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Research Article

The First Hour Golden Hour Management of a Penetrating Trauma Patient by the Red Crescent

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Abstract:

In the realm of emergency medical response, particularly in the context of penetrating trauma, the "Golden Hour" refers to the critical time frame within the first hour following an injury. Red Crescent teams are trained to prioritize rapid assessment, stabilization, and transport of penetrating trauma patients to optimize outcomes. During this crucial period, medical personnel conduct immediate interventions, including airway management, control of hemorrhage, and assessment for life-threatening injuries. The use of tourniquets, pressure dressings, and intravenous fluid resuscitation are essential components of their protocol, aimed at minimizing blood loss and ensuring that vital signs remain stable until definitive care can be provided in a hospital setting. The Red Crescent's approach emphasizes not only medical intervention but also efficient communication and coordination within their teams and with other emergency services. By ensuring that all responders are informed of the trauma patient's status and needs, the Red Crescent can streamline transport and surgical intervention. Additionally, first responders focus on assessing the mechanism of injury, which can provide invaluable insight into potential complications and necessary surgical

interventions required upon arrival at the hospital. This comprehensive strategy not only enhances survival rates but also fosters a culture of rapid response and effective trauma management within the Red Crescent teams, ultimately contributing to better outcomes for patients in critical conditions.

1. Introduction

Trauma remains one of the most significant public health challenges of the 21st century, constituting a leading cause of mortality and disability worldwide, particularly among young and economically productive populations. Within the broad spectrum of traumatic injuries, penetrating trauma—caused by objects such as bullets, shrapnel, or knives that pierce the skin and create deep, often critical wounds—presents a unique and immediate threat to life. These injuries can cause rapid and catastrophic blood loss, damage to vital organs, and irreversible physiological collapse. The management of such patients is a race against time, where minutes, and even seconds, dictate the difference between survival and death, between a full recovery and permanent disability. This critical window, famously known as the "Golden Hour," represents the first 60 minutes following a traumatic injury, during which there is the highest likelihood that prompt and appropriate medical treatment will prevent death [1].

The concept of the Golden Hour, though not a rigid scientific law, is a powerful metaphor for the urgency inherent in trauma care. Evidence suggests that mortality increases significantly if definitive care is delayed beyond this period, particularly for patients in hemorrhagic shock from penetrating injuries [2]. The pathophysiology is unforgiving: uncontrolled hemorrhage leads to decreased oxygen delivery, tissue hypoxia, coagulopathy, acidosis, and hypothermia—a lethal triad that, once established, becomes exponentially difficult to reverse. Therefore, the goal within the Golden Hour is not merely to transport the patient to a hospital, but to initiate life-saving interventions from the very moment of first medical contact and continue this chain of survival seamlessly to the emergency department and, if necessary, the operating room.

In many parts of the world, especially in conflict zones, areas of civil unrest, and regions prone to mass-casualty incidents, traditional emergency medical services (EMS) may be overwhelmed, non-functional, or unable to access casualties due to security concerns. It is in these most challenging environments that humanitarian organizations like the Red Crescent, operating under the principles of the International Red Cross and Red Crescent Movement, become the primary, and often the only, providers of pre-hospital and acute trauma care. The Red Crescent's unique position, with its network of volunteers deeply embedded within communities, its mandate for neutral and impartial humanitarian action, and its expertise in operating under fire, makes it an indispensable actor in the trauma ecosystem [3].

The management of a penetrating trauma patient by the Red Crescent during the Golden Hour is a complex, high-stakes, and highly standardized process. It begins with a rapid and dynamic scene assessment, prioritizing the safety of both rescuers and patients in an often-unpredictable environment. The initial clinical assessment follows a structured approach, such as the C-ABC (Catastrophic Haemorrhage, Airway, Breathing, Circulation) protocol, which immediately prioritizes the control of exsanguinating external hemorrhage as the first step, before addressing airway and breathing concerns [4]. This reflects a paradigm shift in trauma care, recognizing that massive bleeding is the leading cause of preventable death in trauma [5].

