

# International Journal of Orthopaedics Sciences

E-ISSN: 2395-1958  
P-ISSN: 2706-6630  
IJOS 2021; 7(1): 268-271  
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[www.orthopaper.com](http://www.orthopaper.com)  
Received: 17-10-2020  
Accepted: 25-11-2020

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## A retrospective analysis of early antibiotic therapy in reducing wound infection in open fractures

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**DOI:** <https://doi.org/10.22271/ortho.2021.v7.i1e.2495>

### Abstract

**Introduction:** Wound infection is a highly prevalent complication in open fractures. Institution of antibiotics early have come across as a beneficial factor in reducing the infection rate thereby enabling faster rehabilitation. In this study we have observed the impact of delayed initiation of antibiotics in wound infection in open injury cases.

**Materials and Methods:** A retrospective observational study including patients in the age group of 18 to 55 years with open fractures managed between January 2018 to August 2019. About sixty patients with open fractures were included in this study. Patients were grouped based on the Gustilo-Anderson system of classification of open fracture. From the hospital medical records the approximate time interval between the administration of antibiotics and time of injury were calculated. Majority of participants belonged to fracture type III B (31.58%) under Gustilo-Anderson classification.

**Results:** The proportions of fracture grade I, II, IIIA, III C were 21.05%, 3.51%, 29.82%, 14.04% respectively. Among the 43 patients who received intravenous antibiotics (71.67%) within six hours of trauma only 8 had recorded wound infections. Remaining 17 patients received antibiotics later than 6 hours (28.33%) of which 7 (41%) developed wound infection. Open injuries classified under high grades of Gustilo-Anderson showed greater incidence of wound infection.

**Conclusion:** We conclude that early administration of appropriate antibiotics is crucial to minimise the infection risk in open fractures.

**Keywords:** Antibiotics, wound infection, open fracture

### Introduction

Open fractures are associated with the most dreaded complication of wound infection. Fracture associated with a breach in the skin is an open fracture which causes direct communication of fracture site or hematoma with the external environment. Also any fracture in the vicinity of any break in the skin should be treated as open fracture. These fractures can involve significant morbidity and are inherently worrisome, as the body's protective skin barrier has been broken and the potential for contamination is high. The most important aspect in the management of such fractures is to prevent contamination thereby reducing the risk of infection apart from surgical management which includes thorough lavage, debridement and bony and soft tissue reconstruction [1]. In a study conducted by Spencer *et al.* They observed that the overall incidence of infection in open fractures to be about 10.4% [2]. In this retrospective study we observed that injury to femur and humerus were 6.7% and 6.5% respectively. Road traffic accident is the commonest cause of open fracture with two wheelers being the mode of transport implemented in lower limb injuries. Some of the common complications of open fractures are infection, neurovascular injury, delayed union, non-union and loss of function [3]. As per Advanced Trauma Life Support (ATLS) guidelines 2018, early administration of appropriate antibiotics preferably within six hours from the time of trauma is crucial to decrease incidence of wound infection [4]. Since an open fracture is by definition associated with contamination, the use of antibiotics is not only prophylactic, but also therapeutic, and aids prevention of subsequent infection related morbidities like myositis, osteomyelitis, infected non-union, cellulitis, recurrent abscess, chronic drainage followed by fistula formation, and their associated disability which is most likely to occur if the delay exceeds beyond accepted "golden period" of six to eight hours from the time of injury [5].

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## Materials and Methods

**Study area and duration:** A retrospective chart review was performed to segregate patients who were treated for open fractures between January 2018 to August 2019, at our centre.

**Inclusion Criteria:** The population under study were grouped by classifying the injuries based on Gustilo-Anderson classification in the age group of 16 to 55 years. All types of open injuries such as lacerations exposing bones, traumatic amputations, vascular injuries, heel pad avulsion were included in the study. Eighty consecutive patients with 104 open fractures were identified.

**Exclusion criteria:** Patients triaged elsewhere prior to admission in our centre, trauma that led to death and those patients whose medical records lacked adequate/documentation were excluded from this observational study.

**Follow up:** Patients were followed up until there was absolute clinical and radiological evidence of union and resolution of wound infection.

**Surgical procedure:** The routine protocol followed at our institution was administration of intravenous antibiotic empirically for patients with open fractures on arrival to the emergency room. Subsequently it was continued for the next two days. The time lapse between the time of injury and initial dose of antibiotics were calculated from hospital medical records. The time intervals were rounded off to the nearest hour. Patients with open fracture groups were segregated based on the by the Gustilo-Anderson system for classification of open fractures [6]:-

Type I Wound <1 cm long, clean

Type II Wound >1 cm long, without extensive soft- tissue damage

Type III Massive soft-tissue damage, with or without compromised vascularity, severe wound contamination, marked fracture instability

The exact site of the fracture was noted. An open fracture was deemed to be infected if atleast one out of the following three conditions were met:

1. Patients with positive intra-operative cultures, subsequently managed with antibiotics and/or surgical debridement,
2. Patients with negative cultures those who underwent surgery or was initiated on empirical intravenous antibiotics for suspected infection, or
3. Patients clinically diagnosed with infection depending on the time taken for wound healing or time until discharge from wound resolved.

