

CONTEMPORARY MANAGEMENT OF WOUNDS IN THE EMERGENCY DEPARTMENT: CLINICAL APPROACH AND EFFECTIVE MANAGEMENT

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Abstract

Background: Traumatic wounds are among the most frequent reasons for presentation to emergency departments and require rapid assessment, standardized treatment, and multidisciplinary management to prevent infectious complications and functional sequelae (Prevaldi et al., 2016; Singer & Hollander, 2020).

Aim: To analyze the contemporary management of traumatic wounds, evaluate the incidence of complications according to wound type and degree of contamination, and assess the role of debridement, irrigation, and antibiotic prophylaxis in a clinical series at the Clinical Hospital of Tetovo.

Materials and methods: A retrospective-descriptive study including 96 patients treated at the Emergency Department of the Clinical Hospital of Tetovo from January to May 2026. Age, sex, wound type (lacerated, contused, *scissum*, with skin loss, gunshot), anatomical location, contamination level, treatment modality, and postoperative complications were analyzed.

Results: Male patients predominated (70.8%), with a mean age of 39.4 ± 16.2 years. Lacerated wounds accounted for 38.5% of cases, and most wounds were dirty (58.3%) or contaminated (27.1%). Surgical debridement and irrigation with sterile normal saline were performed according to contemporary protocols (Goh et al., 2024; Reeder, 2024). Complications were recorded in 13.5% of cases, with local infection in 9.4%, mainly in wounds with skin loss and gunshot wounds.

Conclusion: Modern wound management in the emergency setting requires early assessment, accurate classification, adequate cleansing and closure technique, and systematic follow-up. A multidisciplinary approach and contemporary protocols improve clinical outcomes and reduce morbidity (Clare & Baxley, 2023; Prevaldi et al., 2016).

Keywords: traumatic wounds, emergency, debridement, irrigation, infection, gunshot wounds, contemporary management.

Introduction

Traumatic wounds are among the most frequent pathologies encountered in emergency departments and constitute a significant clinical challenge due to the high risk of infection, neurovascular injury, and long-term functional sequelae (Singer & Hollander, 2020; Trott, 2019). According to the World Health Organization, trauma associated with open wounds represents a substantial epidemiological burden, particularly in the active age groups of the population (World Health Organization, 2021). Effective and evidence-based management of these lesions contributes to reducing morbidity, shortening hospital stay, and improving aesthetic and functional outcomes.

Contemporary wound management is based on four fundamental principles: rapid clinical assessment, hemorrhage control, adequate wound cleansing with surgical debridement when necessary, and appropriate tissue closure (Reeder, 2024; Lammers, 2014). Current literature emphasizes the importance of controlled-pressure irrigation and removal of devitalized tissue

as key elements in preventing post-traumatic infections (Prevaldi et al., 2016; MSD Manual Professional Edition, 2025). The study by Anglen (2005) demonstrated that irrigation with an adequate volume of normal saline is perhaps the single most important intervention in reducing the bacterial load of a wound.

The classification of traumatic wounds according to mechanism of injury and degree of contamination has direct clinical relevance. According to the classification established by the U.S. National Research Council and widely accepted, wounds are divided into clean, clean-contaminated, contaminated, and dirty/infected (Berríos-Torres et al., 2017). Dirty wounds are characterized by the presence of necrotic tissue, foreign material, or exposure to environments with a high microbial load, significantly increasing the incidence of septic complications (Clinical Tree, 2024). Furthermore, *scissum* (incised), lacerated, contused, and skin-loss wounds present different challenges in management, ranging from simple primary closure to the need for advanced reconstructive procedures.

In modern emergency practice, advanced irrigation methods at 5–8 psi pressure, atraumatic suturing techniques with monofilament materials, evidence-based antibiotic therapy, and tetanus prophylaxis based on immunization status are applied (Centers for Disease Control and Prevention [CDC], 2020; American Heart Association, 2024). The choice of closure — primary, delayed primary, or secondary — depends on the time elapsed since injury, level of contamination, and anatomical location (Forsch, 2008). Studies have shown that primary closure of clean wounds within 6–8 hours of injury is associated with a lower incidence of infection compared with delayed closure (Quinn et al., 2014).

