



The Red Crescent's Triage Framework for Crush Injury Cases at Public Events

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Abstract:

Mass gatherings (MGs) present a significant risk for crush disasters, where the resulting crush injuries can lead to the lethal Crush Syndrome (CS). Standard trauma triage systems are ill-equipped to identify patients at risk for CS, who may appear stable initially but succumb to systemic complications like hyperkalemic cardiac arrest and acute kidney injury post-extrication. This review examines the evidence-based triage framework developed by the Red Crescent to address this critical gap in prehospital emergency care. A comprehensive literature review was conducted, analyzing peer-reviewed publications, disaster medicine reports, and official guidelines from humanitarian organizations. The development, structure, and application of the Red Crescent's protocol were evaluated with a focus on its pathophysiological rationale and operational practicality. The Red Crescent's framework is a product of a systematic methodology involving evidence synthesis, multi-disciplinary expert consultation, and field validation. It modifies the primary survey by integrating a "Mechanism" (M) component to identify prolonged compression. The secondary survey emphasizes rapid limb assessment for key indicators of compartment syndrome—palpable tenseness and sensory deficit—over late signs like pulselessness. Triage prioritization is directly linked to specific interventions; patients with a significant crush mechanism and signs of neurological compromise or myoglobinuria (detected via point-of-care urine

dipstick) are categorized as Immediate (Red) and require aggressive, pre-emptive intravenous fluid resuscitation to prevent CS. The protocol is designed for seamless integration within the broader mass casualty incident response system, leveraging the Red Crescent's extensive volunteer network and logistical capabilities. The Red Crescent's crush injury triage framework represents a critical advancement in disaster medicine. By providing a structured, evidence-based tool for the early identification and prioritization of patients at risk for Crush Syndrome, it empowers responders to prevent predictable, delayed mortality in mass gathering settings. Its widespread adoption and integration into public event medical planning are essential for improving survival outcomes in these complex emergencies.

1. Introduction

Mass gatherings (MGs), defined as events attended by a sufficient number of people to strain the planning and response resources of a community, state, or nation, represent a significant and growing challenge for global public health and emergency medical services (EMS) [1]. The spectrum of MGs is broad, encompassing religious pilgrimages, such as the Hajj, which attracts millions, major sporting competitions, music festivals, and large-scale political rallies [2]. While the specific risks vary by event type, a common and potentially catastrophic threat present in many crowded environments is the risk of a crush disaster. Catastrophic crowd incidents, such as those at the Hillsborough Stadium (1989) or more recently in Seoul (2022), tragically demonstrate the lethal potential of crowd collapse and compressive asphyxia [3]. However, beyond these acute, high-fatality events, a more frequent and medically complex challenge exists: the management of individuals suffering from crush-related injuries within a chaotic and resource-limited field environment.

Crush injuries are not merely severe traumas; they represent a distinct pathological entity with a biphasic clinical course that demands specific and timely intervention. The initial injury results from direct, prolonged mechanical force to skeletal muscle, most commonly in the extremities, leading to muscle compression and necrosis [4]. The critical, and often fatal, complication arises during the post-compression phase, known as Crush Syndrome (CS). Upon extrication or relief of pressure, reperfusion of the ischemic tissues leads to the systemic release of intracellular contents, including myoglobin, potassium, phosphate, and lactic acid, into the circulation [5]. This cascade can precipitate lethal hyperkalemia-induced cardiac arrest, profound metabolic acidosis, and acute kidney injury (AKI) from myoglobinuric tubular necrosis [6]. The cornerstone of preventing CS is aggressive, pre-emptive fluid resuscitation, ideally initiated before or during extrication, a principle that fundamentally alters standard triage and field treatment protocols [3].

This pathophysiological complexity creates a profound dilemma for first responders at MGs. Standard trauma triage systems, such as the Simple Triage and Rapid Treatment (START) protocol, are designed to rapidly identify patients with immediate threats to life from external hemorrhage or airway compromise [7]. However, they are not calibrated to identify the patient with a seemingly stable isolated limb injury who is, in fact, progressing inexorably toward systemic toxicity and renal failure. In the high-noise, high-chaos, and resource-constrained setting of a public event, these "walking wounded" with significant crush mechanisms can be tragically under-triaged, leading to preventable morbidity and mortality.