The above criteria were made rigid to ascertain that cases of open fractures with infection were not left out. Patients with a

single positive culture without clinical evidence of infection in whom additional treatment was not instituted were considered to be uninfected. All superficial and deep infections were included similarly. None of the Patients included in the study show signs of delayed wound infection. Patients with external fixators developing pin-site infections were not taken as wound infections.

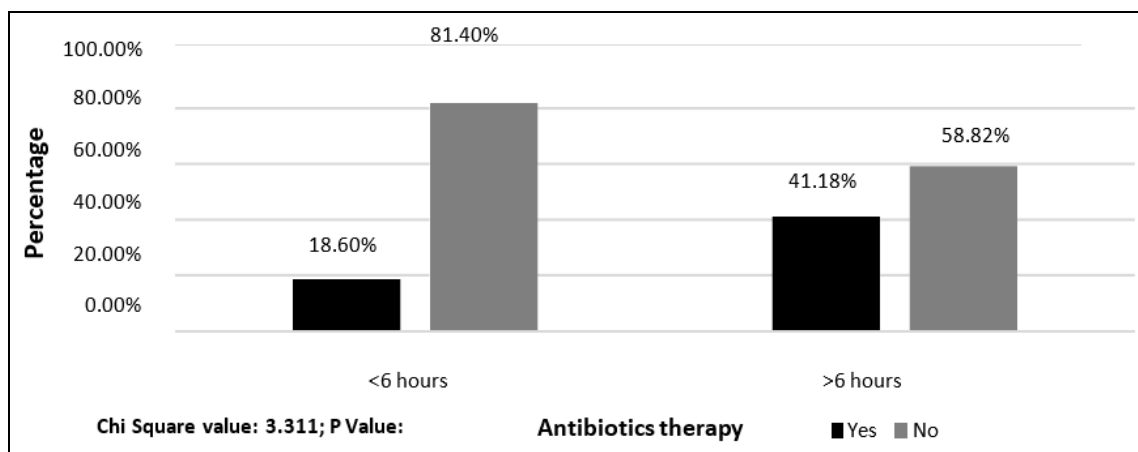
**Statistical Analysis:** The data from medical records were analyzed in two parts. The average time delay between the time of injury and administration of first dose of antibiotic intravenously in emergency room at a tertiary care center. In our study we compared the percentages of wound infection in open fractures among those who received antibiotics within 6 hours and those that received after 6 hours of trauma which was done using Chi square test.

## Results

Sixty patients with open injuries who presented to the emergency room without receiving primary treatment elsewhere were a part of this study. Among the above foresaid study population, 33 patients were between 18-35 years of age, and 27 children were between 35-55 years of age. Out of the 60, 42 were males and 18 were females. Six patients (18%) out of 33 in the 18-35 age group, and eight children (29.6%) out of 27 in the 35-55 age were diagnosed with wound infections associated with open fractures. As per our review 43 (71.67%) patients received antibiotics within 6 hours while the remaining 17 (28.33%) patients received antibiotic later than 6 hours (table 1). We found that majority of patients (31.58%) had type III B under Gustilo-Anderson classification. The individual proportions of fracture grade I, II, IIIA, III C were 21.05%, 3.51%, 29.82%, 14.04% respectively. (Table 1)

**Table 1:** Descriptive analysis of baseline characteristic in the study population (N=60)

Parameter	Frequency	Percentage
<b>Gender</b>		
Male	42	70%
Female	18	30%
<b>Gustilo-Anderson fracture type</b>		
I	12	21.05%
II	2	3.51%
III A	17	29.82%
III B	18	31.58%
III C	8	14.04%
<b>IV antibiotics</b>		
<6 hours	43	71.67%
>6 hours	17	28.33%
<b>Wound infection</b>		
Yes	14	23.33%
No	46	76.67%



**Fig 1:** Comparison of incidence of infection with timing of antibiotics therapy (N=60)

Among the sixty patients, 43 patients (71.6%) received antibiotics within 6 hours of an injury, out of which eight patients had documented wound infections. Among the remaining 17 (28%) patients who did not receive antibiotics within 6 hours, 7 of them (41%) were diagnosed with wound infections. The difference in proportion of incidence of infection between patients with regard to antibiotic therapy

were not significant statistically (P value 0.069).

