ORIGINAL ARTICLE

Management of antimicrobial therapy in emergency department admissions and hospitalizations for firearm injuries: A single-center experience

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ABSTRACT

BACKGROUND: Firearm injuries (FI) remain a significant cause of morbidity and mortality globally. Antibiotic use, supported by guideline recommendations for preventing post-injury infections in FI cases, encounters uncertainties regarding the selection of antimicrobial agents and associated outcomes. This study aimed to investigate the relationship between Injury Severity Scores (ISS) for FI cases presented to the emergency department.

METHODS: We empirically revised antimicrobial treatment protocols based on culture results and mortality rates. In the study, 164 firearm injury cases, admitted to the emergency department in 2022 and subsequently hospitalized in clinics and intensive care units (ICU), were evaluated. Cases included in the study were categorized into four groups based on ISS: mild, moderate, severe, and profound injury severity. The study compared the timing of hospital presentation following the injury, hospital length of stay, tissue or blood culture positivity, empirical treatment administered, antimicrobial revision based on culture results, need for ICU admission, mortality status, and ISS among the cases. Data were analyzed using IBM SPSS Statistics 22.0 (SPSS Inc., Chicago, IL). Variables in trauma patients were compared among various groups using Pearson Chi-Square tests. Binary logistic regression tests were performed to identify independent risk factors. A significance level of $p<0.05$ was considered statistically significant.

RESULTS: The study included 164 patients, all of whom were male. The mean age was calculated as 28.9±4.51 years. The average hospital length of stay was 25.54±21.81 days. Eighty-three patients (50.6%) required intensive care. Tissue cultures were obtained from 79 patients (48%). Bacterial growth was observed in 45 of these 79 patients (57%). The appropriate empirical antibiotic treatment rate, assessed among patients who received empirical treatment followed by culture-based antibiotic sensitivity testing, was 48.9%. It was observed that empirical antibiotic regimens were appropriate in 80% of cases in the mild group and 16.7% in the profound severe group ($p=0.005$). Our study compared the relationship between hospitalization duration and ISS groups. It was observed that hospitalization duration was significantly shorter in the mild group compared to the other groups ($p=0.003$, $p=0.000$, $p=0.000$). It was also observed that the need for ICU admission was higher in groups with higher ISS, indicating a correlation between higher ISS and increased ICU requirements ($p=0.000$).

CONCLUSION: In conclusion, for cases of firearm injuries, we believe empirical antimicrobial therapy should be initiated with narrow-spectrum agents such as beta-lactam + beta-lactamase inhibitor or third-generation cephalosporin + nitroimidazole in the mild group, considering the lack of Pseudomonal activity.

Keywords: Firearm injuries; Injury Severity Score (ISS); mortality.

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INTRODUCTION

Firearm injuries (FI) remain a significant cause of morbidity and mortality globally. In the United States, the mortality rate from firearm injuries has been reported as 11.77 per 100,000 individuals over the past decade, with an estimated 9.21 million potential years of life lost before age 65. In 2020, the total injury cost was approximately $491 billion. Thus, FI impose a substantial socioeconomic burden.[1] Injuries from firearm wounds pose a significant risk of infection due to exposure of the wound to the environment. Antibiotic use is supported by guideline recommendations for preventing post-injury infections in FI cases, but uncertainty persists regarding the selection of antimicrobial agents and associated outcomes.[2] Firearm injuries often pose a risk of infection due to environmental contamination, depending on the mechanism of injury. Therefore, antibiotic therapy is commonly advocated in many studies.[3-8] A detailed review of the literature on antimicrobial management shows that antibiotics have been shown to reduce the risk of infection in open fractures caused by firearm injuries.[9] However, these findings have not been conclusively demonstrated for low-energy firearm injuries.[10] For high-energy FIs, the necessity of antibiotic therapy is evident.[11] Upon reviewing recent studies, it is notable that the literature lacks detailed information regarding the scope of antimicrobial treatment. In a study assessing FI cases, the use of broad-spectrum antibiotics did not show an association with improvement in post-trauma infections. Another study found no significant difference in outcomes between the management of cases using broad-spectrum versus narrow-spectrum antibiotics.[12,13] Trauma scoring systems are widely used tools in the management and clinical studies of trauma cases, facilitating the assessment of injury severity and comparison of treatment outcomes. The Injury Severity Score (ISS) is one of the trauma scoring systems commonly used in the management of blunt and penetrating trauma cases.[14,15] Given our hospital's extensive experience in managing and treating FI cases and the insufficient number of studies in the literature regarding the antimicrobial management of these cases, along with inadequate guidelines, we planned this study. In this study, we aimed to investigate the relationship between ISS scores of FI cases presented to the emergency department. We empirically revised antimicrobial treatment protocols based on culture results and mortality.

