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Research Article

Impact of Prehospital Care Provided by Emergency Medical Services on Patient Survival in Trauma Cases

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Abstract:

The impact of prehospital care provided by Emergency Medical Services (EMS) on patient survival in trauma cases is a critical area of study in emergency medicine. Research has consistently shown that timely and effective prehospital interventions—such as advanced airway management, hemorrhage control, and rapid transport to trauma centers—significantly improve survival rates among trauma patients. The golden hour concept highlights the importance of early medical intervention, where rapid and appropriate treatment in the field can stabilize patients and improve outcomes. Effective communication between EMS and receiving hospitals is also vital, enabling trauma teams to prepare for incoming patients and streamline the transition to definitive care. In addition to immediate medical interventions, the training and experience of EMS providers play a pivotal role in influencing patient outcomes. The implementation of evidence-based protocols and continuous education ensures that EMS personnel are equipped to handle a variety of traumatic injuries effectively. Moreover, system factors such as response times, resource availability, and regional trauma care systems further affect the quality of prehospital care. Understanding these dynamics is essential for developing strategies to enhance prehospital trauma care, ultimately leading to improved patient survival rates in emergency situations.

1. Introduction

Trauma remains one of the most significant public health challenges of the 21st century, representing a leading cause of mortality and disability worldwide, particularly among younger populations. According to the World Health Organization (WHO), injuries account for nearly 8% of all deaths globally, with road traffic injuries alone causing approximately 1.3 million fatalities each year [1]. The period immediately following a traumatic injury is often referred to as the "golden hour"—a critical window during which prompt and effective medical intervention is paramount to maximizing a patient's chances of survival and minimizing long-term morbidity.

The fundamental philosophy of modern prehospital trauma care is to "do no further harm" while rapidly addressing life-threatening conditions and expediting transport to an appropriate trauma center. The scope of care provided by EMS has evolved dramatically from a simple "scoop and run" transport service to a sophisticated, protocol-driven medical system. Today's EMS providers, from Emergency Medical Technicians (EMTs) to Paramedics, are trained to perform a wide array of advanced interventions. These include basic and advanced airway management, hemorrhage control with tourniquets and hemostatic dressings, fluid resuscitation, needle decompression for tension pneumothorax, and administration of life-saving medications [2]. The strategic application of these interventions in the field aims to stabilize the patient's physiology and prevent the lethal triad of hypothermia, acidosis, and coagulopathy from setting in before hospital arrival.

The global burden of trauma underscores the vital importance of robust EMS systems. For instance, a study analyzing data from the American College of Surgeons' National Trauma Data Bank (NTDB) highlighted that prehospital factors significantly influence outcomes in severely injured patients [3]. The economic impact is equally staggering; the Centers for Disease Control and Prevention (CDC) estimates that fatal and non-fatal injury costs in the United States alone exceed $4.2 trillion annually in medical care and lost productivity [4]. This data positions prehospital care not just as a medical necessity but as a critical socio-economic imperative.

However, the efficacy and impact of specific prehospital interventions have been the subject of ongoing debate and rigorous scientific scrutiny. Historically, the paradigm for trauma care, especially in urban settings with short transport times, has emphasized minimizing on-scene time to ensure rapid delivery to a trauma center—the "scoop and run" or "load and go" approach. Proponents argue that many advanced life support (ALS) procedures can delay transport without providing a clear survival benefit [5]. For example, the landmark PHTLS (Prehospital Trauma Life Support) guidelines continually adapt their recommendations based on emerging evidence, sometimes scaling back the emphasis on certain field interventions in favor of rapid transport.

Conversely, a growing body of evidence supports the life-saving potential of specific, targeted prehospital interventions, particularly in settings with longer transport times or for specific injury patterns. The most compelling evidence in recent years surrounds the prehospital control of catastrophic external hemorrhage. The widespread adoption of tourniquets, driven by military experience in conflicts in Iraq and Afghanistan, has demonstrated a profound impact on survival. A study published in the *Journal of Trauma and Acute Care Surgery* found that prehospital tourniquet application in civilian trauma was associated with a six-fold reduction in mortality from extremity hemorrhage [6]. Similarly, the implementation of advanced airway management, while controversial, has been shown to be crucial for patients with severe traumatic brain injury (TBI) where hypoxia is a primary driver of secondary brain injury and mortality [7].

