BRIEF REPORT

Dealing With Burn Patients in War Zones

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ABSTRACT

Objective: Treating burn patients in the battlefield is one of the biggest challenges that military doctors and medical personnel can face. Wound patterns have been changed over time due to the introduction of new weapons, and many different aspects play a major role in the management of those burns nowadays. There is a potential gap in care of burn patients in war zones.

Methods: A thorough literature search in PubMed, scientific journals, and Internet sites was conducted in regard to burn patients and trauma in war zones.

Results: It is crucial for military surgeons to be able to stabilize burn patients during wartime conflicts, especially those patients who suffer from extreme burn injuries, as specialized treatment should be given. Medical personnel should be aware of all medication types used, the ways to minimize the risk of bacterial infection, and the ways to keep the injured safe.

Conclusions: Injured civilians with burn trauma in the field of battle are deserving care, and special recognition should be given to the non-governmental organizations (NGOs) that strive to ease human suffering in war zones. Proper management of burn patients in war zones is crucial, and military medical staff and NGOs can play a key role in that purpose.

Key Words: burn degrees, burn injuries, burn management, medical personnel, NGOs, war zones

Burn injuries are a widespread danger in military environment, and war burns have been depicted in recorded history for over 5000 years.[1] Wound patterns have been changed due to the introduction of new weapons.[2] The majority of people killed in the First and Second World Wars endured generally only 1, big, penetrating wound. The anti-material weapons that have been presented since the Second World War, with the American-made bazooka, have changed the type of wounds from little particles of burning aluminium to multiple entering wounds and profound burns. Similarly, high-kinetic-energy weapon supplies that infiltrate armored vehicles, structures, and strongholds make a cloud of extinguished fracture debris causing similar wounds. The establishment of those new weapon supplies added additionally more burns to the wound case blend of warfare.[1]

Burn wounds during war are disregarded to a great extent. It came to the front of the planning of the Army Medical Corps toward the finish of World War II. The nuclear explosion in 1945 at Hiroshima immediately produced 59 500 burn fatalities. That gigantic number and the huge number of burns in Nagasaki cautioned the Army toward burn wounds as being a noteworthy issue in future clashes, urging the Army's Surgical Research Unit to refocus on the issue of burns and their management.[3,4] Fatalities from burns comprised 8% to 10% in post World War II clashes, and the extent of burn severity depended on the weapon used.[5-8]

The majority of battle wounds result from unstable device explosions (63% of burn wounds among military staff), burning materials (for example, fuel-air bombs, phosphorus ammo, napalms), flash wounds, flame burns (secondary to fuel burning, flaming structures, or vehicles), contact burns from objects that are flaming in the combat zone, burns from steam or hot liquids that were discharged by an immediate hit or a destroyed machine, chemical burns from rankling, spillage of chemicals used or put away in the prompt environment of the wounded, coincidental electrical burns or burns that happened due to laser beams, and, finally, radiation burns because of exposure to atomic weapons.[1,9] Along with the rise in explosive injuries, a rise in burns and inhalation injuries has marked latest wars. It is estimated that, in modern combats, 1 in 4 injuries is a burn injury.[10-13]

The aim of the article is to highlight primary handling of those burn wounds in the battle zone that requires a technique of fast evaluation, protection of airway, and

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proper resuscitation along with a careful examination for related wounds. The gap in the current literature due to the fast evolution of war technology, along with the urge from military doctors to face extreme burn injuries in battle zones, is of high importance and should be discussed.

DEGREES OF BURN DEPTH

The 3 degrees of burn depth are covered in the following texts.

First Degree

First degree burns are superficial, painful, reddish, and cause no blisters. They usually recuperate on their own.

Second Degree

Second degree burns could be superficial or deep burns partially thick. They cause blisters whose floor is often pink or variegated red in appearance with a moist surface. The less they whiten while pressing, the deeper they are. The patient is in great pain and can sense it when the burn is pinpricked. In case that the base of the hair-root cavity is alive, hairs are not easy to pluck out. In fact, they will finally heal, usually by combining re-epithelialization and contraction of the wound, but usually there is a nasty scar left. Some patients will benefit from a possible skin transplant.

Third Degree

Third degree burns are full thickness burns. This means that the patient's skin is fully burnt, rugged, and looks waxy. If there are any hairs left, they can be pulled out easily. Usually, these burns are dry and do not have any sensation, while damage could reach out to muscles and to more profound tissues. Chemicals and electricity usually cause these burns. These burns may also heal, eventually. Extreme distortion and function loss may remain. The best management is by skin transplant.[14]

BURN SEVERITY

Burn severity is not easily graded, but the following is a "rule of thumb" that is easy to follow.