MATERIALS AND METHODS

The center where the study was conducted is a tertiary care hospital with a capacity of 1,150 beds, known for its high experience in handling high-volume firearm injury cases in the past. The study commenced after obtaining approval from the Ethics Committee of SBÜ Gülhane Training and Research Hospital, with approval dated June 28, 2024, and numbered 2024-387.

One hundred sixty-four patients with firearm ınjuries who presented to the emergency department and subsequently underwent inpatient treatment in clinical and intensive care units (ICU) between January 1, 2022 and December 31, 2022, were evaluated. Patient data were obtained from hospital management information systems and medical records of hospitalized cases. The inclusion criteria for the study were: presentation to the emergency department following a FI, hospitalization due to FI, presence of signs of infection during hospitalization leading to the initiation of empirical antibiotic therapy, and age over eighteen years. The exclusion criteria included age under eighteen years, presentation to the emergency department without a FI or related complaints, and no indication for empirical antibiotic therapy during hospitalization. Injuries caused by firearms such as ımprovised explosive devices (IEDs), rifles, mortars, mines, rockets, and grenades were included. Cases included in the study were categorized into four groups based on the Injury Severity Score: mild (ISS <9), moderate (ISS 9-15), severe (ISS 16-24), and profound (ISS ≥25) injury severity.[15,16] In patients, acute infection was defined as the development of infection within the first 21 days following injury. Empirical antibiotic therapy was defined as an antibiotic regimen administered to the patient without waiting for culture results based on suspicion of infection. Antibiotic revision was defined as changing the treatment based on culture results. Patients whose condition worsened or who were found to have additional infection sites before culture results were excluded from the study. Tissue cultures were obtained from the suspected infection site using appropriate methods. The site of injury infection was determined in collaboration with an infectious disease specialist and the patient's primary clinical doctor. Additionally, cases with additional metabolic and internal pathologies that could compromise the patient's general condition and cause fever were evaluated by the same specialists and excluded from the study.

The study compared the timing of hospital presentation following injury, hospital length of stay, tissue or blood culture positivity, empirical treatment administered, antimicrobial revision based on culture results, need for ICU admission, mortality status, and ISS among the cases.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics 22.0 (SPSS Inc., Chicago, IL). Descriptive statistics for numerical data were presented as frequency distributions and percentages. Variables in trauma patients were compared among various groups using Pearson Chi-Square tests. Binary logistic regression tests were performed to identify independent risk factors. A significance level of $p<0.05$ was considered statistically significant.

RESULTS

Between January 1, 2022 and December 31, 2022, a frequency of 60% (164/270) of FI cases presenting to our emergency department received empirical antibiotic treatment initiated by an infectious disease specialist. The study included 164 pa-

tients, all of whom were male. The distribution of patients by clinics was as follows: general surgery 21 patients, orthopedics 72 patients, urology four patients, thoracic surgery 11 patients, neurosurgery 19 patients, ophthalmology 20 patients, cardiovascular surgery two patients, plastic and reconstructive surgery 28 patients, and ear, nose, and throat (ENT) 15 patients. The mean age was calculated as 28.9±4.51 years. The average hospital length of stay was found to be 25.54±21.81 days. Ninety-six percent of patients (158/164) presented to the hospital with acute infection, while 4% (6 patients) presented during the chronic phase. The mean time from injury to emergency department presentation was 2.21±5.07 days. Eighty-three patients (50.6%) required intensive care.

Tissue cultures were obtained from 79 patients (48%). Bacterial growth was observed in 45 out of these 79 patients (57%), while no growth was detected in 34 patients (43%). The most frequently isolated bacteria in culture were *Acinetobacter baumannii* and *Klebsiella pneumoniae*, with their frequencies and other isolated bacteria detailed in Table 1. One case with polymicrobial growth was excluded from the study.

The empirical antibiotic regimens were determined as beta-lactam/beta-lactamase inhibitor without pseudomonal activity and third-generation cephalosporin + nitroimidazole. Based on culture results, all patients were re-evaluated for antibiotic sensitivity and treatment revision. The appropriate empirical antibiotic treatment rate, assessed among patients who received empirical treatment followed by culture-based antibiotic sensitivity testing, was calculated as 48.9%. The most commonly used antibiotic regimen was ampicillin-sulbactam, with all regimens listed in Table 2. Regimens comprised one or two antibiotics; triple antimicrobial therapy was not used.