It is within this critical gap in prehospital care that specialized triage frameworks become paramount. The International Federation of Red Cross and Red Crescent Societies (IFRC), through its extensive experience in disaster response and medical operations at MGs worldwide, has developed and refined a targeted triage framework for crush injury cases. This protocol is designed to be rapidly deployable by trained first-aid and medical personnel to systematically identify patients at risk for CS and to prioritize them for life-saving interventions, particularly fluid therapy. The framework integrates mechanistic criteria (duration of compression), clinical signs (limb swelling, sensory-motor deficit), and simple point-of-care diagnostics where available (e.g., urine dipstick for heme) to stratify risk and guide management [8]. Therefore, the purpose of this comprehensive review is to critically analyze and present the Red Crescent's evidence-based triage framework for crush injury cases at public events.

2. The Importance of Triage in Emergency Medical Services

1. Foundational Principles and Evolution

Triage, derived from the French verb *trier* meaning "to sort," is the cornerstone of effective disaster medicine and emergency medical services (EMS). Its fundamental purpose is to prioritize patient care to achieve the greatest good for the greatest number

when resources are overwhelmed [9]. This represents a radical departure from the standard hospital and prehospital ethic of providing the most extensive care to the most critically injured first. In a mass casualty incident (MCI) or a resource-limited mass gathering (MG), the paradigm shifts from providing optimal care for every individual to providing *rational* care for the entire population of patients.

The evolution of triage systems reflects the changing nature of threats and medical capabilities. Modern field triage systems are typically multi-level processes. The primary triage, conducted within seconds to minutes of first contact, categorizes patients based on immediate life threats and urgency of care. Commonly used systems include the Simple Triage and Rapid Treatment (START) protocol and its pediatric counterpart, JumpSTART [10]. These systems use a simple algorithm based on patient ambulation, respiratory status, perfusion (radial pulse/capillary refill), and mental status (ability to obey commands) to assign one of four color-coded categories:

- **Red (Immediate):** Patients with compromised airways, severe respiratory distress, uncontrolled hemorrhage, or decompensated shock who require immediate, life-saving intervention and have a high probability of survival with such care.
- **Yellow (Delayed):** Patients with significant injuries (e.g., major fractures, stable abdominal wounds) that are not immediately life-threatening. Their treatment can be delayed for a period without a significant increase in mortality.
- **Green (Minimal):** The "walking wounded" with minor injuries who are ambulatory and can often assist in their own care or the care of others.
- **Black (Deceased/Expectant):** Patients who are apneic after a single airway maneuver (in START) or who have injuries so severe that survival is unlikely even with maximal medical care given the current resource constraints.

Secondary triage occurs after the initial scene stabilization, often at a casualty collection point, and involves a more thorough head-to-toe assessment to identify evolving conditions and reassign priorities. A tertiary triage level may be used for prioritizing transport or specialized resource allocation (e.g., operating room time) [11].

2. The Critical Role in Mass Casualty Incidents (MCIs) and High-Density Crowds

The significance of triage is magnified exponentially in the context of MCIs and high-density public events. In these scenarios, the

demand for medical resources (personnel, equipment, transport, and receiving hospitals) instantly and dramatically exceeds supply. Without a systematic, pre-established, and widely understood triage process, the response devolves into chaos, characterized by:

- **Inequitable Resource Allocation:** Well-intentioned responders may devote disproportionate time and resources to the first critically injured patient they encounter (the "first-come, first-served" pitfall) or to vociferous patients, while others with more salvageable, time-sensitive conditions deteriorate unnoticed.
- **Failure to Identify Compensating and Occluded Injuries:** The "walking wounded" (Green tag) category is particularly perilous in crowd-related incidents. Patients with internal hemorrhage, evolving crush syndrome, or closed head injuries may initially appear stable, only to decompensate rapidly after the triage point. Furthermore, in the adrenaline-fueled state following an incident, individuals may not perceive the severity of their own injuries.
- **Provider Overwhelm and Cognitive Load:** The sensory overload of a chaotic MCI—noise, confusion, multiple patients, and emotional distress—impairs clinical judgment. A standardized triage protocol acts as a cognitive forcing strategy, guiding responders through a consistent, reproducible algorithm that reduces errors in judgment under stress [12].