Minor

- Second degree: less than 15% of the total body surface area (TBSA)
- Third degree: less than 3% of TBSA

Moderate

- Second degree: 15–25% of TBSA
- Third degree: less than 10% of TBSA

Major

- Second degree: more than 25% of TBSA
- Third degree: more than 10% of TBSA[14]

BURN MANAGEMENT

Standard steps have to be followed in regard to the management of burns. They include the following, as cited by Giannou and Baldan:

1. *First aid*
2. *Resuscitation (ABC):*
   - *Airway*
   - *Breathing*
   - *Circulation/fluid replacement therapy*
3. *Analgesia*
4. *Prophylactic antibiotics*
5. *Tetanus prophylaxis*
6. *Nutrition*
7. *Hypothermia*
8. *Wound management*[14]

BURN TREATMENT IN WAR ZONES

Burns are common in warfare. Burn hazards happen due to flame weapons and explosive blasts of ignitable materials. The agent that causes them may be thermal, electrical, radiation-linked, and/or chemical. Each agent has specific reactions that may need particular treatment. A burn wound may cause tremendous pain probably requiring an excessive number of hospital resources and nursing care. Impaired airway due to smoke or hot air inhalation is the most imminent threat to life resulting to edema; the subsequent threats (of great importance, too) are caused by subsequent hypovolemic shock and infection (complex pathophysiological consequences that continue after a burn injury).[14]

Primary management of burn wounds in the battle zone requires a technique of fast evaluation, protection of airway, and proper resuscitation along with a careful examination for related wounds associated to the war zone casualty. Proper management of burn wounds in the battlefield begins with a comprehension of the wound mechanism, as well as properties and traits of agents that caused the harm. A variety of weapons may bring about a higher rate of people killed in the battlefield and create a greater incidence of penetrating injuries and burns.[15] Patients with serious facial burns, those exhibiting signs or manifestations suggestive of inhalation harm, and those with extensive burns for which related edema is expected, may be frequently pre-emptively intubated not long after the injury to guarantee the protection of airway and mechanical ventilatory support. Proper volume replacement in the patient who suffers from burns can be exceptionally challenging, requiring satisfactory intravascular replacement administered, while at the same time eliminating the possibility of complications related to high-volume crystalloid revival, as pointed out by Chung et al.[16,17] Burns are a so-called "distracting injury." When a patient is treated with opiates to alleviate pain, this may masquerade a clinical diagnosis of associated wounds.[18] Surgery may have the best outcomes on youngsters with little yet potentially crippling wounds, such as burns in both hands. It should be mentioned, though, that patients with burns that cover 40% to 50% of their total body

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surface will rarely survive in the field, and the best way to manage them is by providing adequate fluids and analgesia in order to relieve thirst and pain.[14]

Medical staff often believe that being aware of weaponry is insignificant and irrelevant regarding their capability to treat burn wounds effectively. However, according to the Geneva and Hague treaties, they are obliged to know how to use weaponry and to be able to comprehend the way that they affect the human.[1] The most common expected injuries in contemporary conflicts are burns and wounds caused by shrapnel fragments or small weapons.[19] Undoubtedly, burn injuries are an omnipresent threat, and they carry a grave danger for military staff during combats.[20] Over the last century, burn injuries may be caused from small to large weaponry, for instance, from missiles launched from the shoulder of the soldier, to nuclear weapons. Materials that could easily cause burns are napalms, white phosphorus, anti-armor weaponry, all types of missiles, and fuel-air explosives.[20] As far as burns caused by imbedded phosphorus particles and chemicals are concerned, patients need immediate treatment. The medical personnel must wash off the agent from the patient's body immediately with a copious water lavage and remove all the particles. After that, coverage of the wounded body surface with bandages soaked in saline in order to keep the body moistened until decisive treatment is given is essential. In case that the patient's transfer to a hospital takes more than 12 hours, the medical staff should cover the wounded body surface with an antimicrobial agent in order to prevent microbial expansion and rebirth of the remaining phosphorus particles.[20]

After stabilization of the burn victim and assessment of burn severity, burn depth, and surface, burn treatment starts with protection of the harmed primary barrier to infection, the skin. Over the last few decades, advancements have reduced the incidence of burn wound infections. Topical and systemic new antimicrobial therapies, early burn wound excision and closure, and the introduction of infection control measures in modern burn units, such as isolation facilities, have benefited burn victims. Recent developments in dressing technology have introduced a variety of materials incorporated into the dressings and gels, such as carbon fiber. The use of proper fluid resuscitation with colloids or crystalloids is also very important. Many papers emphasize the benefit of total early burn wound excisions for survival and improved outcomes. Skin grafting and the development of skin substitutes are also used nowadays for treating burn victims. Moreover, metabolic care and nutritional support are very important. In the last few decades, various pharmacological interventions have been trialed in burn patients, chiefly to attempt to reduce the hypermetabolic response, such as propranolol, anabolic agents, anti-hyperglycemic agents, statins, and erythropoietin.[21,22]