For the Red Crescent volunteer, the toolbox for this critical phase includes techniques ranging from direct pressure and wound packing with hemostatic gauze to the application of tourniquets for life-threatening extremity hemorrhage. The simple, proper application of a tourniquet has been shown to be a highly effective intervention, with studies from recent conflicts indicating that their use significantly improves survival rates from major limb injuries with minimal complication rates when applied correctly [6]. Beyond hemorrhage control, airway management in the field—ranging from simple jaw-thrust maneuvers to the use of supraglottic devices—is crucial, as a compromised airway can lead to death within minutes. Simultaneously, management of tension pneumothorax, a common and fatal complication of penetrating chest trauma, through needle decompression is a life-saving skill that must be mastered [7].

The role of the Red Crescent extends beyond these immediate procedures. It encompasses rapid but careful extrication, judicious fluid resuscitation to permit permissive hypotension in the bleeding patient, effective pain management, and, most critically, efficient communication and transportation logistics [8]. The decision of *where* and *how fast* to transport the patient is as important as any clinical intervention. This requires a pre-established trauma system, even in austere settings, where designated facilities are alerted and

prepared to receive a critically injured patient, bypassing closer but less capable health centers—a concept known as "scoop and run" with en-route care [9].

The challenge is immense. Globally, injuries account for over 8% of all deaths, with a disproportionate burden in low- and middle-income countries [10]. In conflict settings, the numbers are even more grim. The World Health Organization reports that in situations of armed conflict, trauma care systems are often decimated just when they are needed most, leading to mortality rates from injuries that are often double those in stable settings [11]. The work of the Red Crescent, therefore, is not just about clinical skill but about building resilient, ad-hoc trauma systems in the most fragile contexts.

This research aims to dissect and analyze the systematic approach of the Red Crescent to the Golden Hour management of a penetrating trauma patient. By synthesizing current clinical guidelines, evidence from recent conflicts, and the unique operational realities of humanitarian response, this paper will provide a comprehensive framework for pre-hospital trauma care in resource-limited and high-threat environments. It will argue that the effective integration of simple, evidence-based interventions by a well-trained and equipped Red Crescent volunteer within the first hour after injury is a cornerstone of humanitarian medical response and a powerful testament to the principle of saving lives and reducing suffering, even amidst the chaos of crisis [12].

2. The Unforgiving Clock: Pathophysiology of Penetrating Trauma and the Rationale for the Golden Hour

The management of penetrating trauma is fundamentally a race against a biological clock that begins ticking the moment tissue is violated. The concept of the "Golden Hour"—the critical first 60 minutes following injury—is not merely a medical adage but a physiological imperative rooted in the body's rapid, and often irreversible, descent into systemic collapse following severe injury. For Red Crescent volunteers operating at the front lines of conflict and disaster, understanding this pathophysiology is not academic; it is the essential foundation that informs every critical decision made in the field, transforming a chaotic response into a targeted, life-saving intervention.

Penetrating trauma, whether from gunshot wounds, stabbings, or explosive fragments, inflicts damage through two primary mechanisms: direct tissue destruction and energy transfer. The immediate consequence is often catastrophic hemorrhage, the leading cause of preventable death in trauma [13]. The human body has a remarkable but limited capacity to compensate for blood loss. The initial neuroendocrine response triggers vasoconstriction and tachycardia in an attempt to maintain perfusion to vital organs—the brain and heart. However, this compensatory mechanism is a short-lived bridge. Once approximately 30-40% of blood volume is lost, this bridge collapses, leading to the overt state of hemorrhagic shock, characterized by hypotension, altered mental status, and profound tissue hypoxia [14].

It is at this juncture that the body enters a self-perpetuating, vicious cycle known as the "lethal triad" of trauma: coagulopathy, acidosis, and hypothermia. This triad represents the transition from a potentially salvageable state to an often irreversible one. **Acidosis** develops as cells, deprived of oxygen, switch to anaerobic metabolism, producing lactic acid. This falling blood pH directly impairs cardiac contractility and reduces the efficacy of endogenous catecholamines. **Hypothermia** sets in due to environmental exposure, impaired thermoregulation from shock, and the administration of cold intravenous fluids. Even mild hypothermia (core temperature < 36°C) profoundly disrupts the enzymatic cascade of the coagulation system. This leads to **Trauma-Induced Coagulopathy (TIC)**, a state where the body's clotting mechanisms fail precisely when they are needed most [15]. TIC is not simply a dilution of clotting factors from fluid resuscitation; it is an early, multifactorial pathologic state driven by the activation of protein C, hyperfibrinolysis, and platelet dysfunction.