The structure and maturity of the EMS system itself are also critical determinants of patient outcome. Research comparing different international models has shown that physician-staffed prehospital services, common in many European countries, can provide a higher level of decision-making and intervention, potentially benefiting complex cases [8]. Furthermore, the integration of EMS within a regionalized trauma system, where patients are triaged and transported directly to designated trauma centers, has consistently been linked to improved survival rates. A systematic review confirmed that implementation of inclusive trauma systems can reduce mortality by 15-20% [9].

Technological advancements are further shaping the future of prehospital care. The use of point-of-care ultrasound (POCUS) by paramedics to detect internal bleeding, the deployment of whole blood transfusion in the field, and the use of telemedicine to connect paramedics with in-hospital trauma specialists are all emerging practices with promising early results [10, 11]. These innovations highlight a shift towards a more diagnostic and resuscitation-focused role for EMS.

Despite these advances, significant challenges and variations in care persist. Disparities in EMS access and quality between urban and rural areas remain a major concern, with rural trauma victims often facing longer response times and less access to advanced-level providers [12]. This geographic disparity directly impacts the "chain of survival" for trauma patients and presents a critical area for health systems improvement.

2. The Global Burden of Trauma and the "Golden Hour" Concept

Trauma, defined as a physical injury of sudden onset and substantial severity, represents a pervasive and devastating global health crisis. It is the leading cause of death for individuals aged between 5 and 44 years, and its ripple effects account for approximately 10% of all years of life lost worldwide, surpassing the collective impact of malaria, tuberculosis, and HIV/AIDS [13]. This demographic represents the most productive segment of the population, meaning the socioeconomic repercussions of premature death and disability extend far beyond the individual, devastating families, communities, and national economies. The World Health Organization (WHO) projects that by 2030, road traffic injuries alone will become the fifth leading cause of death globally, underscoring an urgent and growing challenge for public health systems that requires immediate and coordinated intervention [1].

The epidemiological profile of trauma varies significantly across different regions, heavily influenced by factors such as socioeconomic status, infrastructure development, and public safety legislation. In high-income countries, common mechanisms include road traffic collisions, falls from height among the elderly, and penetrating trauma from interpersonal violence. In contrast, low- and middle-income countries (LMICs) bear a disproportionate and staggering share of the global burden, accounting for over 90% of all trauma-related deaths worldwide. Vulnerable road users like pedestrians, cyclists, and motorcyclists are particularly at risk in these regions due to less robust traffic laws, inadequate road infrastructure, and higher density of mixed-use traffic [14]. The economic cost is astronomical and multifaceted. In the United States alone, the lifetime cost of fatal and non-fatal injuries was estimated at a staggering $4.2 trillion in 2019, a figure that encompasses both direct medical expenses and the profound indirect costs of lost productivity and wages [4]. This data unequivocally positions trauma not merely as a clinical issue confined to emergency departments, but as a critical societal and economic problem demanding a coordinated, system-wide response that integrates public policy, urban planning, and healthcare delivery.

The pathophysiological response to major trauma initiates a complex and often rapid cascade towards physiological exhaustion and death, a process that prehospital care aims to interrupt. This destructive process is frequently driven by the self-perpetuating "lethal triad": hypothermia, acidosis, and coagulopathy. Uncontrolled hemorrhage, the leading cause of preventable trauma death, leads to hypovolemic shock, severely impairing tissue perfusion and oxygen delivery to vital organs. This state of shock causes a critical switch from aerobic to anaerobic metabolism, generating lactic acid and resulting in profound metabolic acidosis. The combination of hypoperfusion, exposure to the environment, and the administration of cold intravenous fluids leads to a drop in core body temperature, or hypothermia. Hypothermia, in turn, further disrupts the delicate enzymatic processes of the coagulation cascade, preventing effective clot formation and culminating in trauma-induced coagulopathy. Once this vicious, self-reinforcing cycle is fully established, it becomes exponentially more difficult to reverse, even with the full resources of an emergency department or operating room [15]. It is from this fundamental understanding of the body's rapid and predictable decline after severe injury that the seminal concept of the "golden hour" emerged.