Facts are grouped into four categories according to ISS scores: mild for scores less than 9, moderate for scores between 9 and 15, severe for scores between 16 and 24, and profound severe for scores 25 and above.[15,16] In the mild group, 50 patients (30%), in the moderate group, 16 patients (9.7%), in the severe group, 51 patients (31%), and in the profound severe group, 47 patients (28.6%) were identified. When these groups were examined in terms of antibiotic revision, it was observed that 20% in the mild group and 83.3% in the profound severe group underwent antibiotic treatment revision. It was seen that empirical antibiotic regimens were appropriate in 80% of cases in the mild group and 16.7% in the profound severe group. When these two group data were compared, the difference was statistically significant. (p=0.005).

Our study compared the relationship between hospitalization duration and ISS groups. The mild group was compared with the moderate, severe, and profound severe groups. It was observed that hospitalization duration was significantly shorter in the mild group compared to the moderate, severe, and profound severe groups (p=0.003, p=0.000, p=0.000, respectively). When comparing intensive care unit needs across ISS groups, it was found that two out of 50 patients (4%) in the mild group, two out of 16 patients (12%) in the moderate group, and 32 out of 51 patients (62%) in the severe group required ICU care. All patients (47 out of 47) in the profound severe group required ICU care. It was observed that ICU need was higher in groups with higher ISS scores, indicating a correlation between higher ISS scores and increased ICU requirements (p=0.000).

Cases with gram-positive culture findings had a mean hospitalization duration of 27.4±19.5 days, while cases with gram-negative culture findings had a mean of 44.06±22.78 days. The difference between them was not found to be sta-

Table 1. Microorganisms detected in culture results and their frequency

Microorganisms	n (%)
Acinetobacter baumannii	9 (20%)
Klebsiella pneumoniae	9 (20%)
Pseudomonas aeruginosa	6 (13.3%)
Enterococcus faecium	5 (11.1%)
Escherichia coli	4 (8.8%)
Staphylococcus aureus	3 (6.6%)
Enterobacter cloacae	3 (6.6%)
Serratia marcescens	1 (2.2%)
Proteus mirabilis	1 (2.2%)
Citrobacter freundii	1 (2.2%)
Enterococcus faecalis	1 (2.2%)
Achromobacter	1 (2.2%)
Enterobacter cancerogenus	1 (2.2%)

Table 2. Antibiotic treatment regimens and their frequency

Antibiotic Treatment Regimens	n (%)
Ampicillin-sulbactam	48 (29.2%)
Ceftriaxone + metronidazole	21 (12.8%)
Imipenem/meropenem + teicoplanin/ linezolid/vancomycin	19 (11.6%)
Cefoperazone sulbactam/piperacilin tazobactam	19 (11.5%)
Piperacilin tazobactam + teicoplanin/linezolid	17 (10.3%)
Ampicillin-sulbactam + ciprofloxacin/levofloxacin	12 (7.3%)
Ceftriaxone + teicoplanin/vancomycin/linezolid	10 (6.09%)
Meropenem + tigecycline	7 (4.2%)
Meropenem + colistin	3 (1.8%)
Piperacilin tazobactam + tigecycline	3 (1.8%)
Meropenem + amikacin	2 (1.2%)
Linezolid + amikacin	1 (0.6%)
Piperacilin tazobactam + amikacin	1 (0.6%)
Piperacilin tazobactam + colistin	1 (0.6%)

Table 3. Antibiotic treatment regimens used and intensive care unit (ICU) requirement

Treatment Regimen	No need for ICU	Need for ICU	Total
Non-pseudomonal Beta-Lactam	24	24	48 (29.3%)
Antipseudomonal Beta-Lactam	9	10	19 (11.6%)
Quinolone Combination	5	7	12 (7.3%)
Carbapenem + Broad Gram-Positive	14	5	19 (11.6%)
Colistin Combination	2	2	4 (2.4%)
Tigecycline Combination	5	5	10 (6.1%)
Antipseudomonal Beta-Lactam + Broad Gram-Positive	9	8	17 (10.4%)
Amikacin Combination	0	4	4 (2.4%)
Ceftriaxone + Metronidazole	8	13	21 (12.8%)
Ceftriaxone + Broad Gram-Positive	5	5	10 (6.1%)
Total	81	83	164

Table 4. Antibiotic regimens of cases classified according to Injury Severity Scores (ISS)