Complex wounds, particularly gunshot (ballistic) wounds, require a multidisciplinary approach due to multiple soft tissue injuries, possible fractures, and lesions of deep vascular and nerve structures (Clare & Baxley, 2023). The kinetic energy of the projectile causes both temporary and permanent cavitation, resulting in a wide zone of devitalized tissue, even when the entry and exit wounds appear clinically minimal (Bartlett, 2003). For this reason, careful exploration and wound-characteristic-oriented debridement are essential.

The Clinical Hospital of Tetovo, as a referral center for the northeastern region of the Republic of North Macedonia, regularly faces a wide spectrum of traumatic wounds, ranging from minor domestic lacerations to complex ballistic lesions. Systematic analysis of these cases enables the improvement of internal protocols and their alignment with contemporary international guidelines.

Aim of the Study

The general aim of this study is to analyze the contemporary management of traumatic wounds in a real clinical context, based on the experience of the Emergency Department of the Clinical Hospital of Tetovo. More specifically, the study aims to:

Analyze the demographic and clinical characteristics of patients presenting with traumatic wounds.

Evaluate the distribution of wounds by type, anatomical location, and degree of contamination. Assess the incidence of postoperative complications in relation to wound type and classification.

Highlight the role of surgical debridement, normal saline irrigation, and rational use of prophylactic antibiotics.

Analyze the clinical outcomes in patients with complex wounds, including gunshot wounds.

Compare the study findings with current international literature and provide practical recommendations to improve local protocols.

Materials and Methods

3.1. Study design and population: The study was designed as a retrospective-descriptive study and includes 96 patients treated at the Emergency Department of the Clinical Hospital of Tetovo during the period January – May 2026. Data were extracted from official medical records, anamnesis sheets, and operative protocols, fully respecting the principles of personal data protection and patient confidentiality, in accordance with the Declaration of Helsinki (World Medical Association, 2013).

3.2. Inclusion and exclusion criteria: The study included patients of all age groups who presented with traumatic wounds requiring surgical or conservative treatment in the emergency setting.

Inclusion criteria:

Lacerated wounds;

Contused wounds;

Wounds *scissum* (incised wounds caused by sharp objects);

Wounds with loss of skin substance;

Contaminated and dirty wounds;

Gunshot (ballistic) wounds.

Exclusion criteria:

Patients with superficial wounds not requiring surgical intervention;

Patients with incomplete clinical data or no post-procedural follow-up;

Chronic non-traumatic wounds (diabetic ulcers, vascular wounds, etc.).

3.3. Variables analyzed: For each patient, the following variables were recorded and analyzed: age and sex; mechanism of trauma; anatomical location; morphological type of wound; degree of contamination (clean, contaminated, dirty); time of presentation from the moment of trauma; type of treatment (debridement, primary suturing, delayed closure, secondary healing); antibiotic regimen used; tetanus prophylaxis; and postoperative complications (local infection, dehiscence, marginal necrosis).

3.4. Treatment protocol: All patients underwent a systematic examination including physical assessment, hemostasis control, and distal neurovascular evaluation of the affected extremity (Reeder, 2024). Wound cleansing was performed with intensive irrigation using sterile normal saline (NaCl 0.9%) at volumes of 50–100 mL per cm of wound length, in accordance with literature recommendations (MSD Manual Professional Edition, 2025; Anglen, 2005). In dirty wounds and those with necrotic tissue, careful surgical debridement was performed using a scalpel, preserving viable tissue and removing foreign bodies.

Primary closure was applied in clean wounds and some contaminated wounds after adequate debridement, within the recommended time window (typically ≤ 6 –8 hours for trunk and extremities, up to 12–24 hours for the face and head, due to good vascularization) (Quinn et al., 2014; Forsch, 2008). In wounds with severe contamination, delayed primary closure or secondary healing was preferred. Prophylactic antibiotic therapy was used in contaminated and dirty wounds and in all gunshot wounds, with a combination of first-generation cephalosporin and metronidazole as the most frequent regimen (Goh et al., 2024). Tetanus prophylaxis was administered according to the patient's immunization status and wound characteristics (CDC, 2020).

3.5. Statistical analysis: Data were entered and analyzed using Microsoft Excel 2019 and descriptive statistics. Quantitative variables were expressed as mean $\pm$ standard deviation, while qualitative variables were expressed as frequencies and percentages. Comparisons

between groups were performed using the chi-square test for categorical variables, with a p-value < 0.05 set as the threshold for statistical significance.