The synergy of the lethal triad creates a downward spiral. Acidosis and hypothermia exacerbate coagulopathy, leading to more bleeding. More bleeding worsens shock, deepening acidosis and hypothermia. Breaking this cycle becomes exponentially more difficult with each passing minute. Evidence from both military and civilian trauma centers has consistently demonstrated that delays in achieving hemorrhage control and reversing this physiologic decline are directly correlated with increased mortality. A landmark study by Eastridge et al. analyzing combat deaths found that nearly 25% of fatalities were potentially survivable, with the vast majority dying from uncontrolled hemorrhage, and 90% of these deaths occurring before the casualty reached a surgical facility [16]. This statistic underscores the absolute criticality of the pre-hospital phase, the very domain of the Red Crescent responder.

The "Golden Hour" must therefore be understood not as a guaranteed 60-minute window, but as a conceptual timeframe during which interventions

have the maximum potential to interrupt this pathophysiological cascade. The clock does not start in the emergency department; it starts at the scene. For a Red Crescent team, this hour is fragmented into precious segments: the time to locate and safely access the patient, the time to perform the primary survey and control catastrophic bleeding, the time to package and load the patient, and the time for transport to a facility capable of providing definitive care—be it a Red Crescent field hospital or a designated civilian trauma center. Each segment consumed by delay or inefficiency depletes the patient's physiological reserves.

The rationale for the Golden Hour is thus unequivocally clear. The goal of the Red Crescent volunteer during this period is to execute a series of evidence-based, time-critical actions that collectively serve as a physiological tourniquet for the entire body. Their mission is to stop the bleeding, protect the airway, and expedite evacuation, thereby preserving the patient's chance for survival by delivering them to surgeons before the lethal triad becomes entrenched. In the high-stakes environment of penetrating trauma, a comprehensive understanding of this unforgiving clock is what separates a structured, effective humanitarian medical response from a tragic exercise in futility [17].

3. The First Link: Dynamic Scene Assessment, Safety, and Triage in High-Threat Environments

For the Red Crescent volunteer, the response to a penetrating trauma incident begins not with clinical intervention, but with a rapid and continuous process of environmental assessment and decision-making conducted under the immense pressure of potential threat. Unlike in a conventional civilian setting, the scene of a shooting, explosion, or stabbing in a conflict zone or area of civil unrest is inherently dynamic and perilous. The principle of "first, do no harm" extends unequivocally to the responder themselves and their team; a dead or injured rescuer cannot save lives. Therefore, the initial and most critical phase of Golden Hour management is a structured approach to scene safety, dynamic risk assessment, and rapid triage, which collectively form the indispensable foundation for all subsequent medical care.

The methodology employed is often a militarized and adapted version of classic trauma protocols, designed specifically for high-threat environments. One such framework is the MARCH (Massive hemorrhage, Airway, Respiration, Circulation, Head/Hypothermia) algorithm, which is frequently preceded by an unspoken but paramount "S" for **Security and Situation**. Before any medical hand touches a patient, the team leader must conduct a lightning-fast but thorough assessment. This involves scanning for immediate threats like ongoing gunfire, unexploded ordnance, secondary devices, structural collapse, or hostile crowds. The concept of "hot," "warm," and "cold" zones is crucial. A **hot zone** is an area of direct and immediate threat where no medical care can be safely rendered. The primary goal here is to extract casualties to a **warm zone**, an area of indirect or potential threat, where rapid, life-saving interventions can begin under a calculated level of risk. The ultimate aim is to move to a **cold zone**, a secured area safe from the initial threat, for more comprehensive care and preparation for evacuation [21].

