

PREVALENCE AND RISK FACTORS OF SURGICAL SITE INFECTION FOLLOWING  
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**ABSTRACT**

**Background:** Surgical site infection is an important postoperative complication following orthopedic trauma surgery because it may delay wound healing, impair fracture union, prolong hospitalization, increase treatment cost, and negatively affect functional outcome. **Objectives:** To determine the prevalence and risk factors of surgical site infection following orthopedic trauma surgery at Al Salam Teaching Hospital in Mosul. **Methods** This hospital-based observational study was conducted at Al Salam Teaching Hospital in Mosul from January 2021 to June 2025. The study included 500 patients who underwent orthopedic trauma surgery. Data were collected regarding demographic characteristics, comorbidities, injury-related factors, operative variables, antibiotic prophylaxis, postoperative infection, microbiological findings, and management. Surgical site infection was classified as superficial incisional, deep incisional, or organ/space infection. Data were analyzed using Statistical Package for the Social Sciences version 31, and a p-value of less than 0.05 was considered statistically significant. **Results:** Surgical site infection occurred in 48 patients, giving an overall prevalence of 9.6%. Superficial incisional infection was the most common type, accounting for 60.4% of infected cases, followed by deep incisional infection in 33.3% and organ/space infection in 6.3%. Most infections were diagnosed within the first 30 postoperative days. Significant factors associated with surgical site infection included diabetes mellitus, smoking, anemia, obesity, open fracture, contaminated or dirty wound, lower-limb injury, delayed presentation, delayed surgery, prolonged operative duration, blood transfusion, delayed or undocumented antibiotic prophylaxis, and prolonged hospital stay. In multivariable analysis, diabetes mellitus, open fracture, contaminated or dirty wound, delayed presentation, operation duration more than two hours, and blood transfusion were independent predictors of surgical site infection. **Conclusions:** Surgical site infection remains a significant complication following orthopedic trauma surgery in Mosul. Early identification of high-risk patients, timely antibiotic prophylaxis, strict open-fracture management, optimization of diabetic control, careful operative planning, rational blood transfusion, and structured postoperative surveillance are recommended to reduce infection risk and improve patient outcomes.

**KEYWORDS:** Antibiotic prophylaxis; Mosul; Open fracture; Orthopedic trauma; Risk factors; Surgical site infection.**1- INTRODUCTION**

Surgical site infection (SSI) is one of the most important postoperative complications in orthopedic trauma surgery because it increases morbidity, prolongs hospitalization, delays rehabilitation, raises treatment cost, and may lead to implant failure, nonunion, repeated debridement, or limb-threatening complications. The

Centers for Disease Control and Prevention defines SSI as an infection occurring in the part of the body where surgery was performed, and it is classified into superficial incisional, deep incisional, and organ/space infection according to the anatomical level involved. In orthopedic trauma, this definition is particularly relevant because many procedures involve metallic implants,

fracture hematoma, soft-tissue damage, and variable wound contamination, which make infection more difficult to treat than in many elective clean operations.<sup>[1-2]</sup>

Orthopedic trauma surgery has a distinct infection-risk profile. Unlike elective orthopedic procedures, trauma operations are frequently performed in emergency settings after road traffic accidents, falls, crush injuries, or open fractures. Patients may present with contaminated wounds, devitalized soft tissue, delayed presentation, anemia, shock, diabetes mellitus, smoking history, or other comorbidities that impair wound healing. Operative factors such as prolonged surgical duration, repeated procedures, inadequate timing of antibiotic prophylaxis, extensive soft-tissue dissection, blood transfusion, use of implants, and prolonged hospital stay may further increase the risk of SSI. Recent studies have shown that postoperative SSI after orthopedic surgery is associated with patient-related factors, wound contamination, open injury, smoking, high body mass index, and longer operative time.<sup>[3-4]</sup>

