



## Original Article

# Infection rate in adult patients with open fractures treated at the emergency hospital and at the ULBRA university hospital in Canoas, Rio Grande do Sul, Brazil<sup>☆</sup>



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## ABSTRACT

**Objective:** To identify the infection rate in adult patients with open fractures treated at two tertiary hospitals in the city of Canoas, Rio Grande do Sul, Brazil.

**Methods:** This quantitative descriptive study was conducted at Hospital de Pronto Socorro de Canoas. Eligible participants were adults aged 18–60 years with open fractures who were admitted to the orthopedic trauma service from January to May 2014 and followed-up for one year.

**Results:** A total of 133 patients with open fractures were included; most were men (92.48%), with a mean age of 36 years. There was a predominance of Gustilo-Anderson type III fractures. The infection rate was 18.80%, being more frequent in Gustilo-Anderson type III fractures (72.00%). The most commonly observed bacteria were *Staphylococcus aureus* and *Enterobacter aerogenes*.

**Conclusion:** The infection rate in open fractures of patients initially treated at the emergency department of HPSC was 18.8%. The infections occurred predominantly in Gustilo-Anderson type III fractures. The bacteria with the highest incidence in infections were *Staphylococcus aureus* and *Enterobacter aerogenes*.

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## Taxa de infecção em pacientes adultos com fratura exposta atendidos no hospital de pronto socorro e no hospital universitário Ulbra do município de Canoas, Rio Grande do Sul

### R E S U M O

#### Palavras-chave:

Fraturas expostas

Infecção

Emergências

**Objetivo:** Identificar a taxa de infecção em pacientes adultos com fratura exposta atendidos em dois hospitais terciários no município de Canoas, Rio Grande do Sul.

**Métodos:** Estudo quantitativo descritivo feito no Hospital de Pronto Socorro de Canoas (HPSC). Foram elegíveis os pacientes entre 18 e 60 anos internados com fratura exposta no setor de traumatologia e ortopedia da emergência do HPSC, de janeiro a maio de 2014, e que foram acompanhados por um ano.

**Resultados:** Foram incluídos 133 pacientes com fratura exposta, a maioria do sexo masculino (92,48%), com média de 36 anos. Houve predomínio de fraturas do tipo III de Gustilo e Anderson. A taxa de infecção foi de 18,80%, mais frequente em fraturas do tipo III de Gustilo e Anderson (72%). As bactérias mais frequentemente identificadas nas infecções foram *Staphylococcus aureus* e *Enterobacter aerogenes*.

**Conclusão:** A taxa de infecção em fraturas expostas de pacientes atendidos inicialmente na emergência do HPSC foi de 18,80%. As infecções ocorreram predominantemente em fraturas do tipo III de Gustilo e Anderson. As bactérias com maior incidência nas infecções foram *Staphylococcus aureus* e *Enterobacter aerogenes*.

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## Introduction

Traumatic pathologies have an increasing incidence both in diagnoses and hospital admissions,<sup>1</sup> due to the increase in violence and car accidents, main causes of these traumas in adults. As a consequence, there is an increase in emergency expenses, which is usually more onerous than most conventional procedures.<sup>2,3</sup>

Open fractures, also known as compound fractures, are one of the consequences of trauma. In such cases, the fracture segments communicate with the contaminated environment through skin<sup>4</sup> and adjacent soft tissues,<sup>5</sup> no matter how small the soft tissue lesion is.<sup>6</sup> The open fracture may be an isolated injury, or can occur together with a series of multiple wounds,<sup>4</sup> and is usually associated with a large number of comorbidities.

It is estimated that the incidence of open fractures of long bones is 11.5 cases per 100,000 people per annum.<sup>7</sup> Open fractures are more common in men and have a bimodal age distribution, with the tibia being the most affected bone.<sup>5</sup>

The presence of an open fracture results in a range of clinical situations, among which the most common and most serious complication is infection.<sup>8,9</sup> Based on the criteria of the Brazilian National Health Surveillance Agency (Anvisa), which involve clinical, histological and imaging characteristics, the presence of one of the altered criteria is already determinant for the diagnosis of infection.<sup>10</sup> The prevalence of infection is closely related to the severity of the patient's fracture,<sup>11,12</sup> that is, according to the classification by Gustilo and Anderson,<sup>13</sup> the higher the lesion type, the greater the likelihood of infection.<sup>14</sup>

Due to the large number of victims of open fractures, and to their complexity, it is necessary to study the rates of open

fractures in tertiary hospitals to allow better planning and care organization for these patients. Thus, this study aimed to identify the infection rate in adult patients with open fractures treated at two hospitals in the city of Canoas, state of Rio Grande do Sul.