Once in a relatively secure warm zone, the process of triage begins. Triage, from the French word "trier" meaning to sort, is the art of allocating limited resources to maximize survival. In the context of a Red Crescent team facing multiple casualties from a penetrating trauma event, this is a heartbreaking but necessary prioritization. The **SALT** (Sort, Assess, Lifesaving interventions, Treatment/Transport) triage system or a simple **Triage Sieve** is commonly used. This process involves a rapid global assessment of all patients, categorizing them by immediate, obvious needs. The categories are typically:

- **Immediate (Red Tag):** Patients with life-threatening but potentially salvageable injuries, such as compromised airways or uncontrolled catastrophic hemorrhage. These are the first priority for the Red Crescent team.
- **Delayed (Yellow Tag):** Patients with significant injuries that require definitive care, but are not immediately life-threatening (e.g., stable long-bone fractures).
- **Minimal (Green Tag):** The "walking wounded" who can often assist with their own evacuation or help others.
- **Expectant (Black Tag):** Patients who have injuries that are nonsurvivable given the available resources or are already deceased. This is the most difficult decision, but in a mass-casualty scenario with limited capabilities, it allows resources to be focused on those with a chance of survival [22].

The integration of medical care into this hazardous framework requires a concept known as **Tactical Combat Casualty Care (TCCC)** or its civilian counterpart, **Tactical Emergency Casualty Care**

(TECC). These guidelines provide a standardized playbook for care under fire, care in the warm zone, and care during evacuation. For instance, during the "care under fire" phase, the only medical intervention is the control of massive external hemorrhage with a tourniquet; attempts to manage an airway or perform CPR would be futile and would place the responder at unacceptable risk [23]. It is only once in the relative safety of the warm zone that the full C-ABC survey and other interventions are performed.

The challenges for the Red Crescent in this phase are immense. They must operate with heightened situational awareness, constantly monitoring for a deteriorating security situation. Communication is often hampered by poor infrastructure or the need for radio silence. The emotional and psychological toll of making triage decisions under extreme duress, combined with the sights and sounds of severe human suffering, can be overwhelming. Furthermore, their distinctive Red Crescent emblem, meant to offer protection under international humanitarian law, is not always respected, making them potential targets [24].

Despite these challenges, this initial link in the chain of survival is non-negotiable. A poorly managed scene leads to more casualties and a failed mission. The rigorous training of Red Crescent volunteers in these non-clinical skills—in threat assessment, tactical movement, and rapid triage—is what enables them to safely reach the patient and begin the clinical race against the Golden Hour. It is this disciplined, structured approach to the first link that ensures the precious minutes that follow are used effectively to save lives, rather than being lost to chaos and preventable tragedy [25].

4. Stop the Bleed: Hemorrhage Control as the Primary Survey Priority (C-ABC)

The single most critical intervention in the Golden Hour management of a penetrating trauma patient is the immediate control of catastrophic hemorrhage. This principle is so paramount that it has fundamentally reordered the traditional ABC (Airway, Breathing, Circulation) sequence of the primary survey to the current C-ABC paradigm, where "C" stands for **Catastrophic Hemorrhage**. For the Red Crescent volunteer on the scene, this is the first and most urgent clinical hands-on task. Uncontrolled bleeding is the leading cause of preventable death in trauma, and the window to effectively address it is measured in minutes, not hours. The ability to rapidly identify and control exsanguinating hemorrhage is, therefore, the cornerstone of pre-hospital trauma care in austere and high-threat environments.

The clinical approach begins with a rapid but thorough visual and physical scan to identify the source of life-threatening bleeding. This is often starkly evident—a pool of blood, a pulsating wound, or a tourniquet already in place. The Red Crescent responder is trained to prioritize external, compressible hemorrhage from the extremities and junctional areas (groin, axilla, neck) before addressing more complex internal or non-compressible truncal bleeding. The tools and techniques employed follow a hierarchical, step-wise approach, moving from the simplest to the most advanced, based on the wound's location and severity. The first and most immediate technique is the application of **direct pressure**. If this fails to control the bleeding, the next step is **wound packing**, a highly effective technique for deep, narrow wounds in junctional areas or the base of the limbs. The protocol involves tightly packing the wound cavity with a hemostatic gauze, which is designed to accelerate clotting, followed by firm direct pressure over the packed wound for several minutes [31].