The burden of SSI in orthopedic trauma extends beyond the early postoperative period. In fracture fixation, infection may compromise bone healing through persistent inflammation, bacterial biofilm formation on implants, and instability at the fracture site. Implant-associated infection is particularly challenging because bacteria can adhere to metallic surfaces and form biofilms that reduce antibiotic penetration and protect microorganisms from host immune response. As a result, infected orthopedic trauma cases may require prolonged antibiotic therapy, repeated surgical debridement, implant retention or removal, staged reconstruction, and long-term follow-up. These complications negatively affect functional outcome and increase the burden on hospital resources and patients' socioeconomic status.<sup>[5-6]</sup>

Prevention of SSI depends on coordinated perioperative measures. The World Health Organization guidelines for SSI prevention recommend evidence-based interventions during the preoperative, intraoperative, and postoperative periods, including appropriate antimicrobial prophylaxis, surgical hand preparation, skin antisepsis, maintenance of normothermia, glycemic control, and adherence to infection-control practices.<sup>[7]</sup> Similarly, the CDC guideline emphasizes that SSI prevention should be integrated into surgical quality-improvement programs.<sup>[8]</sup> However, implementation of these measures in orthopedic trauma may be difficult because many patients require urgent surgery, have contaminated wounds, or present late after injury.

The reported prevalence of SSI varies widely between studies because of differences in case definition, type of surgery, wound classification, follow-up duration, surveillance method, and patient population. A recent postoperative study reported an SSI prevalence of 9.3%, with increased risk among older patients, smokers,

patients with prolonged operations, non-ambulatory status, blood transfusion, and contaminated or dirty wounds.<sup>[9]</sup> In orthopedic trauma specifically, a recent systematic review and meta-analysis estimated the pooled incidence of deep SSI after orthopedic trauma surgery at approximately 6.7%, confirming that infection remains a clinically significant complication in this field.<sup>[4]</sup>

In Iraq, and particularly in Mosul, orthopedic trauma represents an important surgical workload because of road traffic accidents, occupational injuries, falls, and post-conflict injury patterns. Local hospitals may face additional challenges, including high emergency caseload, delayed presentation, variable referral pathways, limited infection surveillance systems, and differences in antibiotic-use practices. Despite the clinical importance of postoperative infection, local data on the prevalence and determinants of SSI after orthopedic trauma surgery remain limited. Therefore, this study aims to determine the prevalence of SSI among patients undergoing orthopedic trauma surgery and to assess the patient-related, injury-related, and procedure-related factors associated with infection. The findings may help orthopedic surgeons, infection-control teams, and hospital administrators develop targeted preventive measures, optimize antibiotic prophylaxis, improve perioperative care, and reduce postoperative complications in trauma patients.

## 2-PATIENTS AND METHODS

Prior to the study conduction, its protocol was reviewed and approved by the Nineveh Directorate of Health. Administrative authorization was obtained from Al Salam Teaching Hospital before data collection. To ensure confidentiality, all patient-related information was anonymized and recorded using coded data sheets without personal identifiers. Access to the collected data was restricted to the research team, and the information was used exclusively for research purposes.

This hospital-based observational study was conducted at Al Salam Teaching Hospital in Mosul from January 2021 to June 2025. The study included 500 patients who underwent orthopedic trauma surgery during the study period. The aim was to determine the prevalence of surgical site infection and identify the associated risk factors among patients treated surgically for traumatic orthopedic injuries.

All patients of different age groups and both genders who underwent operative management for orthopedic trauma were eligible for inclusion. These included patients with closed or open fractures, dislocations associated with fractures, and other traumatic musculoskeletal injuries requiring surgical intervention such as internal fixation, external fixation, debridement, or implant-related procedures. Patients were excluded if they had pre-existing infection at the operative site before surgery, pathological fractures, elective

orthopedic procedures, incomplete medical records, or loss of follow-up before assessment of postoperative wound status.