High-density crowd situations, such as festivals, sporting events, and political rallies, present a unique subset of MCI risks. The primary mechanism of injury in crowd disasters is often crush trauma and compressive asphyxia, which create specific triage challenges [3]. Standard trauma triage systems like START, which rely heavily on respiratory rate and perfusion, can be misleading in this context. A victim of severe compressive asphyxia may be apneic and pulseless (triaged Black) due to the mechanical inability to expand the chest cavity, even if their underlying organs are viable. Conversely, a patient extricated from a crush incident with a swollen, pulseless limb but a patent airway and normal respiration might be triaged as Yellow (Delayed), failing to capture the imminent risk of lethal hyperkalemia from Crush Syndrome [5, 7].

3. The Imperative for Crush-Specific Triage Modifications

This limitation of generic triage systems underscores the necessity for specialized triage

frameworks, such as the one developed by the Red Crescent, for specific injury patterns. The pathophysiological timeline of Crush Syndrome necessitates a proactive, rather than reactive, triage approach. The goal is not just to identify who is most critically injured now, but to predict who will become critically ill in the near future based on the mechanism of injury.

A crush-specific triage algorithm must integrate additional criteria beyond the standard ABCD (Airway, Breathing, Circulation, Disability) assessment. Key modifications include:

- **Mechanism of Injury:** Explicitly documenting a reported or estimated duration of compression (e.g., >15-30 minutes is often cited as a significant risk factor) [13].
- **Limb-Specific Assessment:** Systematically evaluating all four extremities for signs of compartment syndrome: extreme tension and swelling (wood-like hardness), sensory deficit (paresthesia), motor deficit (paralysis), and loss of distal pulse (a late sign). The presence of these signs, even in a hemodynamically stable patient, should trigger an upgrade in triage priority [7].
- **Point-of-Care Testing:** Where feasible, incorporating urine dipstick analysis for heme (signifying myoglobinuria) can provide an objective, early biomarker for significant muscle necrosis and impending renal failure, warranting an Immediate (Red) triage category for rapid fluid resuscitation [14].

Data from past events supports the value of such targeted triage. Analysis of the 1988 Spitak earthquake response in Armenia demonstrated that early and aggressive volume expansion, guided by a suspicion for crush injury, significantly reduced the incidence of fatal hyperkalemia and acute renal failure requiring dialysis [15]. Similarly, protocols established for earthquake responses have been adapted for MG settings, recognizing that the delayed, second-wave of casualties from CS can be prevented through effective field triage and management [16].

The Role of the Red Crescent in Emergency Medical Response

1. Historical Foundation and Humanitarian Mission

The International Red Cross and Red Crescent Movement is the world's largest humanitarian network, with a history and mission intrinsically linked to organized emergency medical response. Its genesis can be traced to the seminal work of Henry Dunant, a Swiss businessman who witnessed the horrific aftermath of the Battle of Solferino in

1859. His book, *A Memory of Solferino*, not only documented the suffering of wounded soldiers left without care but also proposed a radical solution: the creation of national relief societies to provide neutral and impartial aid during wartime [16]. This vision led to the founding of the International Committee of the Red Cross (ICRC) and the adoption of the First Geneva Convention in 1864.

The Red Crescent emblem was first used by the Ottoman Empire during the Russo-Turkish War (1877-1878) as a culturally acceptable alternative to the Red Cross, and it was formally recognized in 1929. Today, the International Federation of Red Cross and Red Crescent Societies (IFRC) comprises 191 National Societies, including the Turkish Red Crescent and others across the Muslim world, which operate under a shared set of Fundamental Principles: humanity, impartiality, neutrality, independence, voluntary service, unity, and universality [17]. These principles are not merely aspirational; they are operational necessities that grant the Movement access and acceptance in complex and often politically sensitive disaster zones and conflict areas, enabling the delivery of care where other organizations cannot.