First coined by Dr. R. Adams Cowley, the founder of Maryland's renowned Shock Trauma Center, the term "golden hour" encapsulates the critical window of approximately 60 minutes following a traumatic injury during which definitive medical care must be initiated to maximize the patient's chance of survival and minimize long-term disability [16]. While not a rigid scientific law—as outcomes are profoundly influenced by the specific injury pattern, patient physiology, and premorbid conditions—the "golden hour" serves as a powerful metaphor, a guiding operational principle, and a performance benchmark for all emergency care systems. Its core, revolutionary premise is that the timeliness of a life-saving intervention is as crucial as the intervention itself. The clock starts ticking from the moment of injury, not from the patient's arrival at the hospital, which fundamentally places the onus on the prehospital system—the Emergency Medical Services (EMS)—to act as the first, and perhaps most critical, link in the chain of survival. The "golden hour" philosophy has been the primary driver behind the development of rapid-response trauma systems worldwide.

The "golden hour" is not a single, monolithic period but can be conceptually divided into critical phases that dictate the priorities of care. The most crucial of these for EMS is the prehospital "platinum 10 minutes." This concept emphasizes that on-scene time for EMS providers attending to critically injured patients should be limited to ten minutes or less. The goal during this brief, high-pressure window is not to deliver definitive care, which is the role of the trauma team in the hospital, but to rapidly identify and manage only the most immediate life-threats—such as an obstructed airway, a tension pneumothorax, or catastrophic external hemorrhage—and to initiate rapid transport to an appropriate facility capable of providing definitive care [17]. This philosophy prioritizes the principle that for many major trauma patients, especially those in urban settings with short transport times, the single most important intervention is the rapid delivery of the patient to the doors of a trauma center, where surgical control of hemorrhage and other definitive treatments can be performed without further delay.

The evidence supporting the correlation between reduced prehospital time and improved outcomes is substantial, though complex and sometimes nuanced. A large prospective cohort study conducted by the Resuscitation Outcomes Consortium (ROC), a major research network, found that longer emergency medical services intervals were independently associated with increased mortality in trauma patients requiring advanced life support, particularly those with signs of hemorrhagic shock [18]. The study reinforced the physiological principle that delays in the prehospital phase can allow the lethal triad to become established and irreversible, thereby turning a potentially survivable injury into a fatal one. However, it is crucial to note that the "golden hour" principle is not just about raw speed; it is about the *intelligent and efficient use of time*. This means performing only those interventions that are absolutely necessary to sustain life during transport, while avoiding procedures that cause undue delay without providing a proven survival benefit. This critical balance between necessary intervention and rapid transport lies at the very heart of the ongoing debate and evolution in prehospital trauma care protocols, a topic which will be explored in depth in the following sections of this research. The ultimate challenge for any EMS system is to execute this balanced approach effectively under often chaotic and high-stress conditions, making the prehospital phase a defining factor in the trajectory of a trauma patient's survival.

3. Evolution and Scope of Modern Prehospital Trauma Care

The modern Emergency Medical Services (EMS) system is a product of decades of evolution, driven by military conflict, civilian advocacy, and relentless scientific advancement. Its origins can be traced to organized battlefield care, most notably in the Napoleonic Wars and the American Civil War, where the concepts of triage and rapid evacuation were first formally applied. However, the pivotal moment for civilian EMS in the United States, which served as a model for many systems worldwide, is widely attributed to the 1966 National Academy of Sciences "White Paper" entitled, "Accidental Death and Disability: The Neglected Disease of Modern Society." This landmark report delivered a scathing critique, highlighting that the average American citizen had a better chance of being saved by a veterinarian than by an ambulance attendant, as the latter often had minimal to no formal medical training [19, 21].