Data were collected from patients’ medical records, operative notes, anesthesia records, infection-control reports, and follow-up documentation. A structured data collection form was used to record demographic characteristics including age, sex, residence, smoking status, and relevant comorbidities such as diabetes mellitus, hypertension, anemia, renal disease, and immunosuppressive conditions. Injury-related variables included mechanism of trauma, anatomical site of injury, type of fracture, open or closed injury, degree of wound contamination, time from injury to hospital presentation, and time from admission to surgery. Operative variables included type of surgical procedure, type of fixation, use of implant, duration of operation, antibiotic prophylaxis, blood transfusion, wound classification, and length of hospital stay.

Surgical site infection was defined according to standard clinical criteria as infection occurring at or near the surgical incision after the operative procedure and was classified as superficial incisional, deep incisional, or organ/space infection. Diagnosis was based on clinical findings such as redness, swelling, warmth, pain or tenderness, purulent discharge, wound dehiscence, fever, positive wound culture when available, or the need for antibiotic treatment, wound drainage, debridement, or reoperation. Patients were assessed during hospitalization and at postoperative follow-up visits to identify the occurrence of SSI.

The main outcome variable was the development of surgical site infection following orthopedic trauma surgery. The independent variables included patient-related factors, injury-related factors, and procedure-related factors. Risk factors were analyzed by comparing patients who developed SSI with those who did not develop SSI.

Data were entered and analyzed using Statistical Package for the Social Sciences version 31. Descriptive statistics were used to summarize the data. Categorical variables were presented as frequencies and percentages, while continuous variables were presented as mean and standard deviation or median and range according to data distribution. The chi-square test or Fisher’s exact test was used to assess associations between categorical variables, while the independent sample t-test or Mann–Whitney U test was used for continuous variables when appropriate. Variables with significant association in univariate analysis were further assessed using binary logistic regression to identify independent risk factors for SSI. A p-value of less than 0.05 was considered statistically significant.

**3-RESULTS**

A total of 500 patients who underwent orthopedic trauma surgery were enrolled to this study. Table 1 shows the demographic characteristics and patient-related risk factors of the studied patients. Males represented the majority of cases, and the most frequent age group was 21–40 years. Smoking was recorded in nearly one third of patients, while diabetes mellitus was present in 18.6%.

**Table 1: Demographic characteristics and patient-related risk factors.**

Variable	Number	Percentage
Male	342	68.4%
Female	158	31.6%
Age <20 years	72	14.4%
Age 21–40 years	196	39.2%
Age 41–60 years	147	29.4%
Age >60 years	85	17.0%
Urban residence	318	63.6%
Rural residence	182	36.4%
Smoking	154	30.8%
Diabetes mellitus	93	18.6%
Hypertension	78	15.6%
Anemia	64	12.8%
Obesity	58	11.6%
Chronic renal disease	16	3.2%
Immunosuppressive condition/drug use	11	2.2%
No documented comorbidity	246	49.2%

Table 2 summarizes the mechanism of injury and anatomical site of trauma. Road traffic accidents were the most common mechanism of injury, followed by

falls. Lower-limb injuries were more frequent than upper-limb injuries, with tibia/fibula fractures being the most common anatomical site.

**Table 2: Mechanism and anatomical site of injury.**

Variable	Number	Percentage
<b>Mechanism of injury</b>		
Road traffic accident	226	45.2%
Fall from height or ground-level fall	142	28.4%
Occupational injury	61	12.2%
Direct trauma	39	7.8%
Sports-related injury	18	3.6%
Other mechanisms	14	2.8%
<b>Anatomical site of injury</b>		
Tibia/fibula	132	26.4%
Femur	104	20.8%
Radius/ulna	76	15.2%
Humerus	58	11.6%
Ankle/foot fractures	49	9.8%
Pelvic/acetabular fractures	31	6.2%
Clavicle/scapula	28	5.6%
Multiple fracture sites	22	4.4%

Table 3 presents fracture characteristics, wound classification, timing of presentation, and timing of surgery. Closed fractures were more common than open fractures. Among open fractures, Gustilo–Anderson

grade II was the most frequent type. Most patients presented within 24 hours of injury, and surgery was performed within 24 hours of admission in more than half of cases.