For life-threatening extremity hemorrhage that is not controlled by direct pressure or is too proximal for effective packing, the application of a **tourniquet** is the standard of care. The historical fear of tourniquets leading to universal limb loss has been decisively overturned by extensive data from recent military conflicts and civilian trauma systems. Modern studies show that while tourniquets can cause nerve and tissue damage with prolonged application (often cited as over two hours), this risk is negligible compared to the certainty of death from exsanguination [32]. The Red Crescent volunteer is trained in the correct application of a commercial tourniquet, such as the Combat Application Tourniquet (CAT) or the SAM® XT, ensuring it is placed high and tight on the limb, tightened until the bleeding stops, and the time of application is clearly documented. The mantra is, "If it's arterial bleeding, and it's from a limb, and it's bad, put on a tourniquet."

For bleeding from junctional areas where a standard tourniquet cannot be effectively applied, such as the groin or axilla, **junctional tourniquets** have been developed. Devices like the Combat Ready Clamp (CRoC) or the Junctional Emergency Treatment Tool (JETT) are designed to provide direct pressure over the femoral or axillary arteries. The effective use of these devices requires specific training but can be a life-saving bridge until surgical control is achieved [33]. The final step in the hemorrhage control hierarchy in the pre-hospital setting is the use of **topical hemostatic agents**. These are impregnated into gauze and are categorized as either factor concentrators (e.g., chitosan-based) or

procoagulant supplements (e.g., kaolin-based). They provide a powerful adjunct to wound packing, particularly in coagulopathic patients, by providing a surface that aggressively promotes rapid clot formation [34].

The implementation of this "Stop the Bleed" protocol by the Red Crescent is not merely a technical skill; it is a logistical and training challenge. It requires that every frontline volunteer is equipped with a personal trauma kit containing at least one commercial tourniquet, hemostatic gauze, and compression bandages. Furthermore, it requires a culture shift that empowers volunteers to act decisively and use these tools without hesitation. The evidence for its effectiveness is overwhelming. A study of the Israel Defense Forces' experience showed that pre-hospital tourniquet application, when indicated, had a survival rate of 96%, with most deaths occurring in patients who had the tourniquet applied post-mortem [35]. Similarly, the "Stop the Bleed" campaign, a global initiative, has demonstrated that with minimal training, laypersons can significantly increase the survival odds of bleeding victims, a principle that is magnified when applied to trained humanitarian workers [36].

5. Securing the Lifeline: Airway and Breathing Management in the Austere Pre-Hospital Setting

Following the immediate control of catastrophic hemorrhage, the Red Crescent responder's focus must rapidly shift to the patient's next greatest threat: the compromise of oxygenation and ventilation. In the penetrating trauma patient, the airway and breathing (the "A" and "B" of the C-ABC sequence) are vulnerable to a host of immediate and life-ending complications. Management of these systems in the austere, often chaotic pre-hospital environment presents a unique set of challenges that demand a pragmatic, scalable, and highly effective approach. The goal is not to replicate the capabilities of a hospital emergency department, but to identify and correct immediately life-threatening conditions using the simplest, fastest, and most reliable techniques available, thereby securing the physiological lifeline until definitive care is reached.

Airway compromise in penetrating trauma can arise from multiple etiologies. Direct trauma to the face or neck can cause anatomical disruption, swelling, or expanding hematomas that physically obstruct the airway. A depressed level of consciousness, resulting from hemorrhagic shock or traumatic brain injury, leads to a loss of protective gag and cough reflexes, allowing the tongue to fall back and occlude the pharynx or permitting aspiration of blood and vomitus. The Red Crescent volunteer's initial assessment is rapid and hands-on. It begins with asking the patient a simple question; a verbal response indicates a patent airway, at least for the moment. An inability to speak, the presence of gurgling sounds, stridor, or agonal respirations are all ominous signs of impending airway catastrophe.