The scope of practice for prehospital providers has expanded exponentially since the days of the "scoop and run" service operated by funeral homes. Today, EMS personnel are stratified into distinct, hierarchically organized levels of training and certification, each with a rigorously defined set of skills and knowledge. At the foundation are Emergency Medical Responders (EMRs), often the first on scene, who are trained to provide immediate, life-saving interventions with minimal equipment. Emergency Medical Technicians (EMTs) form the backbone of many ground ambulance services, trained in comprehensive basic life support (BLS). Their skill set includes automated external defibrillation (AED), basic airway management using oropharyngeal and nasopharyngeal airways, oxygen administration, spinal motion restriction, and, crucially, the control of external hemorrhage through direct pressure and tourniquet application [22]. The most advanced level in many systems is the Paramedic, who is trained in advanced life support (ALS). Paramedics are qualified to perform a wide range of invasive and pharmacological interventions, such as endotracheal intubation, needle decompression for tension pneumothorax, surgical cricothyroidotomy, intraosseous access for fluid and drug administration, and the management of a complex formulary of emergency medications, including analgesics and vasopressors [2]. This tiered structure allows for the efficient allocation of resources, matching the patient's acuity level with the provider's expertise.

The delivery of prehospital trauma care is not a series of ad-hoc actions but a structured, protocol-driven process designed for maximum efficiency and consistency under chaotic conditions. It begins with a rapid yet comprehensive scene size-up, the first and one of the most critical steps, to ensure provider safety and identify the mechanism of injury (e.g., rollover, high-speed impact, penetrating trauma). This is immediately followed by the primary survey, a systematic, prioritized approach designed to identify and manage immediate threats to life. This process universally follows the ABCDE sequence: **A**irway maintenance with cervical spine protection, **B**reathing with ventilation and oxygenation, **C**irculation with hemorrhage control, **D**isability (neurological status using the AVPU or Glasgow Coma Scale), and **E**xposure/Environmental control [20]. This structured approach ensures that a compromised airway, which can lead to death within minutes, is addressed before a less immediately life-threatening issue like a fractured femur. Following the primary survey and the initiation of life-saving interventions, a more detailed secondary survey is often conducted, either on scene if the situation is stable and transport time is long, or, more commonly, during transport. This head-to-toe assessment aims to identify all other associated injuries that may have been missed in the initial, rapid assessment.

This entire clinical process is supported by and integrated with robust communication and dispatch systems. The role of Emergency Medical Dispatchers is critical, as they are the first point of contact and utilize standardized, medically approved protocols to prioritize calls, provide pre-arrival instructions to bystanders (such as guiding them through CPR or hemorrhage control), and ensure the appropriate level of response is dispatched [23]. Furthermore, effective communication between the EMS team and the receiving trauma center is a cornerstone of modern care. This prehospital notification, often following the MIVT (Mechanism, Injuries, Vital signs, Treatment) format, allows the trauma team to be assembled and prepared in advance, ensuring a seamless handoff and the immediate initiation of definitive care upon the patient's arrival. This "trauma alert" system has been consistently shown to reduce in-hospital delays and improve outcomes for severely injured patients [24].

A defining feature of contemporary EMS is its foundation in evidence-based practice and standardized guidelines. The days of operating on anecdotal experience are largely over, replaced by protocols informed by large-scale research. Internationally recognized educational programs like Prehospital Trauma Life Support (PHTLS) and the International Trauma Life Support (ITLS) provide a universal framework for assessment and management, ensuring a consistent standard of care regardless of geographic location [2, 25]. These programs are continuously updated to reflect the latest evidence, such as the shift away from aggressive crystalloid fluid resuscitation for patients with uncontrolled hemorrhage. The historical practice of administering large volumes of intravenous fluids to achieve normal blood pressure has been largely abandoned, as it can disrupt nascent clots, dilute clotting factors, and contribute to hypothermia, thereby exacerbating the lethal triad. The current standard of care, known as permissive hypotension or hypotensive resuscitation, aims to maintain a lower-than-normal systolic blood pressure (often around 80-90 mmHg) in the bleeding trauma patient without signs of head injury, just enough to maintain vital organ perfusion until surgical control of bleeding can be achieved [26].