ISS Classification	Empirical Treatment	Broad Gram-Positive Activity	Broad Gram-Negative Activity	Tigecycline Combination	Total
Mild ISS <9	21	17	9	3	50
Moderate ISS 9-15	3	6	6	1	16
Severe ISS 16-24	29	10	8	4	51
Profound ISS ≥25	16	13	16	2	47
Total	69	46	39	10	164

tistically significant (p=0.051). In patients with gram-positive cultures, intensive care unit need developed in 77% (7/9), while in patients with gram-negative cultures, ICU need developed in 69% (25/36). There was no statistically significant relationship found between ICU need and patient groups with gram-negative or gram-positive cultures (p=0.622). No statistically significant difference was found when comparing the relationship between patients with gram-positive or gram-negative cultures and ISS scores (p=0.22). No significant association was observed between mortality and antibiotic revision among patients who did or did not undergo revision (p=0.96). Among patients with gram-positive cultures, 77% (7/9) did not undergo antibiotic revision, whereas among those with gram-negative cultures, 58% (21/36) underwent antibiotic revision; however, this difference was not statistically significant (p=0.053). Evaluating culture findings by ISS groups, the ratio of gram-positive to gram-negative cultures was 1/4 in the mild group, 2/1 in the moderate group, 3/16 in the severe group, and 3/15 in the profound severe group, with no statistical significance detected (p=0.22).

Patients classified according to antibiotic regimens were compared based on intensive care unit need, and no significant difference was found (p=0.36). Patients receiving amikacin combination therapy had a 100% ICU need rate. The group with the least ICU need was the imipenem/meropenem + teicoplanin/linezolid/vancomycin treatment regimen. All treatment regimens are listed in Table 3.

Patients with positive culture findings were classified based on whether antibiotic revision was performed and compared in terms of ICU need. Among patients who underwent antibiotic revision, ICU need developed in 19 out of 23 (82%). Among those continuing with empirical treatment, ICU need developed in 13 out of 22 (59%). No statistically significant difference was found in the comparison (p=0.82).

Antibiotic treatment groups were classified into four categories: empirical treatment, extended gram-positive effective antimicrobial therapy, extended gram-negative effective antimicrobial therapy, and tigecycline combination therapy. No statistically significant difference was found between patient groups receiving different antibiotic treatments and ISS scores (p=0.12). Table 4 shows all regimens and ISS groups. No statistically significant difference was found when comparing these treatment regimens with mortality rates (p=0.19). The survival rate was 97% (67/69) in patients receiving empirical treatment. The group with the highest mortality rate (10%) received an extended gram-negative effective regimen. Patients receiving tigecycline combination therapy had a 100%

survival rate.

Upon examining 145 cases admitted within the first 3 days post-injury, 42 cases had positive culture findings. Gram-positive cultures were found in 7 cases (16%), while gram-negative cultures were found in the remaining 35 cases. ICU need was observed in 85% (6/7) of gram-positive cases and 68.5% (24/35) of gram-negative cases (p=0.35). No statistically significant results were found when comparing ISS groups with gram-positive and gram-negative culture findings (p=0.85).

Among the seven deceased patients, two had gram-negative cultures, two had gram-positive cultures, two had no cultures taken, and one patient did not have a culture sample taken. The 30-day mortality rate was determined as 4.2% (7/164). The median ISS score for the deceased patients was calculated as 75 (range 29-75). Antibiotic treatment revision was performed in six of these patients; however, one patient succumbed on the day of admission before antibiotic treatment could be revised. Bacteremia developed in two patients, but mortality was not observed in these cases.

For patients with positive culture findings, the relationship between age, hospitalization duration, time to hospital admission, ISS categorization (mild, moderate, severe, profound), antibiotic revision, detection of gram-negative or gram-positive microorganisms, and ICU need was investigated for its association with mortality. Statistical comparisons and logistic regression analysis showed no statistically significant effect of these parameters on mortality. (p=0.9).