The incidence of infection was relatively higher with latter grades of Gustilo-Anderson types, with a further increase in incidence with the severity of the injury, particularly in those patients who were given antibiotics after six hours of injury. (Table 2)

**Table 2:** Types of injuries and wound infection among 60 patients

Gustilo – Anderson Fracture TYPE	I	II	IIIA	IIIB	IIIC
Number of patients N (%)	12 (20%)	2 (3%)	17 (28%)	18 (30%)	8 (13%)
IV Antibiotics < 6hrs	11/12(91.6%)	0/2 (0%)	9/17(53%)	12/18 (66.6%)	6/8(75%)
IV Antibiotics >6hrs	1/12(8%)	2/2(100%)	8/17(47%)	6/18 (33%)	2/8(11%)
Number of infected cases	0	0	2(11.7%)	8 (44%)	5(62.5%)
<6hrs – Infected	0	0	0	4(33%)	3 (50%)
>6hrs –Infected	0	0	2 (25%)	4 (67%)	2 (100%)

## Discussion

Administration of antibiotics proactively minimizes the associated risk of infection with open fractures. Among our study population, only 18.6% (8/43) of patients had wound infection belonging to the group that received antibiotics within the stipulated six hours since the time of injury, in comparison to the group of patients who received beyond six hours in which 41% (7/17) of the patients developed wound infection, which implies that the percentage of wound infection is higher in the latter group. Therefore 71.6% of patients who were administered the first antibiotic dose in the Emergency room within six hours from the time of injury as per the ATLS guidelines, the infection rate was lower with 18.6% when compared to 41% in the patients who received antibiotics beyond six hours.

The incidence of infection was much higher with injuries associated with a greater degree of soft tissue involvement i.e., later grades of Gustilo - Anderson types of open fractures who received antibiotics later than 6 hours since the time of injury, as shown in the above table.

Empirical administration of antibiotics as early as possible was an important factor in reducing the infection rate by providing antibacterial activity against gram-positive as well as gram-negative micro-organisms. A multivariate analysis done by Lack WD *et al.* Found that antibiotics administered beyond 66 minutes (odds ratio, 3.78; 95% CI, 1.16- 12.31; P = 0.03) was an independent predictor of infection risk. Early antibiotic coverage limited the infection rate by 2.8% (1/36) [8].

Swanson, T.V., *et al.* [9] found that delayed management of open fractures beyond 24 hours contributed to an increase in

the infection rate in a contaminated wound, with a further increase in the presence of systemic illness.

In a study done by Merritt, which included seventy patients with open fractures, the time lapse between injury and first aid in the emergency room did not correlate with rate of infection, nor did the time between primary management in the emergency room followed by wound debridement in the operating room [10].

Also, Skaggs, D. L., *et al.* [11] conducted a large multi-centric trial and found that the infection rate was 3% (12/344) in patients with fractures that were treated within six hours from the time of injury, compared with 2% (4/210) for those cases that were managed at least within seven hours since the time of injury; yet this difference was insignificant (p-value=0.43). Although the fractures were segregated under the Gustilo and Anderson classification system, there was no significant difference in the rate of infection rate between those patients who were treated within six hours from those that had been treated after seven hour since the time of injury which was in accordance with the our study.

Gustilo-Anderson grading system was used in the study. It provides a prognostic framework that guides treatment and facilitates communication among surgeons and clinician-scientists. Years of research correlating the Gustilo-Anderson type with infection risk have aided in refining management of open fractures, antibiotic recommendations, appropriate timing for particular interventions including debridement, fracture reduction and internal fixation and soft tissue coverage [6, 11, 12].

In our study we observed that the infection rate was higher with respect to grade III B followed by grade III A injuries.

Harley, B. J., *et al.* [13] found in his multivariate regression model that infection or non-union cannot be predicted by time of antibiotic administration ( $p$  value  $> 0.05$ ). The determining factor for non-union was the grade of injury and presence of infection ( $p < 0.05$ ). Fracture grade and most commonly fractures involving the lower limb are reliable predictors of wound infection ( $p < 0.05$ ).

Noumi, T., *et al.* [14] concluded in their multivariate analysis that there was a significant correlation between the development of infection and Gustilo-Anderson type ( $p$  value  $< 0.05$ ). While non-union occurred in 12 cases of fractures (14.1%). Their analysis also revealed that only grading of fracture by Gustilo-Anderson type paralleled with the occurrence of non-union ( $p$  value  $< 0.02$ ).

### Limitations

Delayed administration of antibiotic on the incidence rate of infection following open fractures were only analyzed. The confounders were not included in the study, and the sample size was relatively small. The retrospective nature of the study reduces the applicability of the study to the general population. The observations of our study suggest that patients with open fractures who receive early antibiotic therapy have little benefit over those who were administered antibiotics later. A cohort study with a larger sample size would be beneficial to establish the precise relationship between the time of antibiotic administration and risk of infection in patients with open fractures.

### Conclusion

From our retrospective observational study we conclude that empirical administration of antibiotics in open fractures were associated with a significantly lesser incidence of wound infection although early wound debridement is another crucial aspect which could influence wound infection in such cases.

**Conflict of interest:** None declared.

**Funding:** Nil

**Permission from IRB:** Yes

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