Results

4.1. Demographic characteristics: Of the 96 patients included in the study, 68 (70.8%) were male and 28 (29.2%) were female, with a male-to-female ratio of 2.4:1. The mean age was 39.4 ± 16.2 years, ranging from 4 to 78 years. The most affected age group was 21–40 years (47.9% of cases), confirming the findings of the literature that identify the active population as the most exposed to trauma (World Health Organization, 2021).

4.2. Distribution by wound type: The most frequent type of wound was lacerated, followed by contused wounds and those with skin loss. Although less frequent, gunshot wounds presented the most complex clinical challenges (Table 1).

Table 1. Distribution of patients by wound type (n = 96)

Type of wound	Number (n)	Percentage (%)
Lacerated wounds	37	38.5
Contused wounds	21	21.9
Scissum wounds	14	14.6
Wounds with skin loss	18	18.7
Gunshot wounds	6	6.3
Total	96	100

4.3. Classification by degree of contamination: Most wounds were dirty, reflecting delayed presentation and exposure of the trauma site to contaminated environments (Table 2).

Table 2. Classification of wounds by degree of contamination

Classification	Number (n)	Percentage (%)
Clean	14	14.6
Contaminated	26	27.1
Dirty	56	58.3

4.4. Anatomical location: The most frequent location of wounds was the upper extremities — 40 patients (41.7%), followed by the lower extremities with 33 patients (34.4%), the head and face with 15 patients (15.6%), and the trunk with 8 patients (8.3%). The predominance of the extremities is consistent with the data reported by Singer and Hollander (2020) in a systematic review of laceration management.

4.5. Treatment applied: Surgical debridement was performed in 61 patients (63.5%), and primary suturing in 52 cases (54.2%). In 19 patients (19.8%), delayed primary closure was applied due to severe contamination or presentation outside the optimal time window for primary closure. In 25 patients (26.0%), secondary healing was chosen, mainly in wounds with

substantial skin loss. Prophylactic antibiotics were administered to 74 patients (77.1%), with a combination of first-generation cephalosporin (cefazolin/cephalexin) and metronidazole as the most frequent regimen, especially in dirty wounds and gunshot wounds. Tetanus prophylaxis was administered according to immunization status.

4.6. Complications: Complications were recorded in 13 cases (13.5%), with local infection as the most frequent complication (Table 3). No patient developed systemic sepsis or life-threatening complications during the follow-up period.

Table 3. Recorded postoperative complications

Complication	Number (n)	Percentage (%)
Local infection	9	9.4
Wound dehiscence	2	2.1
Marginal necrosis	2	2.1
Total	13	13.5

The highest incidence of infection was observed in dirty wounds (12.5%) and in wounds with skin substance loss and gunshot wounds. All patients with local infection were successfully treated with culture-guided antibiotic therapy, additional drainage, and dressing changes, without the need for major reoperation.

Discussion

The management of traumatic wounds in the emergency setting remains an essential component of surgical and emergency practice. The results of this study demonstrate a predominance of lacerated and contused wounds, in line with international literature reporting similar frequencies in emergency departments (Singer & Hollander, 2020; Trott, 2019). The male predominance (70.8%) and the active-population mean age (39.4 years) are also consistent with other epidemiological studies, explained by the greater exposure of young men to high-risk activities (industrial, sports, motor vehicle, interpersonal violence).

Most of the wounds in our study (58.3%) were dirty, which is associated with delayed presentation to the emergency department, exposure to contaminated environments, and the presence of devitalized tissue. Modern studies emphasize that aggressive debridement and adequate irrigation are the most important factors in reducing the bacterial load and preventing infection (Anglen, 2005; Prevaldi et al., 2016). The prospective multicenter FLOW (Fluid Lavage of Open Wounds) trial demonstrated that normal saline alone is preferable to soap solutions in open traumatic wounds of long bones, and that low pressure is the default choice (Bhandari et al., 2015). Our data are in line with these recommendations: 0.9% NaCl irrigation was used as the standard in all cases.