The mission of the IFRC and its member societies is to "prevent and alleviate human suffering wherever it may be found." This mission extends beyond wartime to include natural disasters, health emergencies, and the medical preparedness for mass gatherings. Their mandate is to protect human life and health, ensure respect for the human being, and prevent and alleviate suffering without any adverse distinction based on nationality, race, religious beliefs, class, or political opinions [17].

2. Operational Framework and Disaster Response Cycle

The operational strength of the Red Crescent lies in its decentralized yet coordinated network. Each National Society is an auxiliary to the public authorities in the humanitarian field within its own country. This unique status means that while they are independent NGOs, they work in close partnership with their national governments' disaster management agencies, filling critical gaps in public service delivery, particularly at the community level.

The Red Crescent's operational framework is structured around the comprehensive disaster management cycle, which includes:

- **Preparedness and Capacity Building:** This is a core function. National Societies maintain a corps of trained volunteers and staff, pre-positioned stocks of emergency supplies (including specialized medical kits for crush

syndrome), and established emergency operations centers. They invest heavily in community-based disaster risk reduction and public health education, which is crucial for mass gatherings. For instance, before a large pilgrimage or festival, the local Red Crescent society will train thousands of volunteers in first aid, crowd management, and specific health threats like heatstroke or crush injury management [18].

- **Response and Emergency Medical Services:** During a disaster or MCI, the Red Crescent activates its emergency response system. Its functions are multi-faceted:
 - **Immediate First Aid and Triage:** As often the first organized responders on the scene, Red Crescent volunteers establish casualty collection points and implement triage protocols. Their widespread presence at public events means they can initiate life-saving interventions within the "golden hour," a critical factor in trauma outcomes [19].
 - **Provision of Emergency Medical Services:** They operate mobile medical teams, field hospitals, and advanced first aid posts to stabilize patients. A key differentiator is their focus on evidence-based protocols for specific disaster medicine pathologies, such as the *First Aid in Crush Syndrome* guidelines, which provide clear algorithms for the pre-hospital management of crush injuries, including fluid resuscitation protocols [14].
 - **Search and Rescue and Extrication:** In collaboration with technical rescue teams, Red Crescent volunteers assist in the safe extrication of victims, applying their medical knowledge to guide the process—for example, advising on the careful handling of crushed limbs and the imperative to initiate intravenous fluids *before* releasing a long-entrapped victim [7].
 - **Psychosocial Support:** Recognizing that the psychological impact of a disaster is immediate and profound, the Red Crescent deploys psychosocial support teams to provide psychological first aid to survivors, families, and often other responders, addressing acute stress reactions and mitigating long-term mental health consequences [20].

- **Recovery and Rehabilitation:** The Red Crescent's role continues long after the acute phase. This includes supporting the restoration of basic health services, providing ongoing care for the injured, facilitating physical rehabilitation for amputees and those with disabilities, and running long-term psychosocial support programs.

3. Specific Functions in Mass Casualty Situations and Mass Gatherings

In the specific context of mass gatherings and MCIs, the Red Crescent's value is amplified by its scalability and specialized medical expertise. Their operational model for such events is characterized by several key functions:

- **Integrated Command and Coordination:** Red Crescent operations are designed to integrate seamlessly within the national incident command system. They co-locate their commanders within the official emergency operations center, ensuring that their medical response is complementary and not duplicative of governmental efforts. This avoids the confusion that often plagues disaster responses with multiple uncoordinated actors [21].
- **Logistics and Supply Chain Mastery:** The IFRC's global logistics system can deploy Emergency Response Units (ERUs)—standardized packages of trained personnel and equipment—anywhere in the world within hours. A specialized ERU can be a fully functional field hospital, a rapid deployment hospital, or a basic health care unit, all pre-equipped to treat specific injuries, including crush syndrome, with necessary supplies like IV fluids, mannitol, and urine dipsticks [14, 18].
- **Leveraging the Volunteer Network:** The ability to rapidly mobilize a large number of trained, disciplined, and identifiable volunteers is a unique asset. In a crowd disaster, these volunteers can be deployed to perform crowd control, direct fleeing attendees to safety, establish a perimeter, and perform the initial, critical step of primary triage, all while wearing the protective and recognizable emblem of the Red Crescent.
- **Specialization in Disaster-Specific Medicine:** Unlike many EMS systems that are optimized for day-to-day emergencies, the Red Crescent continuously develops and refines its protocols for low-frequency, high-acuity events. Their guidelines for managing crush syndrome, heat-related illnesses, and chemical exposures are based on the latest evidence in disaster medicine and are disseminated throughout their

global network, ensuring a standardized, high-quality response [7, 14].

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Development of the Triage Framework for Crush Injuries

1. The Imperative for a Specialized Protocol

The development of the Red Crescent's specialized triage framework for crush injuries was not an academic exercise but a necessary evolution driven by repeated, hard-won lessons from the field. While standard triage systems like START are effective for general trauma, their application in disasters characterized by prolonged entrapment and crush mechanisms, such as earthquakes and crowd collapses, revealed critical shortcomings [11, 21]. The fundamental failure of generic systems was their inability to identify the patient at high risk for Crush Syndrome (CS) *before* the onset of life-threatening systemic complications, particularly hyperkalemic cardiac arrest. As analyzed in the response to the 1999 Marmara earthquake, a significant proportion of fatalities occurred post-extrication due to metabolic disturbances, not the initial trauma [22]. This evidence created a compelling mandate for a triage tool that incorporated the unique pathophysiology of crush injury, shifting the paradigm from reactive to predictive risk stratification.

The methodology for creating this framework was systematic, iterative, and grounded in the principles of evidence-based medicine, humanitarian practice, and operational practicality. Its development can be deconstructed into three core, interconnected phases: evidence synthesis and literature review, multi-disciplinary expert consultation, and field validation through simulation and after-action analysis.

2. Phase One: Evidence Synthesis and Pathophysiological Foundation

The initial phase involved a comprehensive and critical review of the global scientific literature on crush syndrome and disaster triage. This was not limited to a simple compilation of studies but required a deep analysis to extract clinically actionable data points that could be translated into simple field decision points. Key areas of focus included:

- **Epidemiology and Risk Factors:** The development team analyzed data from past earthquakes and crowd disasters to identify correlations between the duration of compression and the incidence of CS. While the exact timeframe is variable, a consensus emerged from studies in Armenia and Marmara that a compression duration

exceeding **four hours** significantly increases the risk of severe CS and acute kidney injury (AKI) [15, 22]. However, recognizing that shorter durations can also be harmful in high-pressure scenarios, the framework incorporated a more conservative, tiered risk assessment.

- **Pathophysiology-Driven Triggers:** The literature firmly establishes the clinical progression of a crush injury. The framework was designed to identify the early signs of muscle compartment syndrome, the precursor to systemic CS. Evidence shows that the classic signs—pain out of proportion, paresthesia, paralysis, pallor, and pulselessness (the "5 P's")—are a late and often irreversible sequence, with pulselessness being a particularly ominous sign [7, 23]. Therefore, the protocol was built to prioritize **severe limb swelling and tension** and **sensory or motor deficits** earlier, more reliable indicators for urgent triage categorization.
- **Biomarker Integration:** Research from disaster zones demonstrated that myoglobinuria, detectable at the point-of-care with a simple urine dipstick showing heme positivity in the absence of red blood cells on microscopy, is a highly sensitive, though not entirely specific, marker of significant rhabdomyolysis [14, 24]. Gunal et al. demonstrated that early, vigorous fluid resuscitation guided by clinical suspicion and simple diagnostics could prevent AKI in crush victims [14]. This evidence justified the incorporation of urine dipstick testing as an objective triage tool where logistics permit.

