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EDITORIAL

Hemorrhage Management in Blast Injuries: Insights and Implications

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Background:
Recent airstrike attacks on civilian populations have highlighted a critical gap in trauma response: the scientific and tactical management of hemorrhage during mass-casualty events. Hemorrhage remains the leading cause of preventable death in both military and civilian blast injuries. This editorial reviews eight evidence-based strategies for hemorrhage control in bombing scenarios, emphasizing the urgent need to integrate military-grade techniques into civilian surgical and emergency care systems.

Keywords: Hemorrhage control, Bombing trauma, Mass casualty, War injuries

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Introduction

The recent wave of airstrikes targeting civilian areas in parts of Iran, particularly during the 12-day conflict beginning on June 13, 2025, has resulted in significant casualties, overwhelming emergency departments with complex blast injuries. While these events are deeply humanitarian in nature, they also present critical clinical challenges that test the readiness and capacity of surgical and prehospital trauma systems. In nearly every such incident, uncontrolled hemorrhage remains the leading cause of death before patients can access definitive care. Evidence from both battlefield medicine and civilian disaster settings demonstrates that hemorrhage-particularly from extremity and junctional sites-is largely preventable when appropriate interventions are applied early (1). This editorial provides a focused, evidence-based synthesis of eight contemporary strategies for hemorrhage control, all of which are essential for preparing Iranian surgeons, paramedics, and healthcare systems for future crises. Effective management of hemorrhage in blast injuries requires the integration of multiple evidence-based interventions, each targeting a specific aspect of bleeding control in high-stress, resource-limited settings. Among the most critical prehospital tools is the tourniquet, which is essential for controlling life-threatening extremity hemorrhage (2, 3). When applied correctly and promptly, tourniquets can prevent exsanguination and substantially improve survival

rates. Data from U.S. military operations in Iraq and Afghanistan indicate that timely tourniquet application has markedly increased patient survival (4).

Expanding training and public access to tourniquets is therefore a critical component of any national trauma response infrastructure. Complementing mechanical hemorrhage control, hemostatic dressings impregnated with agents such as kaolin (QuickClot®) or chitosan (Celox®, HemCon®) provide chemical support for coagulation, particularly in areas where tourniquets cannot be applied, such as junctional zones like the groin or neck. These dressings activate the intrinsic clotting cascade and have demonstrated efficacy in both military and civilian trauma care (5), warranting inclusion in all emergency medical service (EMS) kits and trauma packs. A more advanced systemic approach to hemorrhagic shock is Damage Control Resuscitation (DCR). Unlike traditional fluid resuscitation, DCR emphasizes minimal crystalloid use, early transfusion with a balanced ratio of red blood cells, plasma, and platelets (1:1:1), and proactive prevention of the lethal triad-coagulopathy, acidosis, and hypothermia. This physiologically guided protocol has been shown to significantly improve patient outcomes and is increasingly adopted as the standard in both battlefield and urban trauma centers (6).

In tandem with DCR, Damage Control Surgery (DCS) provides a staged surgical approach for severely injured patients. The initial priority in DCS is rapid hemorrhage control, limitation of contamination, and stabilization of physiology, with definitive surgical repair deferred until the patient's metabolic and hemodynamic status improves (7). In blast victims with complex polytrauma, DCS has proven to be a life-saving, time-efficient strategy that conserves critical resources while prioritizing survival (8).

Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) has emerged as a promising intervention for non-compressible torso hemorrhage. The technique involves endovascular placement of a balloon catheter via the femoral artery, which is inflated within the aorta to temporarily occlude distal blood flow, thereby preserving perfusion to vital organs while hemorrhage is controlled. REBOA is particularly valuable when surgical access is delayed or logistically challenging (9), and its integration into trauma center protocols through targeted training could substantially improve patient survival.

Another critical component of modern hemorrhage control is the use of Warm Fresh Whole Blood (WFWB). Unlike component-based transfusions, WFWB contains all coagulation factors and platelets in their natural balance and at physiological temperature, helping to mitigate dilutional coagulopathy and hypothermia. WFWB has demonstrated superior outcomes in massive transfusion scenarios, particularly in prolonged field care and mass-casualty incidents (10). The implementation of Tactical Combat Casualty Care (TCCC) guidelines reflects a paradigm shift in trauma management, adapting battlefield medicine principles to civilian emergencies. TCCC provides a structured framework for managing hemorrhage, airway compromise, and evacuation priorities in chaotic, high-risk conditions. Its emphasis on tourniquet application, hemostatic agents, and field-ready interventions has proven highly adaptable for civilian responders operating in unstable environments (11).

Finally, simulation-based crisis training has become indispensable for preparing surgical and emergency personnel to respond effectively to mass-casualty events. High-fidelity simulations-utilizing manikins, virtual environments, and moulage-allow teams to rehearse complex scenarios under pressure, enhancing coordination, clinical decision-making, and procedural performance. Implementing routine simulation training in hospitals near high-risk zones is a critical step toward system-wide preparedness for future bombing-related emergencies.

In conclusion, in the wake of airstrikes targeting civilian populations, hemorrhage control must shift from a reactive to a proactive national strategic priority. The integration of military-grade trauma practices-such as Damage Control Resuscitation (DCR), Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA), and Tactical Combat Casualty Care (TCCC)-into civilian health systems is essential. Trauma systems should prioritize early intervention, prehospital hemorrhage management, and

standardized, ongoing training to reduce preventable deaths. Collaboration among national surgical associations, emergency agencies, and healthcare institutions is crucial to establish preparedness across clinical, logistical, and educational domains.

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