The total complication rate in our study (13.5%) and the local infection rate (9.4%) are within the acceptable range reported in the literature for open traumatic wounds, where the figures typically vary from 5% to 15% depending on initial contamination and location (Hollander & Singer, 1999). A higher incidence was observed in wounds with skin substance loss and in gunshot wounds, consistent with existing data showing that ballistic wounds and those with

extensive tissue damage have a substantially higher risk of septic complications (Clare & Baxley, 2023; Bartlett, 2003).

The rational use of prophylactic antibiotics remains a debated topic. In this study, 77.1% of patients received antibiotics, a percentage that may be perceived as high compared with recent recommendations. However, this reflects the high prevalence of dirty and contaminated wounds in our cohort. Current literature suggests that careful irrigation and good debridement have a greater impact than the antibiotic itself in preventing infection of simple lacerated wounds (Cummings & Del Beccaro, 1995; Quinn et al., 2014). Antibiotic prophylaxis is more justified in deep contaminated wounds, wounds of the hands and feet, wounds with bone or tendon exposure, and gunshot wounds (Goh et al., 2024).

Gunshot wounds in our study accounted for 6.3% of cases, a percentage that reflects a non-negligible incidence of civilian ballistic trauma in the region. Their treatment requires careful exploration of neurovascular injuries, rapid hemorrhage control, wound-characteristic-oriented debridement, and sometimes reconstructive intervention (Clare & Baxley, 2023). Modern practice has abandoned routine aggressive debridement in low-energy wounds and favors conservative treatment with prophylactic antibiotics in selected cases (Bartlett, 2003). Multidisciplinary management — involving the general surgeon, orthopedist, vascular surgeon, and plastic surgeon — is decisive for long-term functional outcome.

Tetanus prophylaxis, administered according to the patient's immunization status and wound characteristics, is an indispensable component of traumatic wound management (CDC, 2020). In our study, this element was systematically applied, and no case of tetanus was recorded during the follow-up period.

This study has several limitations that must be acknowledged. First, the retrospective design limits the control of confounding variables and depends on the quality of existing documentation. Second, the five-month period of data collection and the sample size ($n = 96$) may not fully reflect seasonal and long-term variations. Third, long-term follow-up of patients, especially regarding aesthetic and functional outcomes of head and extremity wounds, was not fully accomplished. Prospective studies with larger samples and extended follow-up will be necessary to confirm our results and refine internal protocols.

Despite these limitations, the findings are consistent with existing literature and provide a realistic picture of the current practice of traumatic wound management at a regional referral center. The systematic adoption of contemporary protocols, continuous staff training, and a multidisciplinary approach are key to further improving clinical outcomes.

Conclusion

Traumatic wounds represent a significant challenge in emergency departments and require a standardized, evidence-based approach. The results of this study at the Clinical Hospital of Tetovo support the following conclusions:

Lacerated and contused wounds are the most frequent types of traumatic wounds in emergency practice, mainly in males of active age.

Dirty wounds, which constitute the majority of cases, have the highest incidence of infectious complications.

Surgical debridement and intensive irrigation with normal saline remain the principal and most effective components of treatment.

Prophylactic antibiotic therapy should be used selectively, tailored to wound type, location, and degree of contamination.

Multidisciplinary management and systematic tetanus prophylaxis improve the prognosis in complex wounds, including gunshot wounds.

The systematic application of contemporary protocols in the treatment of traumatic wounds reduces complications, improves healing, shortens hospital stay, and contributes to more efficient and safer patient care. The experience of the Clinical Hospital of Tetovo confirms that the application of fundamental principles — rapid assessment, adequate irrigation, careful debridement, contamination-based closure, and systematic follow-up — yields clinical results comparable to those reported in advanced international centers.