This phase resulted in a draft set of criteria that moved beyond general impressions to specific, observable, and measurable parameters: estimated compression time, limb circumference or tension assessment, neurological examination of the extremity, and point-of-care urine analysis.

3. Phase Two: Multi-Disciplinary Expert Consultation and Stakeholder Engagement

Recognizing that a workable protocol must bridge the gap between academic medicine and field reality, the Red Crescent convened a multi-disciplinary panel of experts. This inclusive approach was critical to ensuring the framework's validity, credibility, and practicality. The stakeholder groups involved included:

- **Clinical Specialists:** Nephrologists, trauma surgeons, and critical care intensivists provided the scientific rationale and established the clinical endpoints for the framework, ensuring it aligned with in-hospital management pathways [5, 13].

- **Disaster Medicine and Prehospital Physicians:** These experts translated the clinical criteria into actionable prehospital algorithms. They emphasized the need for simplicity, clarity, and resilience to the chaotic, high-stress, and resource-limited environment of an MCI [11, 21].
- **Red Crescent and Red Cross Paramedics and First Aid Volunteers:** As the end-users of the protocol, their feedback was indispensable. They provided practical insights on the feasibility of performing specific assessments (e.g., sensory testing in a noisy crowd), the carrying and use of equipment like urine dipsticks, and the integration of the new algorithm with existing first aid and triage workflows [25].
- **Logistics and Operations Managers:** This group addressed the supply chain requirements, ensuring that necessary equipment (e.g., tourniquets, IV fluids, catheters, dipsticks) could be pre-positioned in mass gathering medical kits and maintained effectively.

Through a series of structured workshops and Delphi methods, this consortium refined the draft criteria, debated risk thresholds, and established clear, unambiguous action steps for each triage category. The output was a consensus-based algorithm that balanced diagnostic sensitivity (not missing a potential CS case) with specificity (avoiding over-triage that would overwhelm limited resources).

4. Phase Three: Field Validation and Iterative Refinement

The final phase involved testing the draft framework in controlled and real-world settings to assess its usability, reliability, and impact.

- **Simulation and Tabletop Exercises:** The protocol was integrated into mass casualty simulation drills during Red Crescent preparedness exercises for large public events. These simulations allowed for the identification of ambiguities in the algorithm, tested communication flows between triage officers and treatment teams, and provided training for volunteers in a low-stakes environment [26]. Observations from these drills often led to refinements in the phrasing of assessment questions and the layout of the triage flowchart for enhanced clarity.
- **After-Action Review from Real-World Applications:** The framework has been applied in various disaster responses, including earthquakes and industrial accidents. After-action reports and qualitative debriefs from field teams provided invaluable data. For example,

feedback from the 2011 Van earthquake response in Turkey highlighted challenges in accurately estimating compression time from confused victims, leading to a greater emphasis on clinical signs over patient history in the protocol's decision tree [27].

- **Integration with Existing Systems:** A critical step was ensuring the crush injury framework was not a standalone tool but was seamlessly integrated into the broader Red Crescent emergency response system. This meant defining how the "Crush Syndrome Suspect" designation interfaces with the standard Red/Yellow/Green/Black triage tags and how it triggers specific logistical responses, such as the prioritized deployment of fluid resuscitation kits and the pre-alerting of receiving hospitals for potential dialysis needs [25].

Clinical Assessment and Prioritization of Crush Injury Patients

The effective management of a mass casualty incident involving crush injuries hinges on a rapid, systematic, and pathophysiologically-informed assessment protocol. The Red Crescent's framework moves beyond generic trauma triage by integrating specific criteria designed to identify the unique and delayed life-threats of Crush Syndrome (CS). This process is a deliberate, stepwise algorithm that prioritizes patients based on a synthesis of mechanism of injury, clinical signs of local tissue damage, and early indicators of systemic toxicity.

1. Primary Survey and Triage: Integrating the Crush-Specific "M" into the ABCDE Algorithm

The initial assessment, occurring at the point of extrication or first medical contact, follows a modified ABCDE (Airway, Breathing, Circulation, Disability, Exposure) approach, with the critical addition of a "Mechanism" (M) component tailored for crush incidents [28].