## Material and methods

This is a descriptive study, based on consecutive sampling, performed in an emergency hospital and in another tertiary hospital in the city of Canoas. The study was approved by the Research Ethics Committee of both institutions (protocol #447594.15.2.0000.5349). The anonymity of the participants was assured, as well as the use of data only by the main author, exclusively for study purposes.

All patients between 18 and 60 years of age attended and admitted with open fractures by the trauma and orthopedics team in the hospital emergency room, from January 1 to May 24, 2014, were eligible for the study and were followed up for one year in the institutions. The patients who could not be evaluated for a period of one year, from the date of admission, and the patients who were not admitted by the traumatology and orthopedics team of the institution were excluded.

Patient data were collected from the medical records from July to August 2015 by the main author with a specific form. The patients were evaluated by age, gender, type of fracture according to Gustilo and Anderson classification,<sup>13</sup> and for the presence of infection at the open fracture site according to Anvisa's criteria<sup>10</sup> and bacteriological profile.

A database was created on the Microsoft Office Excel 2007 software; the data was entered by the main author. After typing, all the data were checked with the original collected

**Table 1 – Relation between gender and type of fracture, according to the Gustilo and Anderson classification.**

Gender	Type									
	I		II		IIIA		IIIB		IIIC	
	n	%	n	%	n	%	n	%	n	%
Female	1	3.10	1	2.60	3	8.10	3	17.60	2	25.00
Male	31	96.90	38	97.40	34	91.90	14	82.40	6	75.00

Fisher's exact test,  $p < 0.065$ .

questionnaires; the consistency and coherence of the data were analyzed. Data were then stored in a database using Excel software.

Quantitative variables were presented by mean and standard deviation (SD) and categorical variables by absolute (n) and relative (%) frequencies. The association between the categorical variables was evaluated using Fisher's exact test, an appropriate method for this evaluation when more than 25% of the values are below the level of significance ( $p < 0.05$ ). For the variables with normal distribution, the means were compared with the variance analysis (Anova). The statistical analysis was performed with the *Statistical Package for the Social Sciences* (SPSS) software, version 18.0 (SPSS Inc., IBM Company, Chicago, IL, USA) and the level of significance used was 5% ( $p < 0.05$ ).

## Results

From January 1 to May 24, 2014, 519 patients were attended and admitted by the traumatology and orthopedics team of the emergency hospital, with a mean of 1.08 case per day. Of these, 154 patients had an open fracture and were analyzed for inclusion in the study. Twenty-one patients were excluded because they did not have a one-year follow-up, counting from the day of admission, which resulted in 133 patients with an open fracture included in the study.

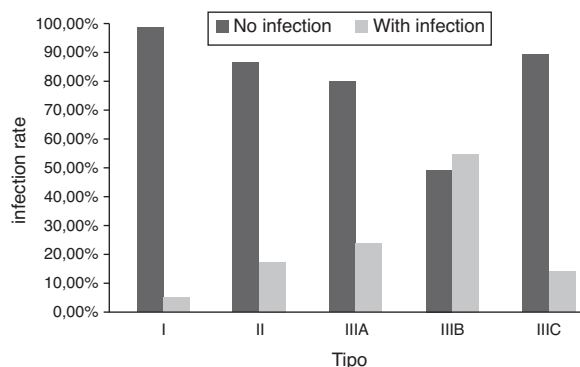
The mean age of the patients with open fractures was 36 years (SD: 12.60 years) and most of them were male ( $n = 123$ ; 92.48%). The mean age was 35.50 years (SD: 12.45 years) among males, and 41.60 years (SD: 14.50 years) among females.

The most prevalent type of fracture was type III, accounting for 46.70% of all cases (62 patients). Of these, 59.70% (37 patients) were type IIIA, 27.40% (17) IIIB and 12.90% (eight) IIIC. Type I was the least prevalent, with 24.70% (32), followed by type II, with 29.30% (39).

Type IIIC fractures were the most frequent among females (25%), while type II fractures were the most frequent among males (97.40%). There was no association between gender and type of fracture ( $p < 0.065$ ) (Table 1).

Twenty-five patients (18.80%) developed an infection. Of these, one (4%) was classified as type I fracture, six (24%) with type II fractures, and 18 (72%) with type III fractures. Fractures classified as type IIIB presented the highest infection rate (36%), while those classified as type I had the lowest infection rate (4%). There was a significant association between the type of fracture and the occurrence of infection ( $p < 0.001$ ) (Fig. 1).

Twenty-seven positive cultures were found in 17 infected patients (68%). In these cultures, 11 microorganisms were



**Fig. 1 – Relation between infection rate and type of fracture, according to the Gustilo and Anderson classification. Fisher's exact test,  $p < 0.001$ .**

identified, described in Table 2. Of these, 33.30% were gram-positive bacteria, and 66.70% were gram-negative bacteria.

The relationship between the use of prophylactic antibiotics and the occurrence of infection is presented in Table 3. Twenty-eight patients with type III fractures used two or more antibiotics, while 13 patients with type I or II fractures used two or more prophylactic antibiotics.