References

- [1]. American Heart Association. (2024). First aid guidelines for superficial wounds and abrasions. Dallas, TX: AHA Publications.
- [2]. Anglen, J. O. (2005). Comparison of soap and antibiotic solutions for irrigation of lower-extremity open fracture wounds: A prospective, randomized study. *The Journal of Bone and Joint Surgery*, 87(7), 1415–1422. <https://doi.org/10.2106/JBJS.D.02615>
- [3]. Bartlett, C. S. (2003). Clinical update: Gunshot wound ballistics. *Clinical Orthopaedics and Related Research*, 408, 28–57. <https://doi.org/10.1097/00003086-200303000-00005>
- [4]. Berríos-Torres, S. I., Umscheid, C. A., Bratzler, D. W., Leas, B., Stone, E. C., Kelz, R. R., ... Schecter, W. P. (2017). Centers for Disease Control and Prevention guideline for the prevention of surgical site infection, 2017. *JAMA Surgery*, 152(8), 784–791. <https://doi.org/10.1001/jamasurg.2017.0904>
- [5]. Bhandari, M., Jeray, K. J., Petrisor, B. A., Devereaux, P. J., Heels-Ansdell, D., Schemitsch, E. H., ... FLOW Investigators. (2015). A trial of wound irrigation in the initial management of open fracture wounds. *New England Journal of Medicine*, 373(27), 2629–2641. <https://doi.org/10.1056/NEJMoa1508502>
- [6]. Centers for Disease Control and Prevention. (2020). Tetanus: Vaccination and prevention guidelines. Atlanta, GA: U.S. Department of Health and Human Services.
- [7]. Clare, D., & Baxley, S. (2023). An evidence-based approach to managing gunshot wounds in the emergency department. *Emergency Medicine Practice*, 25(4), 1–28.
- [8]. Clinical Tree. (2024). Wound care and repair. In *Textbook of Adult Emergency Medicine*. Elsevier.
- [9]. Cummings, P., & Del Beccaro, M. A. (1995). Antibiotics to prevent infection of simple wounds: A meta-analysis of randomized studies. *American Journal of Emergency Medicine*, 13(4), 396–400. [https://doi.org/10.1016/0735-6757\(95\)90122-1](https://doi.org/10.1016/0735-6757(95)90122-1)
- [10]. Forsch, R. T. (2008). Essentials of skin laceration repair. *American Family Physician*, 78(8), 945–951.
- [11]. Goh, C., Punyadasa, A., Ibrahim, I., & Ooi, S. (2024). Wound care and management. In *Guide to the Essentials in Emergency Medicine* (3rd ed.). McGraw-Hill Medical.
- [12]. Hollander, J. E., & Singer, A. J. (1999). Laceration management. *Annals of Emergency Medicine*, 34(3), 356–367. [https://doi.org/10.1016/S0196-0644\(99\)70131-9](https://doi.org/10.1016/S0196-0644(99)70131-9)
- [13]. Lammers, R. L. (2014). Methods of wound closure. In J. R. Roberts & J. R. Hedges (Eds.), *Roberts and Hedges' Clinical Procedures in Emergency Medicine* (6th ed., pp. 644–689). Philadelphia, PA: Elsevier Saunders.
- [14]. MSD Manual Professional Edition. (2025). How to cleanse, irrigate, debride, and dress wounds. Retrieved from <https://www.msdmanuals.com>
- [15]. Prevaldi, C., Paolillo, C., Locatelli, C., Ricci, G., Catena, F., & Ansaloni, L. (2016). Management of traumatic wounds in the Emergency Department: Position paper from the Academy of Emergency Medicine and Care and the World Society of Emergency Surgery. *World Journal of Emergency Surgery*, 11(30), 1–13. <https://doi.org/10.1186/s13017-016-0084-3>
- [16]. Quinn, J. V., Polevoi, S. K., & Kohn, M. A. (2014). Traumatic lacerations: What are the risks for infection and has the 'golden period' of laceration care disappeared? *Emergency Medicine Journal*, 31(2), 96–100. <https://doi.org/10.1136/emmermed-2012-202143>
- [17]. Reeder, T. (2024). Evaluating and preparing wounds. In *Tintinalli's Emergency Medicine Manual* (7th ed.). New York, NY: McGraw-Hill Education.
- [18]. Royal Children's Hospital Melbourne. (2025). Clinical practice guidelines: Wound dressings – acute traumatic wounds. Melbourne, Australia.
- [19]. Singer, A. J., & Hollander, J. E. (2020). Laceration management. *New England Journal of Medicine*, 382(11), 1057–1066.
- [20]. Trott, A. T. (2019). *Wounds and lacerations: Emergency care and closure* (5th ed.). Philadelphia, PA: Elsevier.
- [21]. World Health Organization. (2021). *Injuries and violence: The facts*. Geneva, Switzerland: WHO Press.
- [22]. World Medical Association. (2013). World Medical Association Declaration of Helsinki: Ethical principles for medical research involving human subjects. *JAMA*, 310(20), 2191–2194. <https://doi.org/10.1001/jama.2013.281053>