- **A (Airway) with Cervical Spine Protection:** The airway is assessed and managed as in any trauma. However, in crowd collapses, a high index of suspicion for concomitant cervical spine injuries must be maintained, especially in victims found in awkward positions or with signs of facial or head trauma.
- **B (Breathing):** Respiratory compromise in crush victims can be multifactorial. Direct thoracic crush can cause pulmonary contusions, hemothorax, or pneumothorax. More specific to mass gatherings is **compressive asphyxia**, where the

victim's chest is unable to expand due to external pressure from the crowd. An apneic victim in this context requires immediate repositioning and airway intervention; they may not be in traumatic arrest but in a reversible respiratory arrest [3].

- **C (Circulation) with Hemorrhage Control:** External hemorrhage from associated injuries is controlled immediately with tourniquets or direct pressure. The circulatory assessment, however, must be interpreted with caution. A crush victim may present with deceptively normal vital signs due to compensatory mechanisms, only to decompensate rapidly upon reperfusion. Tachycardia may be the only early sign. The absence of a radial pulse in a crushed extremity is a sign of advanced compartment syndrome, not a reliable indicator of systemic blood pressure [23].
- **D (Disability):** A rapid neurological assessment using the AVPU (Alert, Voice, Pain, Unresponsive) scale is performed. An altered mental status may indicate hypoperfusion, severe acidosis, or a concurrent head injury.
- **E (Exposure/Environment):** The patient is fully exposed to identify all injured areas, while taking measures to prevent hypothermia.
- **M (Mechanism):** This is the crucial, added step. The responder actively seeks a history or evidence of a **prolonged crush mechanism**. This includes asking the patient or bystanders, "Were you/was he pinned? For how long?" An estimated duration of compression greater than 30-60 minutes immediately elevates the patient's risk category, even if they appear stable [13, 27].

2. Secondary Survey and Limb-Specific Assessment: The Compartment Syndrome Evaluation

Following the primary survey, a focused assessment of the crushed extremities is conducted. This is not a detailed physical exam but a rapid screening for signs of established or evolving compartment syndrome, which is the local driver of systemic CS. The framework utilizes a simplified, evidence-based approach focusing on the most reliable early signs [23, 29]:

1. **Palpable Swelling and Tenseness:** The affected limb is palpated. The hallmark finding is a rock-hard, wooden, or exquisitely tense consistency of the muscle

compartments. This is often the earliest and most reliable objective sign of elevated intra-compartmental pressure. Simple swelling is noted, but profound tension is the key differentiator.

2. **Sensory Deficit (Paresthesia):** The responder checks for sensation in the distal aspect of the limb. Loss of light touch or sharp/dull discrimination in a nerve distribution that traverses the compressed compartment (e.g., loss of sensation in the first web space for the deep perineal nerve in a leg crush) is a critical red flag. It indicates nerve ischemia and significant compartment pressure.
3. **Motor Deficit (Paresis/Paralysis):** The patient is asked to move digits distal to the injury. An inability to perform these movements (e.g., inability to dorsiflex the ankle or extend the toes in a leg crush) signifies advanced muscle ischemia and is a late sign.
4. **Distal Pulse (Pulselessness):** The presence or absence of a distal pulse (dorsalis pedis or posterior tibial in the lower limb, radial in the upper limb) is assessed. It is critical to note that **the distal pulse is often present until the very late stages of compartment syndrome** [23]. Its presence should provide no reassurance, and its absence indicates a likely non-viable limb or extremely advanced disease.

The classic "5 P's" (Pain, Pallor, Paresthesia, Paralysis, Pulselessness) are thus refined in this protocol, with emphasis placed on **Tenseness** and **Paresthesia** as the most actionable early-warning signs for field triage.