DISCUSSION

The high rates of morbidity and mortality caused by firearm injuries, compounded by the burden of trauma-related infections and management challenges, pose a significant problem for clinicians.[17] In our hospital's emergency department, empirical antibiotic initiation by an infectious disease specialist was observed in 60% (164/270) of firearm injury cases within a year. No existing study in the literature explicitly addresses the rate of empirical treatment in this patient group, suggesting our study will contribute novel insights. We found that culture sampling frequency was 48% (79/164) in our study. The literature review shows varying culture sampling rates between 50% and 80%.[18] Therefore, our findings align with existing literature. Among appropriate culture samples from patients in our study, bacterial growth was observed in 56% (45/79) of cases. A study from 2014 reported bacterial growth in 78% of 128 swab cultures.[19] *Acinetobacter baumannii* and *Klebsiella pneumoniae* were most frequently isolated in our culture results, accounting for 20% of cases, with gram-negative species predominating. *Enterococcus faecium* was the most common gram-positive microorganism, with an occurrence rate of 11%. A study involving 384 firearm injury cases reported a bacterial wound infection prevalence of 54.7%, with *Klebsiella spp*. (23.3%), *Staphylococcus aureus* (27.6%), and *coagulase-negative staphylococci* (8.6%) as the most frequently isolated organisms.[20] Another study on 239 patients found gram-negative bacteria (57.9%) to be the most prevalent, with *Pseudomonas aeruginosa* (40.2%), *Escherichia coli* (20.7%), *Proteus mirabilis* (11.2%), and *Acinetobacter baumannii/haemolyticus* (9,5%) being the most common among them. Gram-positive bacteria accounted for 36.6%, with *Staphylococcus aureus* (79.4%) being the predominant species.[21] We attribute the differences observed between our study and the literature to variations in injury type, site of injury, wound contamination awareness, and differences in hospital/city microbial flora. In our study, a correlation was observed between ISS scores and hospitalization duration and ICU need, consistent with findings in the literature.[22,23]

In a recent study, it was found that broadening the coverage of gram-negative bacteria in antimicrobial therapy for fractures followed in FIs resulted in a decrease in infection rates.[24,25] However, there are also studies indicating that this antimicrobial treatment method does not alter infection rates.[7,26,27] It is thought that this situation may be associated with many patient- or hospital-related factors, but further studies are needed in this regard. According to our study results, in cases of firearm injuries with fever, we predominantly used ampicillin-sulbactam and ceftriaxone + metronidazole treatments in our hospital. In the mild ISS group, we did not change the treatment regimen we started with in 80% of patients and achieved clinical response. In the severe penetrating group, antimicrobial treatment revision was performed in 83.3% of cases. As a result, according to ISS classification, it was observed that broadening the coverage of gram-negative bacteria was not significant in the mild group, while in the severe group, antimicrobial therapy should consider gram-negative microorganisms such as *Acinetobacter baumannii*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa,* and extending the antimicrobial treatment accordingly was found to be significant. In a study conducted, intravenous first-generation cephalosporins are recommended for high-energy FI cases in antimicrobial therapy, and it is stated that gentamicin should be added to the treatment if there are cavitary lesions or soft tissue defects.[11] In our study, it was observed that aminoglycosides were used in severe cases according to culture results, and these patients were classified in the severe penetrating group. In our cases, we preferred amikacin treatment more often and did not opt for gentamicin due to its side effects. In a study where 222 low-energy FI cases were examined and randomized into two groups based on antimicrobial treatment regimen, the first group was treated with intravenous cephapirin sodium and gentamicin, while the second group received ciprofloxacin. All patients were followed until fracture healing, and no significant difference in terms of infection monitoring was observed between the two groups.[25] A similar result was also observed in our study. In our patients, the intensive care requirement was 61% in the ceftriaxone + metronidazole group and 58% in the quinolone combination group, with mortality rates calculated as 9% and 6%, respectively.

In another study on FI cases, it is stated that accompanying colon injury in patients with fractures is associated with an increased risk of infectious complications. The optimal antibiotic regimen for case management remains uncertain. In the study, approximately 100 patients with similar age, gender, race/ethnicity were divided into two groups based on the presence of colon injury: the group with colon injury had a median ISS of 21 (14-29), while the group without colon injury had a median ISS of 19 (13-25). It was observed that 16.1% of patients with colon injury received broad-spectrum antibiotics, compared to only 3.9% of patients without colon injury receiving this antibiotic treatment. This study concluded that simultaneous colon injuries in FI-related fractures are likely associated with a higher risk of infectious complications, possibly due to the direct spread of fecal contaminants, and early use of broad-spectrum antibiotics may be associated with reducing these complications.[28] In our study, patients with colon injury had a median ISS value of 30.5. Antimicrobial treatment revision was performed in 77% of patients (14/18). Culture samples from patients undergoing abdominal surgery revealed *Klebsiella pneumoniae*, *Enterococcus faecalis*, and *Enterococcus faecium species*, which is unsurprising. Literature review shows that commonly found microorganisms in culture results are from the Escherichia coli and Enterobacteriaceae families, and it has been observed that treatments such as piperacillin/sulbactam and cefotaxime/metronidazole were ineffective in various cases.[29]

Our limitations include, firstly, that all our cases consist of young males, and secondly, that the number of cultures obtained is insufficient. In cases suspected of infection, we believe that establishing dynamic and collaborative communication between relevant departments and obtaining cultures from appropriate body sites can facilitate patient management, allowing empirical treatments to be rationally revised. Developing protocols to facilitate and expedite the culture collection process could also contribute positively to this goal.