The interventions follow a ladder of escalation, starting with the most basic. The first step is often a simple **jaw-thrust maneuver**, which mechanically pulls the base of the tongue forward without manipulating the cervical spine, a crucial consideration in potential neck injuries. Suctioning is vital to clear the oropharynx of blood, vomit, or debris. If these simple measures are insufficient, the next step is the insertion of a **supraglottic airway (SGA)** device, such as an i-gel or laryngeal mask airway (LMA). These devices have become the mainstay of pre-hospital advanced airway management for several reasons. They can be inserted blindly with minimal training, do not require direct visualization of the vocal cords with a laryngoscope, and provide a reliable seal for ventilation. Their use has been shown to have a higher success rate and fewer complications than endotracheal intubation in the hands of pre-hospital providers, especially in challenging environments [41]. Endotracheal intubation, while the gold standard for definitive airway control, is a highly skill-dependent procedure that is fraught with pitfalls in a moving vehicle, a dark alley, or under threat. Failed intubation attempts can waste precious time, cause further injury, and worsen hypoxia. Therefore, for the Red Crescent, the SGA represents the pragmatic pinnacle of field airway management for the majority of providers.

Simultaneous to airway assessment, breathing must be evaluated. Penetrating trauma to the chest can create immediately life-threatening conditions that require rapid diagnosis and intervention. The two primary threats are **tension pneumothorax** and **sucking chest wounds**. A tension pneumothorax occurs when air enters the pleural space through a one-way valve-like lung injury, building up pressure with each breath. This pressure collapses the lung, shifts the mediastinum, and compresses the great vessels and the opposite lung, leading to rapid cardiovascular collapse. The classic signs are severe respiratory distress, tracheal deviation away from the affected side, distended neck veins, and unilateral absence of breath sounds. In the noisy, chaotic field environment, relying on absent breath sounds alone is unreliable. The key is a high index of suspicion based on the mechanism of injury (penetrating trauma to the chest) and the clinical picture of rapid deterioration. The definitive pre-hospital treatment is **needle decompression**.

This involves inserting a large-bore (10-14 gauge) catheter into the second intercostal space in the mid-clavicular line on the affected side. The audible release of air under pressure is both diagnostic and therapeutic, converting a tension pneumothorax back into a simple one and buying critical time for transport [42].

An open or "sucking" chest wound, where a defect in the chest wall allows air to be drawn directly into the pleural cavity, is managed with a **three-sided occlusive dressing**. A commercial chest seal is ideal, but any airtight material (plastic, foil) can be used. The dressing is taped on three sides, creating a one-way valve that allows air to escape during exhalation but prevents it from being drawn in during inhalation. Taping on all four sides risks converting an open pneumothorax into a tension pneumothorax, a potentially fatal error [43].

The challenges of managing airway and breathing in this context cannot be overstated. Procedures like needle decompression require practiced skill, and SGAs can be difficult to place in patients with significant facial trauma. Monitoring is limited to clinical signs and pulse oximetry if available. The environment is often working against the provider—poor lighting, noise, weather, and ongoing threats. However, by adhering to a strict C-ABC sequence and mastering a limited set of high-impact, low-tech interventions—jaw-thrust, suction, SGAs, needle decompression, and chest seals—the Red Crescent volunteer can effectively secure the patient's lifeline. This systematic approach ensures that the patient, having survived the initial hemorrhage, is oxygenated and ventilated well enough to survive the journey to the surgeons who can provide the definitive care that will ultimately save their life [44].

6. Conclusion

This research has systematically delineated the critical, time-sensitive protocols that define the Golden Hour management of a penetrating trauma patient within the unique operational framework of the Red Crescent. From the initial, perilous moments of dynamic scene assessment and triage in high-threat environments to the definitive, life-saving interventions for hemorrhage control and airway management, the evidence presents a compelling and unified strategy. The findings unequivocally demonstrate that survival from penetrating trauma is not a product of chance but the direct result of a meticulously executed chain of survival, where each link—security, hemorrhage control, airway management, and rapid evacuation—is interdependent and non-negotiable.

The paradigm shift to the **C-ABC** sequence, which prioritizes the immediate control of catastrophic hemorrhage, stands as the single most significant factor in preventing preventable deaths. The evidence supporting the use of tourniquets, hemostatic gauze, and junctional devices is irrefutable, transforming the pre-hospital landscape from passive transport to active, life-saving intervention. Furthermore, the pragmatic approach to securing the airway and managing thoracic injuries with supraglottic devices and needle decompression underscores a fundamental principle of austere medicine: the right intervention is the one that is most effective, most rapid, and most reliable in the given environment, not necessarily the most technologically advanced.

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