The paradigm of prehospital trauma management is not monolithic and is often strategically divided into two overarching philosophies: the "Stay and Play" and "Scoop and Run" (or "Load and Go") approaches. The "Stay and Play" model, often associated with physician-staffed EMS systems in parts of Europe, involves performing extensive, advanced interventions on scene to fully stabilize the patient before transport. This may include advanced airway management, thoracostomy, and even the initiation of blood product transfusion [27]. In contrast, the "Scoop and Run" philosophy, which is predominant in many North American systems, especially for penetrating trauma in urban settings, prioritizes the absolute minimization of on-scene time. The goal is to perform only those interventions essential for sustaining life during transport—primarily controlling catastrophic external hemorrhage and managing the airway with basic techniques if needed—and then rapidly transporting the patient to a trauma center where definitive care can be provided [5]. The choice between these models is not arbitrary; it is a strategic decision based on a complex algorithm of factors including the mechanism of injury, the patient's physiology, the transport time to an appropriate facility, and the specific skill level of the EMS crew. This strategic debate remains one of the most dynamic and critical areas of discussion in prehospital trauma care, directly influencing system configuration, provider training, and ultimately, patient survival.

4. Critical Interventions in the Field:

Uncontrolled hemorrhage remains the leading cause of preventable death in trauma, accounting for nearly 40% of trauma mortality. Consequently, prehospital hemorrhage control represents the area with the most robust and universally agreed-upon evidence for intervention. The modern approach has been revolutionized, largely by military experience, which demonstrated that timely control of catastrophic bleeding is non-negotiable. The most significant advancement in this domain has been the widespread adoption of tourniquets. For decades, tourniquet use was discouraged due to fears of limb damage. However, extensive data from both military and civilian settings have unequivocally reversed this dogma. A seminal study on civilian trauma found that prehospital tourniquet application, when indicated for life-threatening extremity hemorrhage, was associated with a six-fold reduction in mortality without a concomitant increase in limb complications [6]. The key to success lies in proper training and the use of commercial, rather than improvised, tourniquets. Beyond tourniquets, the use of hemostatic dressings—impregnated with agents like kaolin or chitosan that accelerate clotting—has become a standard for junctional hemorrhages (e.g., groin, axilla) not amenable to tourniquet placement. These dressings have been shown to be highly effective in achieving hemostasis in scenarios where direct pressure alone fails [31]. The public health initiative to empower bystanders through programs like "Stop the Bleed" further extends this life-saving chain of survival into the minutes before EMS arrival, reinforcing that hemorrhage control is the paramount priority in trauma care.

Perhaps no other prehospital skill is as complex and controversial as advanced airway management. The fundamental goal is to ensure adequate oxygenation and ventilation and to protect the airway from aspiration. However, the method to achieve this goal is hotly debated. The options range from basic maneuvers (jaw thrust, chin lift) and adjuncts (oropharyngeal airway) to advanced techniques like endotracheal intubation (ETI) and the use of supraglottic devices (e.g., laryngeal tube, i-gel). Endotracheal intubation has long been considered the gold standard for definitive airway control, as it provides a sealed airway and protects against aspiration. Its benefit is most clear in specific patient populations, particularly those with severe traumatic brain injury (TBI), where preventing even a single episode of hypoxia or hypercapnia is critical to mitigating secondary brain injury. Studies have shown that successful prehospital ETI in severe TBI patients is associated with improved neurological outcomes [7].

However, the procedure is fraught with challenges in the prehospital environment. Difficulties include poor lighting, environmental hazards, patient positioning, and the physiological stress of the procedure itself. Failed intubation attempts or unintended esophageal intubation can have catastrophic consequences. Furthermore, multiple intubation attempts or prolonged on-scene times to secure the airway can delay transport to definitive care. This has led to significant controversy, with several large-scale studies suggesting that prehospital ETI, particularly when performed by paramedics with less frequent exposure to the procedure, may be associated with worse outcomes compared to basic airway management or rapid transport [32]. In response to these challenges, many EMS systems have increasingly adopted the use of supraglottic airways as a primary advanced airway device or as a rescue device after a failed intubation attempt. These devices are easier and faster to insert and provide adequate ventilation in most cases, though they offer less protection from aspiration than an ET tube [28]. The current trend is a move towards a standardized, protocol-driven approach that emphasizes first-pass success, continuous waveform capnography to confirm tube placement, and a clear backup plan, prioritizing the overall goal of oxygenation over the specific method of intubation.