**Table 3: Fracture characteristics, wound classification, and timing of management.**

Variable	Number	Percentage
<b>Fracture type</b>		
Closed fracture	356	71.2%
Open fracture	144	28.8%
<b>Gustilo–Anderson classification of open fractures</b>		
Grade I	39	27.1% of open fractures
Grade II	61	42.4% of open fractures
Grade III	44	30.5% of open fractures
<b>Wound classification</b>		
Clean wound	286	57.2%
Clean-contaminated wound	82	16.4%
Contaminated wound	91	18.2%
Dirty/infected wound	41	8.2%
<b>Time from injury to presentation</b>		
Within 6 hours	162	32.4%
6–24 hours	214	42.8%
>24 hours	124	24.8%
<b>Time from admission to surgery</b>		
Surgery within 24 hours	292	58.4%
Surgery after 24 hours	208	41.6%
Antibiotic prophylaxis documented before surgery	441	88.2%
Antibiotic prophylaxis delayed/not clearly documented	59	11.8%

Table 4 demonstrates the operative characteristics of the studied patients. Open reduction and internal fixation was the most frequently performed procedure, followed

by intramedullary nailing. Implant use was documented in most patients, and approximately one third of operations lasted more than two hours.

**Table 4: Operative characteristics.**

Operative variable	Number	Percentage
Open reduction and internal fixation	238	47.6%
Intramedullary nailing	112	22.4%
External fixation	68	13.6%
Debridement with fixation	51	10.2%

Closed reduction and percutaneous fixation	31	6.2%
Implant used	431	86.2%
Operation duration ≤2 hours	327	65.4%
Operation duration >2 hours	173	34.6%
Blood transfusion required	96	19.2%
Hospital stay ≤7 days	331	66.2%
Hospital stay >7 days	169	33.8%

Table 5 shows the prevalence, classification, and timing of surgical site infection. SSI was recorded in 48 patients, giving an overall prevalence of 9.6%.

Superficial incisional infection was the most common type, and most infections were diagnosed within the first 30 postoperative days.

**Table 5: Prevalence, classification, and timing of surgical site infection.**

Variable	Number	Percentage
<b>SSI outcome</b>		
Developed SSI	48	9.6%
No SSI	452	90.4%
<b>Type of SSI among infected patients</b>		
Superficial incisional SSI	29	60.4% of SSI cases
Deep incisional SSI	16	33.3% of SSI cases
Organ/space SSI	3	6.3% of SSI cases
<b>Timing of SSI diagnosis</b>		
During hospital admission	17	35.4% of SSI cases
Within 30 days after surgery	24	50.0% of SSI cases
After 30 days	7	14.6% of SSI cases

Table 6 shows the association between selected patient-related, injury-related, and operative factors with SSI. Diabetes mellitus, smoking, anemia, obesity, open fracture, contaminated or dirty wound, lower-limb injury,

delayed presentation, delayed surgery, prolonged operation, blood transfusion, delayed or undocumented antibiotic prophylaxis, and prolonged hospital stay were significantly associated with SSI.

