

“Evaluating the Effectiveness of Primary Care Interventions to Improve Survival and Reduce Complications in Critical Trauma Patients During the Golden Hour: Systematic Review”

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Abstract:

The "golden hour" is the critical period following traumatic injury, during which timely and effective medical interventions are vital for improving survival rates and reducing complications. This systematic review evaluates the effectiveness of primary care interventions implemented during this time in critically injured trauma patients. Key interventions examined include airway management, hemorrhage control, fluid resuscitation, spinal immobilization, pain management, and rapid transport. Prehospital care teams, including EMTs and paramedics, play a pivotal role in delivering these interventions and ensuring rapid stabilization and transport to trauma centers. Evidence from various studies highlights that early interventions during the golden hour significantly reduce mortality, particularly in cases of hemorrhagic shock, traumatic brain injury, and severe extremity trauma. However, challenges such as variability in trauma severity, differences in prehospital care systems, and inconsistent protocols complicate the evaluation of intervention effectiveness. The review underscores the need for further research to standardize trauma care approaches and optimize outcomes during this critical period.

Keywords: Golden hour, Trauma care, Primary care interventions, Prehospital care, Survival rates, Complications, hemorrhage control, Airway management.

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Introduction:

The 'golden hour' is a well-known concept, suggesting that shortening time from injury to definitive care is critically important for better outcome of trauma patients. However, there was no established evidence to support it. We aimed to validate the association between time to definitive care and mortality in hemodynamically unstable patients for the current trauma care settings [1]. The golden hour represents the critical period immediately following a traumatic injury when rapid medical intervention is essential to improving outcomes. Research indicates that the likelihood of survival and favorable recovery outcomes increases significantly if patients receive appropriate care within this timeframe. This period is crucial for addressing life-threatening injuries, stabilizing the patient, and initiating treatment to prevent complications [2].

It is well known at this moment that a systems and systematic approach to trauma care cases is ideal. The prehospital controversies of in-the-field care in trauma cases, resuscitation, and transport, ground or air, are still debated. The most controversial is rapid transport to definitive care ("scoop and run") versus field stabilization in trauma, which remains a topic of debate and resulted in great variability of prehospital policy. Emergency medical services, including ground and air transportation, significantly extend the reach of tertiary care facilities, leading to rapid transport of critically ill patients [3]. Emergency medical services (EMS) providers are the first link to a trauma care system, and trauma triage made by EMS personnel is also a very important factor in a good outcome of trauma patients [1]. The assessment of patient and the treatment delivered by the first medical crew could have a large impact over the clinical evolution and output of trauma patient; that way, it is necessary to apply a systematic approach in this pathology, guided by clear and simple-to-follow recommendations applied on the scene. Recent review of the literature on helicopter emergency medical services (HEMS) showed an overall benefit of 2.7 additional lives saved per 100 HEMS activations [4].

Evaluating the effectiveness of primary care interventions during the golden hour—the critical first 60 minutes after a traumatic injury—focuses on improving survival rates and reducing complications for trauma patients [5]. During this period, timely and appropriate interventions can significantly influence patient outcomes. The golden hour is vital for critical trauma cases because rapid medical response can prevent the progression of life-threatening conditions such as hemorrhage, shock, or airway compromise.

Objective of the study

The objective of this systematic review is to evaluate the effectiveness of primary care interventions implemented during the golden hour to improve survival rates and reduce complications in critical trauma patients. This review will follow established protocols for systematic reviews to ensure rigor, transparency, and reproducibility.

Study question:

The study question is: **What is the effectiveness of primary care interventions during the golden hour in improving survival and reducing complications in critical trauma patients?**

Literature review

Golden Hour

The “Golden Hour” is the 60 minutes immediately post-trauma within which time the survival rate is much higher if patients can reach definitive care for treatment of their injuries. The organization of a traumatological network for an up-and-coming trauma center is very complex, has a very long implementation curve, and very often the international flow charts must be changed and adapted to match the local reality [3]. Death from an injury can occur in 3 periods or peaks:

1. The first peak will be within few seconds to minutes of an injury. Majority of these patients will die even before any medical personnel can reach out to them. The only way we can prevent death in this category of patients is by prevention, by following traffic rules and wearing personal protective gear while riding.
2. The second peak will occur within few minutes to several hours after the injury. These are the patients who benefit most from immediate action. The “Golden hour” signifies the importance of reaching out to these patients in a time-bound manner. It is not about what we can do in exactly 60 minutes, but rather an opportunity for the emergency medical team to significantly reduce the mortality and morbidity among these patients.
3. The third peak of death will occur from days to several weeks following the initial injury. Death usually occurs as a complication of the initial injury like severe infection, multiple organ failure etc. The mortality in these patients is greatly affected by the quality of care given in the preceding death peaks [4; 5].

