vital signs, mechanism of injury, and interventions performed facilitates continuity of care and minimizes delays in definitive treatment. Collaborative protocol development and simulation-based training between EMS and hospital teams optimize resource utilization and ensure that prehospital care aligns with in-hospital capabilities. In conclusion, blunt and penetrating thoracic injuries carry high morbidity and mortality rates and may result in complications ranging from mild to fatal. EMS providers are integral to the early management of these patients, and their ability to rapidly assess, stabilize, and transport individuals directly influences survival. Timely interventions, adherence to trauma protocols, and coordinated communication with receiving hospitals are essential components of high quality prehospital trauma care [11][12][13].

Conclusion:

In summary, the management of chest trauma in the prehospital setting is a time-critical endeavor where EMS providers play a pivotal role in determining patient outcomes. The high morbidity and mortality associated with thoracic injuries, which account for a substantial proportion of trauma deaths, necessitate a highly structured and efficient response. The cornerstone of this approach is the rapid application of the ABC (Airway, Breathing, Circulation) sequence to identify and address immediately life-threatening conditions such as tension pneumothorax, open pneumothorax, and flail chest. While specific interventions like needle decompression and occlusive dressings can be lifesaving, the overarching principle remains a "load and go" strategy. This emphasizes performing only essential stabilization to prevent further physiological decline while prioritizing rapid transport to a facility capable of providing definitive care, such as tube thoracostomy, operative hemorrhage control, or surgical fixation. The effectiveness of prehospital care is thus intrinsically linked to seamless integration with the broader trauma system. Through prompt recognition, adherence to established trauma protocols, and clear communication with receiving hospitals, EMS providers form the crucial first link in a chain of survival that significantly enhances the prospects for recovery in chest trauma patients.

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