CONCLUSION

In conclusion, for cases of firearm injuries, we believe empirical antimicrobial therapy should be initiated with narrow-spectrum agents such as beta-lactam + beta-lactamase inhibitor or third-generation cephalosporins + nitroimidazole in the mild group, considering the lack of Pseudomonal activity. In the severe group, we suggest starting with a broader spectrum covering gram-negative bacteria. Although factors such as conflict environment, mode, and duration of evacuation may influence or alter antimicrobial treatment planning, we particularly believe that tertiary trauma centers should establish systematic treatment protocols for these patient groups.

We propose that large-volume prospective randomized studies should be planned to clarify the antimicrobial treatment process in FI cases, considering various factors.

Ethics Committee Approval: This study was approved by the Gulhane Training and Research Hospital Ethics Committee (Date: 28.06.2024, Decision No: 224-387).

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REFERENCES

1. Centers for Dısease Control and Prevention (CDC). WISQARS Fatal and nonfatal injury infographics. Deaths and Injuries due to All Injury among Persons Aged All Ages Years, 2018 to 2022, United States. Available from: https://wisqars.cdc.gov/infographics/. Accessed Jul 17, 2024.
2. Papasoulis E, Patzakis MJ, Zalavras CG. Antibiotics in the treatment of low-velocity gunshot-induced fractures: a systematic literature review. Clin Orthop Relat Res 2013;471:3937–44. [CrossRef]
3. Geissler WB, Teasedall RD, Tomasin JD, Hughes JL. Management of low velocity gunshot-induced fractures. J Orthop Trauma 1990;4:39–41.
4. Brien WW, Kuschner SH, Brien EW, Wiss DA. The management of gunshot wounds to the femur. Orthop Clin North Am 1995;26:133–8.
5. Cannada LK, Jones TR, Guerrero-Bejarano M, Viehe T, Levy M, Farrell ED, et al. Retrograde intramedullary nailing of femoral diaphyseal fractures caused by low-velocity gunshots. Orthopedics 2009;32:162. [CrossRef]
6. Bartkiw MJ, Sethi A, Coniglione F, Holland D, Hoard D, Colen R, et al. Civilian gunshot wounds of the hip and pelvis. J Orthop Trauma 2010;24:645–52. [CrossRef]
7. Long WT, Chang W, Brien EW. Grading system for gunshot injuries to the femoral diaphysis in civilians. Clin Orthop Relat Res 2003;408:92–100. [CrossRef]
8. Wisniewski TF, Radziejowski MJ. Gunshot fractures of the humeral shaft treated with external fixation. J Orthop Trauma 1996;10:273–8.
9. Lack WD, Karunakar MA, Angerame MR, Seymour RB, Sims S, Kellam JF, et al. Type III open tibia fractures: immediate antibiotic prophylaxis minimizes infection. J Orthop Trauma 2015; 29:1–6. [CrossRef]
10. Sathiyakumar V, Thakore RV, Stinner DJ, Obremskey WT, Ficke JR, Sethi MK. Gunshot-induced fractures of the extremities: a review of antibiotic and debridement practices. Curr Rev Musculoskelet Med 2015;8:276–89. [CrossRef]
11. Turker T, Capdarest-Arest N. Management of gunshot wounds to the hand: a literature review. J Hand Surg Am 2013;38:1641–50. [CrossRef]
12. Khak M, Shariyate MJ, Villarreal-Espinosa JB, Kheir N, Momenzadeh K, McNichol M, et al. Antibiotic prophylaxis following low-velocity gunshot fractures: an updated review. Int Orthop 2024;48:37–47. [CrossRef]
13. Woolum JA, Bailey AM, Dugan A, Agrawal R, Baum RA. Evaluation of infection rates with narrow versus broad-spectrum antibiotic regimens in civilian gunshot open-fracture injury. Am J Emerg Med 2020;38:934–9.
14. Li H, Ma YF. New injury severity score (NISS) outperforms injury severity score (ISS) in the evaluation of severe blunt trauma patients. Chin J Traumatol 2021;24:261–5. [CrossRef]
15. Bolorunduro OB, Villegas C, Oyetunji TA, Haut ER, Stevens KA, Chang DC, et al. Validating the Injury Severity Score (ISS) in different populations: ISS predicts mortality better among Hispanics and females. J Surg Res 2011;166:40–4. [CrossRef]
16. Javali RH, Krishnamoorthy, Patil A, Srinivasarangan M, Suraj, Sriharsha. Comparison of ınjury severity score, new ınjury severity score, revised