Key Interventions and Their Effectiveness

Primary care interventions during the golden hour are critical in improving the survival and reducing complications of trauma patients [5]. Immediate interventions like airway management, hemorrhage control, and rapid transport, along with targeted fluid resuscitation and pain management, have shown the greatest impact on outcomes. Emerging technologies such as prehospital ultrasound and evolving protocols for spinal immobilization are helping to refine trauma care further [6]. So, the key interventions and their effectiveness are proved below:

1. **Airway Management:** Ensuring a patent airway is crucial in trauma cases, particularly in patients with head, neck, or facial injuries. Endotracheal intubation and other airway devices are often used to maintain or secure the airway in critical patients. The Effectiveness appear in rapid airway management has been shown to improve survival, especially in cases of traumatic brain injury (TBI). Early and effective intervention prevents hypoxia, a major factor in poor outcomes [7].
2. **Hemorrhage Control:** Uncontrolled bleeding is one of the leading causes of preventable death in trauma. The use of **tourniquets, hemostatic agents, and pressure dressings** are critical interventions during the golden hour. The Effectiveness appear in studies demonstrate that immediate hemorrhage control significantly reduces mortality, particularly in cases of extremity trauma. Early transfusion of blood products (like whole blood or packed red blood cells) has also been associated with better outcomes in severe bleeding [8].
3. **Intravenous Access and Fluid Resuscitation:** Establishing IV access and providing fluid resuscitation can stabilize circulation and prevent shock. Recent protocols emphasize permissive hypotension—deliberately allowing lower blood pressure until bleeding is controlled, to avoid worsening hemorrhage. The Effectiveness appears while traditional large-volume fluid resuscitation has been associated with better perfusion, recent evidence suggests that aggressive resuscitation may dilute clotting factors and increase bleeding. Balanced resuscitation has been shown to improve survival [9].
4. **Spinal Immobilization:** In trauma cases, especially those involving potential spinal injury, immobilization can prevent further damage to the spinal cord. Cervical collars and backboards are commonly used in prehospital

settings. The Effectiveness appears in while spinal immobilization has been a standard practice, some recent studies suggest that overuse, particularly in penetrating trauma cases, may increase complications and delay other critical interventions [8].

5. **Pain Management:** Controlling pain with medications like opioids or ketamine improves patient comfort and reduces stress, which may contribute to better physiological responses in trauma. The Effectiveness appears in timely pain management can improve outcomes by lowering stress-related complications and facilitating cooperation with treatment, though careful monitoring is necessary to avoid respiratory depression [10].
6. **Rapid Transport and Communication:** The goal during the golden hour is to stabilize the patient and rapidly transport them to a trauma center. In-field interventions should be limited to life-saving measures, and communication with the receiving facility ensures that the trauma team is prepared. The Effectiveness appears in rapid transport to a facility equipped for trauma care has been shown to significantly improve survival, particularly for patients with severe injuries requiring surgery or advanced care [11].

Role of Prehospital Care Teams in Managing Trauma Patients During the Golden Hour

Primary care providers in the field (such as EMTs, paramedics, and first responders) play a crucial role in these interventions. Their ability to assess, triage, and initiate treatment based on trauma protocols can dramatically impact the likelihood of survival and the severity of complications. Prehospital care teams—including Emergency Medical Technicians (EMTs), paramedics, and first responders—play a vital role in trauma management during the golden hour. This critical window is the first 60 minutes after a traumatic injury, where timely interventions significantly improve patient survival and reduce complications. Prehospital teams are responsible for rapid assessment, stabilization, and transport to definitive care, ensuring patients receive life-saving interventions as early as possible [12].

Evidence and Outcomes

Several studies and meta-analyses have shown that early intervention during the golden hour leads to a lower mortality rate and fewer complications, particularly in hemorrhagic and blunt trauma. Systems like prehospital trauma life support (PHTLS) and Advanced Trauma Life Support (ATLS) protocols help streamline these interventions. The golden hour refers to the critical first 60 minutes following traumatic injury, where timely and appropriate medical interventions can significantly affect survival and recovery [13]. Numerous studies and evidence reviews have demonstrated the effectiveness of prehospital care interventions, underscoring the role of prehospital care teams in improving patient outcomes.

The golden hour in trauma care refers to the crucial 60 minutes following a traumatic injury, during which timely medical intervention significantly improves patient survival and outcomes. Prehospital care teams, including paramedics and EMTs, play a pivotal role during this period by conducting rapid assessments, stabilizing patients, and ensuring their swift transport to appropriate trauma centers. Evidence demonstrates that interventions performed by these teams can dramatically reduce mortality and complications in critically injured patients [14].