Civilian and military burn trauma managements have many similarities. However, they have distinctive challenges in the war-zone environment that make the second difficult to manage, especially when there are multiple traumatized war fatalities,[23,24] which require a whole chain of actions (starting with co-soldiers giving first aid and continuing with prompt actions that need to be taken).[25] Nowadays, unlike civilian burn injuries, most war burn injuries include inhalation and combined thermodynamic injuries. Early intubation and the use of lower tidal volumes during ventilation of patients with acute lung injury and acute respiratory distress syndrome protect against pulmonary complications. In explosion injuries, there are not just the skin burns resulting from exposure to high temperatures to be taken into account. Internal body compartments may have suffered extensive trauma, and a thorough assessment of vital organs should be performed. Stabilization with external fixation of bone fractures and indication for fasciotomy in order to preserve extremities and their functions in the battlefield are also very important. Unlike civilian burn treatment, which can be performed in specialized burn units, all those actions should be accomplished in the battlefield or in small military medical camps where appropriate equipment is sometimes absent making the stabilization and the patient transport in military hospitals challenging.[21,22] In non-military practice, many resources and equipment are available and emergency treatment may be given to every single burn patient. Those who are gravely wounded are transferred to proper facilities. On the contrary, in a war zone, optimal care is usually not an option and is hampered by restrictions and reduced availability of medical staff.[26] Additionally, a great probability of medical burn inexperienced staff may be urged to treat huge numbers of severely burn wounded. This is the reason that in such cases specific plans are adopted and personnel follow safe and specific rules given in table formats; as in the case of mass casualties, even a simple resuscitation with liquids proves to be a challenging situation.[25,27]

What should also be highlighted in burn management is scene safety. Someone must not forget that fumes and fluids can be caustic and electrical wires may electrify everyone who touches them with bare hands.[28] So, when the scene is cleared, the burn patient must be evacuated and decontaminated properly. Then, small burns must be cooled with cold water in order to prevent histamine release. In that way, edema is decreased and thromboxane is prevented and this, in turn, leads to ischemia inhibition.[29]

Inside the military base, administration of war zone fatalities constitutes the peak of any military medical action.[25] Nongovernmental organizations (NGOs), also, may play a key role by providing essential staff, help, and equipment. Medical supplies and equipment are many times funded by NGOs. Many members are medical staff who can initially triage mass burn casualties, start resuscitation, and treat burn victims. Food and burn casualties' safe transportation to military hospitals may also be provided by NGOs.

What continues to be the most important problem in the field of burn management is smoke inhalation, which causes

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breathing difficulties.[25] When the patients have small burns, after being treated properly, they can go back to their duty. When the burn is of moderate degree, the patients will be treated and then sent to a hospital close to their home. Finally, when the burn is extended, first, the patient is rescuscitated and then evacuated to continue being treated away from the war zone.[19] Additionally, spinal safety measures need to be taken and so does aggressive airway management. What is also critical for the burn victim is the use of supplemental oxygen. Medical personnel should consider intubation, continuous positive airway pressure (CPAP), and rapid sequence intubation (RSI) as well. They should start cardiac monitoring and try to address dysrhythmias caused by electrolyte imbalance, fast fluid resuscitation, and possible blood loss from concurrent trauma.[29] Unfortunately, in the battlefield, antiseptic measures cannot be taken. Central lines may not be inserted under proper aseptic techniques because there is no equipment or time for the seriously injured. Antibiotics are administered later, and all prompt actions are taken after seriously burned patients are stabilized.[30] Surgery in combat zones limits to the principles of "damage control surgery," and plastic and cosmetic surgery has no position.

Because all burn casualties cannot be hospitalized in military bases and hospitals, burn victims with minor or moderate surface burns, without inhalation or combined thermodynamic injuries, may be treated at home. If patient safety is not compromised, even severe surface burns after 24–48 hours of monitoring, antibiotics administration, and fluid resuscitation may be treated at home.

Military staff and military medical personnel can assist with civilian treatment by providing the essential medical equipment, facilities, and their expertise in treating burn casualties in the battlefield and in emergent mass casualties situations. Military staff may also transport patients safely to hospitals and special burn units.

To end up, there are also mental issues that result from a burn injury. Burn victims usually indicate recovery impediment, and severe impairment leads to psychological and physical problems.[31]

CONCLUSION

Being in a war is a grave situation. Injuries, casualties, and damages are tremendous. Burn injuries are considered 1 of the major injuries that military personnel may have to face. Their degrees of depth vary and so does their management, depending on the burn injury type. Medical personnel should be able to manage burn patients in such difficult situations. Although they find ways to address the situation, simultaneously, weaponry becomes harsher and burn injuries still pose a grave threat during wars. Military medical personnel and NGOs can play a key role in the management of burn patients during wars.

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Author's Contributions

All authors contributed equally.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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