trauma score and trauma and injury severity score for mortality prediction in elderly trauma patients. Indian J Crit Care Med 2019;23:73–7.
17. Centers for Disease Control and Prevention, National Center for Injury Prevention and Control. Web-based Injury Statistics Query and Reporting System (WISQARS). (2015). Available from: www.cdc.gov/injury/wisqars. Accessed Jun 10, 2024.
18. Torvikoski JA, Lehtola LK, Ahava MJ, Pakarinen LM, Tissari PJ, Pätäri-Sampo AS. Impact of selective reporting of wound cultures on microbiology reports and antimicrobial-drug use on a wound-care ward in Finland: a retrospective cohort study. EBioMedicine 2024;100:104992. [CrossRef]
19. Valentine KP, Viacheslav KM. Bacterial flora of combat wounds from eastern Ukraine and time-specified changes of bacterial recovery during treatment in Ukrainian military hospital. BMC Res Notes 2017;10:152.
20. Tigabu E, Melese A, Mekonen F, Siraj Y. Bullet-related bacterial wound infections among injured personnel at emergency site hospitals in Bahir Dar: prevalence, antimicrobial susceptibility and associated factors. BMC Microbiol 2024;24:166. [CrossRef]
21. Puca V, Marulli RZ, Grande R, Vitale I, Niro A, Molinaro G, et al. Microbial species isolated from infected wounds and antimicrobial resistance analysis: data emerging from a three-years retrospective study. Antibiotics (Basel) 2021;10:1162. [CrossRef]
22. Cummock JS, Wong KK, Volpi JJ, Wong ST. Reliability of the National Institutes of Health (NIH) stroke scale between emergency room and neurology physicians for initial stroke severity scoring. Cureus 2023;15:e37595. [CrossRef]
23. Abajas Bustillo R, Amo Setién FJ, Ortego Mate MDC, Seguí Gómez M, Durá Ros MJ, Leal Costa C. Predictive capability of the injury severity score versus the new injury severity score in the categorization of the severity of trauma patients: a cross-sectional observational study. Eur J Trauma Emerg Surg 2020;46:903–11. [CrossRef]
24. Bartkiw MJ, Sethi A, Coniglione F, Holland D, Hoard D, Colen R, et al. Civilian gunshot wounds of the hip and pelvis. J Orthop Trauma 2010;24:645–52. [CrossRef]
25. Knapp TP, Patzakis MJ, Lee J, Seipel PR, Abdollahi K, Reisch RB. Comparison of intravenous and oral antibiotic therapy in the treatment of fractures caused by low-velocity gunshots: a prospective, randomized study of infection rates. J Bone Joint Surg Am 1996;78:1167–71. [CrossRef]
26. Hohmann E, Tetsworth K, Radziejowski MJ, Wiesniewski TF. Comparison of delayed and primary wound closure in the treatment of open tibial fractures. Arch Orthop Trauma Surg 2007;127:131–6. [CrossRef]
27. Wright DG, Levin JS, Esterhai JL, Heppenstall RB. Immediate internal fixation of low-velocity gunshot-related femoral fractures. J Trauma 1993;35:678–81; discussion 681–2. [CrossRef]
28. Banks KC, Mooney CM, Alcasid NJ, Susai CJ, Mazzolini K, Browder TD, et al. Colon injuries and infectious complications in concurrent gunshot-related fractures. J Surg Res 2024;293:152–7. [CrossRef]
29. Grotelueschen R, Luetgehetmann M, Erbes J, Heidelmann LM, Grupp K, Karstens K, et al. Microbial findings, sensitivity and outcome in patients with postoperative peritonitis a retrospective cohort study. Int J Surg 2019;70:63–9. [CrossRef]

ORİJİNAL ÇALIŞMA - *ÖZ*

Acil servise başvurup hospitalize edilen ateşli silah yaralanmalarında antimikrobiyal tedavi yönetimi: Tek merkez deneyimi