**Table 6: Factors associated with surgical site infection.**

Factor	SSI present n=48	SSI absent n=452	p-value
Age >60 years	14 (29.2%)	71 (15.7%)	0.018
Male sex	36 (75.0%)	306 (67.7%)	0.302
Smoking	24 (50.0%)	130 (28.8%)	0.003
Diabetes mellitus	19 (39.6%)	74 (16.4%)	<0.001
Anemia	13 (27.1%)	51 (11.3%)	0.002
Obesity	11 (22.9%)	47 (10.4%)	0.010
Open fracture	29 (60.4%)	115 (25.4%)	<0.001
Gustilo–Anderson grade III open fracture	15 (31.3%)	29 (6.4%)	<0.001
Contaminated/dirty wound	27 (56.3%)	105 (23.2%)	<0.001
Lower-limb injury	36 (75.0%)	249 (55.1%)	0.008
Road traffic accident	28 (58.3%)	198 (43.8%)	0.055
Presentation >24 hours after injury	21 (43.8%)	103 (22.8%)	0.002
Surgery after 24 hours of admission	29 (60.4%)	179 (39.6%)	0.006
Operation duration >2 hours	27 (56.3%)	146 (32.3%)	0.001
Implant used	45 (93.8%)	386 (85.4%)	0.104
Blood transfusion	19 (39.6%)	77 (17.0%)	<0.001
Delayed/not documented antibiotic prophylaxis	12 (25.0%)	47 (10.4%)	0.003
Hospital stay >7 days	31 (64.6%)	138 (30.5%)	<0.001

Table 7 presents the independent predictors of SSI using binary logistic regression analysis. Diabetes mellitus, open fracture, contaminated or dirty wound, delayed

presentation, operation duration more than two hours, and blood transfusion remained significant independent predictors of SSI.

**Table 7: Binary logistic regression analysis of independent predictors of SSI.**

Risk factor	Adjusted odds ratio	95% confidence interval	p-value
Diabetes mellitus	2.41	1.28–4.54	0.006
Smoking	1.74	0.94–3.21	0.076
Open fracture	3.18	1.69–5.97	<0.001
Contaminated/dirty wound	2.86	1.51–5.43	0.001
Presentation >24 hours	2.09	1.10–3.97	0.024
Operation duration >2 hours	2.32	1.24–4.36	0.008
Blood transfusion	2.27	1.17–4.39	0.015
Delayed/not documented antibiotic prophylaxis	1.89	0.89–4.02	0.096

Table 8 shows the microbiological profile and management of SSI cases. Wound culture was performed in 39 infected patients. Staphylococcus aureus was the most commonly isolated organism. Most superficial

infections were managed by antibiotics and regular dressing, while deep infections required wound drainage or debridement.

**Table 8: Microbiological profile and management of SSI cases.**

Variable	Number	Percentage
<b>Culture result among SSI cases</b>		
Culture performed/positive	39	81.3% of SSI cases
Culture not performed/negative	9	18.7% of SSI cases
<b>Isolated organism among positive cultures</b>		
Staphylococcus aureus	13	33.3%
Escherichia coli	8	20.5%
Klebsiella species	6	15.4%
Pseudomonas aeruginosa	5	12.8%
Coagulase-negative Staphylococci	4	10.3%
Proteus species	3	7.7%
<b>Management of SSI</b>		
Antibiotics and regular dressing only	25	52.1% of SSI cases
Wound drainage/debridement	15	31.3% of SSI cases
Reoperation with implant retention	5	10.4% of SSI cases
Implant removal after fracture stability/union	3	6.2% of SSI cases

**4- DISCUSSION**

Surgical site infection remains a major postoperative complication after orthopedic trauma surgery because it may delay wound healing, impair fracture union, prolong hospitalization, increase the need for antibiotics or reoperation, and negatively affect functional recovery. In the present study, surgical site infection was identified in 48 of 500 patients, giving an overall prevalence of 9.6%. This finding indicates that SSI represents a clinically relevant burden among orthopedic trauma patients treated at Al Salam Teaching Hospital in Mosul. The observed prevalence is comparable to recent reports from hospital-based surgical populations, where SSI rates around 10% have been documented, but it is slightly higher than the pooled incidence of deep SSI after orthopedic trauma surgery reported in a recent meta-analysis. This difference may be explained by the inclusion of both superficial and deep infections in the present study, as well as the relatively high proportion of open fractures, contaminated wounds, delayed presentation, and emergency trauma procedures.<sup>[4,9,10]</sup>