## Discussion

The present study investigated the association between the incidence of infections and open fractures in two tertiary hospitals in the city of Canoas, in the southern region of the country. It was also evident the lack of research in Brazilian

**Table 2 – Prevalence of microorganisms.**

Bacteria	n	%
<i>Enterobacter aerogenes</i>	5	18.50
<i>Staphylococcus aureus</i>	5	18.50
<i>Acinetobacter</i> sp.	3	11.10
<i>Enterococcus</i> sp.	3	11.10
<i>Pseudomonas aeruginosa</i>	3	11.10
Mixed flora	2	7.40
<i>Serratia</i> sp.	2	7.40
Gram bacillus – non-fermenting	1	3.70
<i>Enterobacter cloacae</i>	1	3.70
<i>Escherichia coli</i>	1	3.70
<i>Staphylococcus</i> sp.	1	3.70

**Table 3 – Relation between the use of prophylactic antibiotics (ATB) and the occurrence of infection.**

	Infection				p
	No (n = 108)		Yes (n = 25)		
	n	%	n	%	
Prophylactic ATB					0.615
No	5	4.60	2	8.00	
Yes	103	95.40	23	92.00	
Number of prophylactic ATB					<0.001
0	5	4.60	2	8.00	
1	76	70.40	7	28.00	
2	24	22.20	12	48.00	
3	3	2.80	4	16.00	

literature. An infection rate of 18.80% was found in open fractures of patients seen initially in the emergency room, and followed up for a year in the hospitals in which the studies were conducted. Infections occurred predominantly in Gustilo and Anderson type III fractures.

The study has three limitations. Firstly, the short period, because on May 25, 2014, a protocol of antibiotic prophylaxis and antibiotic therapy was instituted in the emergency room, which could interfere with the results of the research. Thus, the study was interrupted on May 24, 2014. Secondly, patients with an open fracture who were not admitted to the hospital by the trauma and orthopedics team of the emergency room were excluded from the study. These hospitals are reference in Orthopedics and Traumatology for 140 municipalities in the state of Rio Grande do Sul. However, some patients have private healthcare plans and prefer to be cared for in hospitals of their choice. In addition, patients from cities that are not a reference of the municipality of Canoas are often taken by the Emergency Mobile Care Service (SAMU) to one of the two health institutions to receive first care, then they return to their home municipality for follow-up. Thirdly, a relevant number of patients with open fractures (n = 21) were excluded from the study because they were transferred or because they lost the link with the health institutions, making it impossible to analyze these patients for a full year from the date of admission.

In the present study, most patients with open fractures were male, with a mean age of 36 years, consistent with the literature, which estimates the highest prevalence among men in the fourth decade.<sup>6</sup> The female age group presented in the literature is over 60 years of age,<sup>6</sup> different from that found in the present study, which was 41.60 years, most probably due to the age range stipulated as inclusion criterion (18–60 years).

Type III fractures of the Gustilo and Anderson classification were prevalent (46.70%), data that is common in previous studies of open fractures.<sup>15,16</sup> For the other fracture types, the values found were also similar to those reported in the literature, of 15.80% for type I, and 29.50% for type II.<sup>15</sup>

The infection rate found (18.80%) was higher than the 10% rate described in similar international studies,<sup>17</sup> but lower than that reported in national studies, with rates higher than 20%.<sup>16</sup> The estimated rate of infection for type I fractures is 0–2%, for type II is 2–7%, and for type III is 10–25%, values lower than those found in the present study (type I: 4%, type II: 24%, and type III: 72%).

Regarding the microorganisms present in the infections, *Staphylococcus aureus* and *Enterobacter aerogenes* had the highest incidence, which is in agreement with the literature.<sup>17</sup> In addition, there was a higher incidence of gram-negative agents, which may be justified by the presence of these bacteria in the open fractures infections,<sup>17,18</sup> and by the prevalence of bacteria in each institution.<sup>17</sup> The study by Collinge et al.,<sup>19</sup> in which only intravenous cefazolin was used in the patients, showed that time was directly associated with the infection rate, but the amount of antibiotics did not present a statistically significant impact on the infection rate.

## Conclusion

The present study aimed to identify the rate of infection in open fractures in two tertiary hospitals, HPSC and HU, by means of the variables gender, age, severity of open fractures, infection and infectious agents. The rate of infection in open fractures found in patients admitted through the HPSC emergency was 18.80%, and the most frequent microorganisms were *Enterobacter aerogenes* and *Staphylococcus aureus*. It should be noted that the infection is not directly linked to the number of antibiotics used. In view of the data obtained, the importance of the follow-up of the studies is emphasized, so that there can be a constant improvement in patient care.

## Conflicts of interest

The authors declare no conflicts of interest.

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