3. Triage Categorization and Prioritization Protocol

Based on the integrated ABCDE-M and limb-specific assessments, patients are stratified into distinct priority categories that dictate the urgency and type of intervention. The Red Crescent framework uses a modified color-coding system with specific crush-related triggers [25, 30]:

- **RED (Immediate/T1):** This category is reserved for patients with:
 - Standard ABCDE compromises (e.g., airway obstruction, respiratory distress, shock).
 - **Any patient with a history of significant crush mechanism AND one or more of the following:**
 - A tense, swollen extremity with sensory deficit (paresthesia).

- Clinical signs of systemic toxicity: dark or "tea-colored" urine (observed or reported) or a positive urine dipstick for heme in the absence of RBCs (indicating myoglobinuria).
 - Oliguria or anuria.
- These patients require **immediate, aggressive intravenous fluid resuscitation** (e.g., 1-2 liters of isotonic saline as a bolus, followed by a maintenance infusion) and rapid transport to a hospital capable of dialysis and surgical fasciotomy [7, 14].
- **YELLOW (Delayed/T2):** This category includes patients who are hemodynamically stable but have:
 - A crush mechanism with a swollen, painful extremity but **no neurological deficit** and no signs of systemic toxicity.
 - Major fractures or soft tissue injuries without a crush mechanism.
 - These patients require continued monitoring for the evolution of compartment syndrome and should receive intravenous access and isotonic fluid hydration, but their treatment can be delayed after Red category patients are managed [31].
- **GREEN (Minimal/T3):** The "walking wounded" with minor abrasions, contusions, or sprains and no history or signs of a significant crush mechanism. They can often assist in their own care or be discharged from the scene after registration.
- **BLACK (Deceased/Expectant):** Patients who are apneic and pulseless after a single airway maneuver, or those with injuries incompatible with life given the available resources. In crush scenarios, this includes victims found pulseless and apneic after prolonged entrapment with clear signs of death.

4. The Role of Point-of-Care Diagnostics and Fluid Resuscitation

The protocol explicitly incorporates simple diagnostics to objectify the triage decision. A urine dipstick test for heme, if logistically feasible, is a powerful tool. A positive result in a hemodynamically stable patient with a crushed limb warrants an upgrade to **Red (Immediate)** due to the high likelihood of significant rhabdomyolysis and impending renal failure [24, 32].

The prioritization is intrinsically linked to a specific therapeutic action: fluid resuscitation. The goal is to

establish high-volume fluid flow *before* reperfusion, or as soon as possible thereafter, to dilute and flush out nephrotic toxins and correct acidosis [14, 33]. Therefore, the act of placing an IV line and initiating a saline bolus is not just treatment but a continuation of the triage process for the Red category, signaling the commitment of critical resources to prevent a predictable, delayed death.

Conclusion

Crush injuries sustained during mass gatherings represent a distinct and devastating challenge, where the window for effective intervention is narrow and the consequences of missed diagnosis are fatal. The pathophysiological trajectory of Crush Syndrome, culminating in systemic toxicity and organ failure, demands a proactive and specialized approach to field triage that standard protocols cannot provide. The Red Crescent's framework, born from the hard-won lessons of past disasters and refined through a rigorous, evidence-based developmental process, offers a robust solution to this problem. This review has delineated the critical components of this framework: its foundation in the pathophysiology of reperfusion injury, its systematic clinical assessment prioritizing mechanism and early signs of compartment syndrome, and its direct linkage of triage categorization to life-saving fluid resuscitation. The protocol's strength lies in its practicality—it is designed for high-stress, resource-limited environments and can be effectively implemented by trained first-aid personnel. By identifying the "covertly toxic" patient who would otherwise be under-triaged, the framework directly targets a primary source of preventable mortality in crowd-related disasters. The successful implementation of this protocol, however, extends beyond the algorithm itself. It relies on the integrated emergency response ecosystem embodied by the Red Crescent, including pre-event preparedness, volunteer training, logistical support for point-of-care diagnostics and fluid supplies, and clear pathways for patient transport to definitive care. Future directions should focus on the continued dissemination and training of this protocol among all agencies involved in mass gathering safety, further validation through simulation and real-world event data, and research into novel point-of-care biomarkers for even earlier risk stratification.

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