infections are more frequently detected than deep or organ/space infections. In this study, superficial incisional infection accounted for 60.4% of SSI cases, while deep incisional infection represented 33.3%. Although superficial SSI is generally less severe, it remains clinically important because it may require antibiotics, repeated dressing, wound drainage, and additional follow-up. Deep infection is more serious in orthopedic trauma because it may involve implants, bone, and fracture hematoma, increasing the risk of fracture-related infection, delayed union, nonunion, and repeated surgery. Recent literature emphasizes that fracture-related infection is particularly difficult to manage because implant-associated bacteria may form biofilms that reduce antibiotic penetration and protect microorganisms from host immune response.<sup>[5,6,11,12]</sup>

Most infections in the present study were diagnosed within the first 30 postoperative days, which supports the importance of early postoperative wound surveillance. However, a smaller proportion of infections were detected after 30 days, reflecting the possibility of delayed presentation, especially in implant-related or deep infections. This is important in orthopedic trauma because the presence of internal fixation devices may

The predominance of superficial incisional SSI in the current study is consistent with the usual distribution of postoperative wound infections, where superficial

allow infection to present later than ordinary superficial wound infection. Recent reviews of fracture-related infection highlight that delayed and late infections are more difficult to eradicate because mature biofilm formation increases bacterial tolerance to antibiotics and host defenses.<sup>[11,13]</sup> Therefore, postoperative follow-up beyond hospital discharge is essential, particularly for patients with open fractures, implants, diabetes, or prolonged operations.

Diabetes mellitus was significantly associated with SSI in the present study and remained an independent predictor in multivariable analysis. Diabetic patients had more than twice the odds of developing SSI compared with non-diabetic patients. This finding is biologically plausible because hyperglycemia impairs neutrophil function, reduces collagen synthesis, compromises microvascular circulation, and delays wound healing. Recent orthopedic evidence supports the association between diabetes and postoperative infection, with diabetic patients showing a higher risk of SSI after orthopedic procedures. In trauma patients, this risk may be amplified by open wounds, soft-tissue damage, implant fixation, and emergency surgery.<sup>[10,14,15]</sup> These findings support the need for perioperative glucose monitoring and optimization in diabetic orthopedic trauma patients.

Smoking was significantly associated with SSI in univariate analysis, although it did not remain an independent predictor after adjustment. This suggests that smoking may contribute to infection risk but may also interact with other factors such as male sex, high-energy trauma, open fracture, and delayed wound healing. Smoking causes vasoconstriction, tissue hypoxia, impaired leukocyte function, and delayed collagen deposition, all of which may increase susceptibility to wound complications. A recent meta-analysis of deep SSI after orthopedic trauma surgery identified current smoking as a significant risk factor, with a strong association with postoperative infection.<sup>[4]</sup> Therefore, smoking status should still be documented and considered in postoperative risk stratification, even when emergency surgery prevents preoperative cessation.

Open fracture was one of the strongest predictors of SSI in the present study. Patients with open fractures had significantly higher infection rates than those with closed fractures, and open fracture remained independently associated with SSI in regression analysis. This finding is consistent with established orthopedic trauma principles because open fractures involve direct bacterial contamination, devitalized tissue, periosteal stripping, vascular compromise, and variable degrees of soft-tissue loss. The risk is particularly high in severe open fractures, especially Gustilo–Anderson grade III injuries. Recent studies and reviews have reported that infection risk in open fractures may exceed 20% in severe cases, and may be even higher when soft-tissue coverage is

required.<sup>[11,16,17]</sup> Therefore, early antibiotic administration, adequate debridement, irrigation, stabilization, and timely soft-tissue management remain essential measures for reducing infection after open fracture surgery.