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AMAÇ: Ateşli silah yaralanmaları (ASY) küresel olarak halen önemli bir morbidite ve mortalite nedenidir. Antibiyotik kullanımı, ASY olgularında yaralanma sonrası enfeksiyonların önlenmesi için kılavuz önerileri ile desteklenmektedir, ancak antimikrobiyal ajan seçimi ve bunlarla ilişkili sonuçlar belirsizliğini korumaktadır. Bu çalışmada acil servise başvuran ASY olgularının yaralanma şiddet skorları (ISS) ile ampirik ve kültür sonucuna göre revize edilen antimikrobiyal tedavi protokolleri ve mortalite arasındaki ilişkiyi araştırmayı amaçladık.

GEREÇ VE YÖNTEM: Araştırmada 2022 yılında acil servise başvurusu olan ve sonrasında klinik ve yoğun bakım ünitelerinde (YBÜ) yatarak tedavi gören 164 ASY olgusu değerlendirildi. Bu vakalar ISS'a göre 9'dan küçük olanlar hafif, 9-15 arası olanlar orta, 16-24 arası olanlar şiddetli, 25 ve üzeri olanlar derin şiddetli olmak üzere dört gruba ayrıldı. Olgularda hastane yatış süresi, hastaneye yaralanma sonrası kaçıncı günde başvurduğu, doku veya kan kültür üremesi, verilen ampirik tedavi seçeneği, kültür sonucuna göre yapılan antimikrobiyal revizyon durumu, hastanın YBÜ ihtiyacı olup olmaması ve mortalite durumu, ISS ile karşılaştırıldı. Araştırmanın verileri SPSS IBM 22,0 (SPSS Inc, Chicago, IL) istatistik programına aktarılarak veri kontrolü ve analizler bu programda yapıldı. Travma hastalarında değişkenler çeşitli gruplar arasında Pearson Chi-Square ile karşılaştırılmıştır. Binary logistic regression testleri ile analiz edilerek bağımsız risk faktörleri belirlenmiştir. İstatistiksel açıdan $p<0,05$ düzeyi anlamlı kabul edildi.

BULGULAR: Çalışmaya alınan 164 hastanın tamamı erkekti. Ortalama yaş 28.9±4.51 yıl olarak hesaplandı. Ortalama hastane yatış süresi 25.54±21.81 gün olarak bulundu. Hastaların %96'sı (158/164) akut enfeksiyon ile hastaneye başvurmuştur. Hastaların 83'ünde (%50.6) yoğun bakım ihtiyacı gelişmiştir. Hastaların 79'undan (%48) doku kültürü alındı. Doku kültürü alınan 79 hastanın 45'inde (%57) bakteri üremesi olmuştur. Kültür üremelerinde en sık *Acinetobacter baumannii* ve *Klebsiella pneumoniae* görülmüştür. Ampirik tedavi verilen ve sonrasında kültür sonucuna göre antibiyotik duyarlılıklarına bakılan hastalar incelendiğinde uygun ampirik antibiyotik tedavi oranı %48,9 hesaplanmıştır. Ampirik antibiyotik rejimlerinin hafif grupta %80 olguda, derin şiddetli grupta ise %16.7 olguda uygun verildiği ve bu sonucun anlamlı olduğu görülmektedir ($p=0.005$). Hafif grupta hastanede kalış süresinin istatistiksel anlamlı şekilde daha kısa olduğu görülmüştür ($p=0.003$, $p=0.000$, $p=0.000$). ISS dört grupta sınıflandırılan hastalar YBU ihtiyacına göre değerlendirildiğinde anlamlı bir fark saptanmış olup ($p=0.000$) ISS skorunun yüksek olduğu gruplarda yoğun bakım ihtiyacı daha yüksek hesaplanmıştır.

SONUÇ: Sonuçta ASY olgularında ampirik antimikrobiyal tedavinin hafif grupta psödomonal etkinliği olmayan beta laktam+beta laktamaz inhibitörü veya üçüncü kuşak sefalosporin+nitroimidazol gibi dar spektrumlu olacak şekilde, şiddetli grupta ise gram negatif bakterileri de kapsayacak şekilde daha geniş spektrumlu olarak başlanması gerektiğini düşünmekteyiz. Özellikle üçüncü basamak travma merkezlerinin bu hasta gruplarına yönelik sistematik tedavi protokolleri oluşturması gerekmektedir.

Anahtar sözcükler: Ateşli silah yaralanmaları; ISS; mortalite.

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