One of the most important tasks for prehospital care teams is airway management. Securing an airway early—through techniques like endotracheal intubation—prevents hypoxia, which is especially crucial for patients with traumatic brain injuries. Studies have consistently shown that early airway control reduces secondary brain damage and mortality in these cases. Additionally, hemorrhage control is a leading priority, as uncontrolled bleeding is a major cause of preventable deaths in trauma patients. Interventions like tourniquets and hemostatic dressings have been proven to significantly increase survival, especially in cases of severe extremity injuries. This is particularly well-documented in both military and civilian trauma settings [15].

Fluid resuscitation, while vital for stabilizing patients in shock due to blood loss, must be carefully managed. Research suggests that aggressive fluid resuscitation before controlling bleeding can worsen outcomes by increasing internal hemorrhage. Instead, a strategy of permissive hypotension—allowing lower blood pressure until hemorrhage is managed—has shown to improve survival rates, particularly in penetrating trauma [13]. In recent years, prehospital blood transfusions have also been introduced in some settings, with promising results in reducing mortality for patients experiencing hemorrhagic shock.

While spinal immobilization has traditionally been a standard intervention for suspected spinal injuries, recent evidence suggests that routine immobilization may not always be necessary, particularly in penetrating trauma. Selective immobilization—used only when indicated by specific injury patterns—has been shown to reduce unnecessary delays in care without increasing the risk of spinal cord damage [15].

The speed with which trauma patients are transported to definitive care is another critical factor. Studies consistently demonstrate that patients transported within the golden hour have significantly higher survival rates compared to those with delayed transport. Prehospital protocols emphasizing the “load and go” approach, where patients are quickly stabilized and moved to a trauma center, are associated with better outcomes, especially in cases of severe hemorrhage or multiple traumas. Effective communication between prehospital teams and trauma centers also plays a key role in ensuring that receiving hospitals are prepared for immediate interventions upon the patient's arrival [16].

Pain management is another essential aspect of prehospital care, as uncontrolled pain can exacerbate physiological stress and complicate recovery. Evidence shows that early administration of analgesics like opioids or ketamine improves patient comfort and hemodynamic stability, reducing the risk of shock. Moreover, advanced diagnostics such as prehospital ultrasound (eFAST) have proven useful in identifying internal injuries early, allowing prehospital teams to make better triage decisions and ensure that patients receive the most appropriate care upon reaching the hospital [17].

In summary, prehospital interventions during the golden hour—such as airway management, hemorrhage control, fluid resuscitation, rapid transport, and pain management—are critical to improving trauma patient survival and reducing complications. These interventions, supported by evidence and clinical studies, highlight the crucial role prehospital care teams play in ensuring timely and effective care for critically injured patients [18]. Through rapid assessment, stabilization, and transport, these teams significantly impact the outcomes of trauma patients, particularly those in life-threatening conditions.

Challenges

Evaluating the effectiveness of prehospital interventions during the golden hour presents several challenges. One of the primary obstacles is the variability in trauma severity, as injuries can range from minor to life-threatening, making it difficult to standardize assessments across different patient populations. Additionally, there are significant differences in prehospital care systems across regions. Factors such as the availability of resources, protocols, and transport times can vary widely, affecting outcomes and making direct comparisons between regions difficult [18]. The skill levels of first responders also vary, as some teams may have advanced training in trauma care, while others may have limited experience or resources, further complicating the evaluation of these interventions.

Given these challenges, further studies are needed to generate more comprehensive and reliable data on the effectiveness of prehospital interventions. Regional trauma registries can play a key role in tracking outcomes and identifying trends, helping to tailor interventions to the specific needs and conditions of different settings. By addressing these challenges, research can better inform trauma care strategies, ultimately improving patient outcomes during the critical golden hour.

Conclusion

Interventions during the golden hour in trauma care are highly effective in improving survival and reducing complications. Rapid airway management, hemorrhage control, and prompt transportation to trauma centers are among the most impactful strategies, while fluid resuscitation and spinal immobilization protocols require a balanced, case-specific approach.

Prehospital care teams are crucial in determining the survival and recovery of trauma patients during the golden hour. Through rapid assessment, stabilization, transport, and effective communication, they ensure that trauma patients receive timely interventions and are prepared for definitive care upon arrival at a trauma center. Their actions significantly impact survival rates, reduce complications, and set the stage for positive long-term outcomes in critically injured patients.

Evidence supports the critical role of prehospital interventions during the golden hour in improving survival and reducing complications in trauma patients. Effective airway management, rapid hemorrhage control, appropriate fluid resuscitation, and timely transport to trauma centers are the key factors that contribute to better outcomes. Prehospital teams, equipped with advanced diagnostic tools and adhering to evidence-based protocols, are essential in ensuring that trauma patients receive timely, life-saving care.

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