Contaminated and dirty wounds were also independently associated with SSI. This finding supports the role of wound classification as a practical indicator of infection risk in orthopedic trauma. Wound contamination increases bacterial load at the operative site and may be associated with high-energy trauma, road traffic accidents, soil contamination, delayed presentation, and inadequate early wound care. The recent meta-analysis by Liu *et al.* found that wound class  $\geq 2$  was significantly associated with deep SSI after orthopedic trauma surgery.<sup>[4]</sup> In the present study, the association between contaminated or dirty wounds and SSI highlights the need for careful wound assessment at admission, appropriate documentation, early antimicrobial therapy, and repeated debridement when necessary.

Delayed presentation more than 24 hours after injury was significantly associated with SSI and remained an independent predictor. Delayed presentation may increase infection risk by prolonging wound contamination, delaying antibiotic administration, increasing tissue edema, and reducing the effectiveness of early debridement. In trauma settings, delay may occur due to referral from peripheral centers, transport difficulties, late recognition of injury severity, or limited emergency surgical capacity. Similar findings have been reported in orthopedic and trauma surgery studies, where prolonged preoperative duration and emergency surgical conditions were associated with increased SSI risk.<sup>[18]</sup> This finding is particularly relevant to Mosul because trauma patients may arrive from urban and rural areas with variable access to early orthopedic care.

Prolonged operative duration was another independent predictor of SSI. Patients whose operations lasted more than two hours had significantly higher infection risk. Longer surgery increases tissue exposure time, bacterial contamination risk, blood loss, tissue handling, and the probability of intraoperative technical difficulty. It may also reflect fracture complexity, open injury, comminution, difficult reduction, or need for extensive soft-tissue dissection. Recent orthopedic studies and meta-analyses have identified prolonged operative time and multiple procedures as important risk factors for SSI after orthopedic surgery.<sup>[4,10]</sup> This supports the importance of preoperative planning, experienced surgical teams, adequate implant availability, and efficient operating room workflow.

Blood transfusion was significantly associated with SSI and remained an independent predictor in the current study. This association may reflect more severe trauma, greater operative blood loss, anemia, physiological instability, or longer operative time. However,

transfusion itself may also contribute to infection susceptibility through transfusion-related immunomodulation. A recent study on orthopedic trauma patients reported that blood transfusion within 24 hours of hospital arrival was a significant risk factor for SSI.<sup>[19]</sup> Therefore, careful hemostasis, rational transfusion thresholds, correction of anemia when possible, and close monitoring of transfused patients may help reduce postoperative infection risk.

Delayed or undocumented antibiotic prophylaxis was significantly associated with SSI in univariate analysis, although it did not remain statistically significant in multivariable analysis. This finding still has clinical importance because antibiotic prophylaxis is one of the most modifiable components of SSI prevention. The World Health Organization and CDC guidelines emphasize that antimicrobial prophylaxis should be administered appropriately and integrated with other preventive measures such as skin antisepsis, surgical hand preparation, aseptic technique, normothermia, and glycemic control.<sup>[7-8]</sup> In orthopedic trauma, particularly open fractures, antibiotics should be given as early as possible after presentation rather than waiting until the time of surgery. The current finding supports the need for a standardized trauma antibiotic protocol and clear documentation of timing, dose, and redosing.

Lower-limb injuries were significantly associated with SSI in the present study. This may be explained by the high frequency of tibial and femoral fractures, greater soft-tissue injury, higher contamination risk, and longer operative duration in lower-extremity trauma. Tibial fractures are particularly vulnerable because of limited soft-tissue coverage and frequent association with open wounds. Recent hospital-based studies have also identified lower-extremity surgery as a factor associated with SSI.<sup>[10]</sup> In the present study, this finding suggests that lower-limb trauma patients should receive careful wound assessment, early infection-prevention measures, and structured follow-up.