Tension pneumothorax is another immediate life-threat that requires rapid prehospital intervention. It occurs when air accumulates in the pleural space under pressure, collapsing the lung and shifting the mediastinum, which impairs venous return to the heart and leads to cardiovascular collapse. The definitive prehospital treatment is needle thoracostomy, or needle decompression, which involves inserting a large-bore catheter into the second intercostal space at the mid-clavicular line to release the trapped air. While this is a potentially life-saving procedure, its success rate is highly dependent on patient anatomy and equipment. Traditional teachings and catheter lengths have been called into question, as studies using computed tomography (CT) have shown that the chest wall thickness in many patients, particularly those who are obese or muscular, may exceed the length of a standard catheter, leading to treatment failure [33]. This has prompted recommendations for the use of longer catheters or alternative insertion sites. For open pneumothorax (a "sucking chest wound"), the standard management involves applying a three-sided occlusive dressing or a specialized vented chest seal. This allows air to escape during exhalation, preventing the development of a tension pneumothorax, while preventing more air from entering during inhalation [34]. The evidence for prehospital needle decompression, while based on strong physiological principles, is primarily derived from case series and cohort studies, with a clear recognition of its technical limitations.

The philosophy of prehospital fluid resuscitation for hemorrhagic shock has undergone one of the most dramatic shifts in modern trauma care. The historical approach was to aggressively infuse large volumes of intravenous crystalloid fluids (e.g., normal saline, Lactated Ringer's) to achieve a normal blood pressure. This practice, however, has been largely discredited. Aggressive fluid administration in the context of uncontrolled internal bleeding can be detrimental; it can increase blood pressure, which may disrupt unstable clots and lead to renewed hemorrhage. It also dilutes the remaining clotting factors and platelets, worsens coagulopathy, and contributes to hypothermia and acidosis, thereby accelerating the lethal triad [26].

The current standard of care, as established by major trauma life support courses, is permissive hypotension or hypotensive resuscitation. This strategy aims to maintain a systolic blood pressure that is sufficient for end-organ perfusion (typically in the range of 80-90 mmHg) but low enough to not disrupt clotting or exacerbate bleeding. The goal is not to normalize the blood pressure but to keep the patient alive until surgical hemostasis can be achieved [35]. This is typically managed with smaller, titrated fluid boluses. More recently, the paradigm is shifting further from crystalloids towards the early administration of blood products. Some advanced EMS systems are now carrying and administering prehospital plasma and, in some cases, whole blood. The rationale is to replace what is lost—oxygen-carrying capacity and clotting factors—rather than just volume. Early studies on prehospital blood product administration have shown promising results, with reductions in mortality and corrections of coagulopathy upon hospital arrival [36]. This represents the cutting edge of prehospital trauma resuscitation, moving the capabilities of the hospital to the scene of the injury.

For decades, the standard prehospital practice for any trauma patient with a potential spinal injury was full spinal immobilization using a rigid cervical collar, a long backboard, and head blocks. This practice was based on the principle of preventing further injury to an unstable spinal column. However, a growing body of evidence has revealed significant downsides to this one-size-fits-all approach. Prolonged immobilization on a hard backboard can cause pain, respiratory compromise, pressure ulcers, and difficulty in assessing the patient's back for other injuries [37]. Furthermore, large registry studies have shown that the vast majority of immobilized patients do not have a spinal injury, indicating a very low positive predictive value for the mechanism of injury alone.

In response, the terminology and practice have shifted from "spinal immobilization" to "spinal motion restriction." Modern protocols, such as those from the National Association of EMS Physicians, advocate for a selective approach based on validated clinical decision rules like the NEXUS (National Emergency X-Radiography Utilization Study) criteria or the Canadian C-Spine Rule [38]. For alert, sober, low-risk patients without midline cervical tenderness or distracting injuries, no immobilization is necessary. For those requiring intervention, the current preference is to use a cervical collar and secure the patient directly to the ambulance stretcher, which is well-padded, rather than to a long backboard. The backboard is now primarily viewed as an extrication device, from which the patient should be log-rolled as soon as practical [39]. This evolution in practice demonstrates a mature understanding of balancing a small theoretical risk with the very real and common harms of overtreatment, emphasizing patient comfort and clinical assessment over rigid, unproven protocols.

5. The "Scoop and Run" vs. "Stay and Play" Paradigm Debate

The "Scoop and Run" philosophy is predicated on a core principle: for the critically injured trauma patient with life-threatening, surgically correctable injuries (particularly uncontrolled internal hemorrhage), the single most important therapeutic intervention is rapid transport to a trauma center where definitive care—namely, an operating room and blood bank—is available. Proponents of this approach argue that most advanced life support (ALS) procedures performed in the field are, at best, a temporary bridge and, at worst, a dangerous distraction that consumes precious minutes of the "golden hour." The primary objective is to minimize the prehospital time interval, especially on-scene time, which is viewed as a period of high risk and low therapeutic yield.

The evidence supporting "Scoop and Run" is particularly strong in the context of penetrating trauma in urban environments with short transport times. A landmark study by Durham et al. demonstrated that for patients with penetrating trauma to the torso, every minute of increased prehospital time was associated with a measurable increase in mortality, leading to the conclusion that "the only treatment is transport" [41]. The rationale is that procedures like starting intravenous lines, performing detailed assessments, or even attempting advanced airway management can delay transport without addressing the core problem of ongoing internal bleeding, which can only be stopped in the operating room. This approach heavily relies on the "platinum 10 minutes" concept, where EMS crews perform a rapid primary survey, address only the most immediate external threats (e.g., applying a tourniquet, placing a basic airway adjunct), and expedite load-and-go transport [17]. The success of this model is contingent upon a robust trauma system with designated trauma centers located within a reasonable geographic distance, allowing for short transport times that make rapid transit a feasible and life-saving strategy.

In contrast, the "Stay and Play" model advocates for a more comprehensive stabilization of the patient on scene before beginning transport. This philosophy, often associated with physician-staffed or highly advanced paramedic systems in parts of Europe (e.g., France, Germany, and the Nordic countries), operates on the principle that certain critical interventions are so time-sensitive that they must be initiated in the field to prevent irreversible physiological decline before the patient reaches the hospital [27]. The goal is to deliver a more stabilized, "ICU-ready" patient to the trauma team.

This approach is justified in several specific scenarios. For patients with severe traumatic brain injury, prehospital advanced airway management and controlled ventilation to prevent hypoxia and hypercapnia are considered paramount, and the time taken to secure the airway on scene is viewed as a necessary investment [7]. Similarly, in systems with long transport times (e.g., rural or remote areas), performing critical interventions like needle decompression, chest tube insertion, or even emergency anesthesia and surgery at the scene or during transport may be the only chance for patient survival. Furthermore, the advent of prehospital blood product transfusion is a powerful argument for the "Stay and Play" model. Administering plasma and red blood cells in the field to correct coagulopathy and anemia before long transports has been shown in several studies to improve survival compared to receiving crystalloids alone [36]. The "Stay and Play" model requires a higher level of provider training, more extensive equipment, and often the presence of a physician, but it aims to interrupt the lethal triad at its inception, rather than after a prolonged transport.

In contemporary practice, the rigid dichotomy between "Scoop and Run" and "Stay and Play" is increasingly seen as an oversimplification. The modern, evidence-based consensus leans towards a hybrid, or physiology-driven, approach. This model dictates that the strategy should be dynamically determined by a rapid assessment of the patient's physiological status, the mechanism of injury, and the system's operational context [42].

Under this framework, patients can be broadly categorized to guide strategy:

- **The "Unstable" Patient (The "Scoop and Run" Candidate):** A patient with compromised physiology (e.g., hypotension, altered mental status) following blunt or penetrating trauma is presumed to have uncontrolled internal bleeding. For these patients, the strategy is unequivocally "Scoop and Run." On-scene time should be limited to less than 10 minutes, with interventions restricted to controlling external hemorrhage, managing the airway with basic techniques if immediately feasible, and rapid extrication and transport [43]. Performing procedures like IV access should be attempted en route to the hospital, not on scene.
- **The "Stable" Patient (The "Controlled Stabilization" Candidate):** A patient with normal vital signs and an isolated injury may allow for a more thorough on-scene assessment and stabilization, including pain management and splinting, without incurring significant risk.
- **The Patient with a Critical, Time-Sensitive Airway Issue (The "Stay and Play" Candidate):** A patient in severe respiratory distress or with a Glasgow Coma Scale score of 8 or less requires definitive airway management. In this specific case, the time taken to secure the airway on scene is a necessary component of resuscitation, and transport is delayed until the airway is controlled [44].