The microbiological findings showed that *Staphylococcus aureus* was the most common isolated organism, followed by gram-negative bacteria including *Escherichia coli*, *Klebsiella* species, and *Pseudomonas aeruginosa*. This pattern is clinically relevant because orthopedic SSI may include both skin flora and organisms related to environmental contamination, open wounds, and hospital exposure. *Staphylococcus aureus* remains a leading cause of orthopedic implant-related infection because of its ability to adhere to tissue and implants and form biofilm. However, the presence of gram-negative organisms in the present study suggests that empirical therapy in contaminated trauma wounds should consider local microbiological patterns and antibiotic sensitivity results. Recent literature emphasizes culture-guided therapy and antimicrobial stewardship in fracture-related infection management to avoid

unnecessary broad-spectrum antibiotic use and reduce antimicrobial resistance.<sup>[11,13]</sup>

Management of SSI in the present study varied according to infection severity. More than half of infected patients were treated with antibiotics and regular dressing, while others required wound drainage, debridement, reoperation with implant retention, or implant removal after fracture stability or union. This reflects the stepwise approach used in orthopedic infection management, where superficial infections may respond to conservative measures, whereas deep or implant-associated infections often require surgical intervention. Recent reviews of fracture-related infection emphasize that management decisions depend on infection duration, implant stability, fracture union status, soft-tissue condition, organism virulence, and patient factors.<sup>[11-13]</sup> Therefore, early differentiation between superficial SSI and deep fracture-related infection is essential for appropriate treatment planning.

The association between prolonged hospital stay and SSI was significant in the present study. Patients with SSI were more likely to stay in hospital for more than seven days. This relationship may be bidirectional: prolonged hospitalization may increase exposure to hospital-acquired organisms, while SSI itself may extend admission due to antibiotic therapy, wound care, debridement, or reoperation. Recent economic evidence indicates that SSI substantially increases healthcare costs in orthopedic and trauma surgery, with deep infections producing higher cost burdens than superficial infections.<sup>[20]</sup> In a busy trauma center, reducing SSI may therefore improve bed availability, reduce antibiotic consumption, decrease reoperation rates, and reduce financial burden on patients and the healthcare system.

The findings of this study should be interpreted in light of some limitations. Since the study was performed at a single tertiary hospital in Mosul, the results may not fully represent the situation in other hospitals or healthcare settings. In addition, reliance on hospital records may have led to missing or incomplete information regarding some clinical variables, including antibiotic timing, wound contamination, comorbidities, and follow-up details. Post-discharge surveillance was also limited, and therefore some infections that developed later or were managed outside the hospital may not have been recorded. Another limitation was that wound culture and antibiotic sensitivity testing were not performed for all patients with surgical site infection, which restricted the microbiological analysis. Furthermore, the inclusion of different fracture types, anatomical sites, and operative procedures created heterogeneity within the study population. Long-term outcomes, including fracture union, implant-related complications, functional recovery, and recurrence of infection, were not comprehensively evaluated.

## 5- CONCLUSION AND RECOMMENDATION

Surgical site infection was a relevant postoperative complication among patients undergoing orthopedic trauma surgery at Al Salam Teaching Hospital in Mosul, with an overall prevalence of 9.6%. Most infections were superficial incisional and occurred within the first 30 postoperative days. The main factors associated with SSI were diabetes mellitus, smoking, anemia, obesity, open fractures, contaminated or dirty wounds, lower-limb injuries, delayed presentation, delayed surgery, prolonged operative duration, blood transfusion, delayed or undocumented antibiotic prophylaxis, and prolonged hospital stay. Independent predictors included diabetes mellitus, open fracture, contaminated or dirty wound, delayed presentation, operation duration more than two hours, and blood transfusion. These findings highlight the need for early identification of high-risk patients, strict adherence to infection-prevention protocols, timely antibiotic prophylaxis, proper management of open fractures, optimization of diabetic control, careful operative planning, rational blood transfusion, and structured postoperative wound surveillance. Further prospective multicenter studies are recommended to confirm these findings and evaluate the effectiveness of targeted SSI prevention strategies in orthopedic trauma patients.

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