This physiology-driven approach is formally encapsulated in protocols like the "Trauma Triage Rule" and assessments that prioritize physiological parameters over mechanism alone. It acknowledges that while rapid transport is generally beneficial for the bleeding patient, there are specific, critical physiological derangements that must be addressed before or during transport to prevent death en route.

The feasibility and preference for one paradigm over another are heavily influenced by the EMS system's structure and geography. Urban systems in North America, with short average transport times to Level I or II Trauma Centers, are naturally inclined towards the "Scoop and Run" model. The benefit of performing a complex procedure on scene is unlikely to outweigh the cost of a 5-10 minute delay when the hospital is only 5 minutes away [45].

Conversely, in rural settings, transport times can routinely exceed 30 or even 60 minutes. In these environments, a pure "Scoop and Run" approach may condemn the patient to a long period without critical interventions. Therefore, rural EMS systems must be trained and equipped to provide a higher level of "Stay and Play" care, including advanced airway management, pain control, and in some systems, prehospital blood transfusion [46]. The disparity in outcomes between urban and rural trauma patients, often referred to as the "rural trauma gap," is partly attributed to these geographical and systemic challenges in applying an optimal prehospital strategy [47].

The relationship between prehospital time and mortality is not linear nor universally negative, which adds complexity to this debate. While prolonged times are harmful to patients in hemorrhagic shock, studies have shown that for certain subgroups, such as those with severe traumatic brain injury, a slightly longer prehospital time was not associated with increased mortality, and in some cases, was linked to better outcomes, possibly due to more thorough stabilization and gentler transport [48]. This suggests that the *content* of care during the prehospital interval is as important as its *duration*. The key is to avoid "unproductive" time—delays for procedures that do not change outcomes—while investing in "productive" time for essential, life-saving interventions.

The future of this debate lies in the development of more refined point-of-care diagnostic tools to guide these critical decisions. The use of prehospital ultrasound (e.g., E-FAST exam) to identify internal bleeding could provide objective data to solidify the "Scoop and Run" decision for hypotensive patients [49]. Similarly, the use of viscoelastic haemostatic assays (like TEG or ROTEM) in the field, though futuristic, could precisely guide transfusion therapy, making "Stay and Play" resuscitation more targeted and effective [50].

6. Conclusion

The prehospital phase of trauma care, once considered merely a means of patient transport, has unequivocally established itself as a critical determinant of survival and functional outcomes. This research has systematically examined the multifaceted impact of Emergency Medical Services (EMS) on trauma patient survival, revealing a complex and evolving landscape where strategic paradigms, specific interventions, and system-level integration intersect.

The analysis confirms that the "golden hour" remains a powerful guiding principle, emphasizing that time to definitive care is paramount. However, the simplistic dichotomy of "Scoop and Run" versus "Stay and Play" has been superseded by a more sophisticated, **physiology-driven approach**. The evidence strongly advocates for the rapid identification of patients with uncontrolled hemorrhage and their expedited transport to an appropriate trauma center, with on-scene interventions limited to life-saving measures such as catastrophic hemorrhage control. Conversely, for patients with specific, time-critical physiological insults—notably, severe traumatic brain injury requiring definitive airway management or those in systems with prolonged transport times—a period of targeted, advanced stabilization in the field is not only justified but essential. This nuanced strategy ensures that the prehospital interval is used intelligently, avoiding harmful delays while performing critical interventions that can alter the patient's physiological trajectory.

Furthermore, the review has highlighted specific interventions where the evidence is compelling. The prehospital control of external hemorrhage through tourniquets and hemostatic dressings stands out as a definitive, life-saving practice with an undeniable impact on mortality. Similarly, the paradigm of **permissive hypotension** has replaced aggressive crystalloid resuscitation as the standard of care, acknowledging the iatrogenic harm of disrupting nascent clots and exacerbating the lethal triad. In contrast, the role of other advanced skills, such as endotracheal intubation, remains context-dependent, requiring a high degree of provider proficiency and a clear protocol to ensure that the benefits outweigh the risks of delayed transport.

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