Original Article

Length of preoperative hospital stay: a risk factor for reducing surgical infection in femoral fracture cases

Hoberdan Oliveira Pereira a,*, Edna Maria Rezende a, Bráulio Roberto Gonçalves Marinho Couto b

a Department of Nursing, Federal University of Minas Gerais (UFMG), Belo Horizonte, MG, Brazil
b Institute of Engineering and Technology, University Center of Belo Horizonte (UNIBH), Belo Horizonte, MG, Brazil

A R T I C L E   I N F O

Article history:
Received 23 September 2014
Accepted 14 November 2014
Available online 23 October 2015

Keywords:
Infection of the operative wound
Femoral fractures
Risk factors

A B S T R A C T

Objective: To analyze infections of the surgical site among patients undergoing clean-wound surgery for correction of femoral fractures.

Methods: This was a historical cohort study developed in a large-sized hospital in Belo Horizonte. Data covering the period from July 2007 to July 2009 were gathered from the records in electronic medical files, relating to the characteristics of the patients, surgical procedures and surgical infections. The risk factors for infection were identified by means of statistical tests on bilateral hypotheses, taking the significance level to be 5%. Continuous variables were evaluated using Student’s t test. Categorical variables were evaluated using the chi-square test, or Fisher’s exact test, when necessary. For each factor under analysis, a point estimate and the 95% confidence interval for the relative risk were obtained. In the final stage of the study, multivariate logistic regression analysis was performed.

Results: 432 patients who underwent clean-wound surgery for correcting femoral fractures were included in this study. The rate of incidence of surgical site infections was 4.9% and the risk factors identified were the presence of stroke (odds ratio, OR = 5.0) and length of preoperative hospital stay greater than four days (OR = 3.3).

Conclusion: To prevent surgical site infections in operations for treating femoral fractures, measures involving assessment of patients’ clinical conditions by a multiprofessional team, reduction of the length of preoperative hospital stay and prevention of complications resulting from infections will be necessary.

© 2015 Sociedade Brasileira de Ortopedia e Traumatologia. Published by Elsevier Editora Ltda. All rights reserved.
Introduction

Surgical site infection (SSI) is a disastrous adverse event for both patients and surgeons, especially in clean surgery for open reduction of fractures of the femur and hip. In Latin America, the financial costs involved in fractures of the proximal femur were assessed between 1980 and 2003 and were found to range from US$4500 to US$6000 per patient. In Brazil, these amounts may reach US$5500 per patient.\(^1\) Every year, the Brazilian National Health System (Sistema Único de Saúde, SUS) undertakes greater numbers of treatments on femoral fractures in elderly patients. In 2009, the expenditure was approximately R$57.61 million on admissions versus R$24.77 million on medications for treating osteoporosis, which is an important cause of femoral fractures. In 2006, these expenditures had been R$49 million and R$20 million, respectively. Hannan et al.,\(^2\) stated that the social and economic cost of femoral fractures becomes even greater because after a period of hospitalization, elderly patients need intensive medical care and long periods of rehabilitation, and also present a high mortality rate. The treatment for most femoral fractures is surgical. In using new materials for replacing prostheses, lower complication rates through better technology and design are sought. According to the potential of surgical procedures for wound contamination, they can be classified as clean, potentially contaminated, contaminated or infected. Arrowsmith\(^3\) noted that clean surgical procedures ought to have lower incidence of surgical site infection (SSI) because they presented lower risk of contamination than other categories. Such procedures are considered to be markers of service quality and present better execution (elective, non-traumatic, tissues that are easily decontaminated and intact skin). The rate of incidence of SSI should be less than 2%.

Several risk factors relating to the patient and to the surgical procedure have been correlated with the incidence of SSI in femoral fractures. The intrinsic factors relating to elderly patients comprise inadequate nutritional status, diabetes mellitus (DM), use of tobacco, obesity, surgical site infection, colonization of the skin, immune response and prolonged period of preoperative hospitalization.\(^4\) The extrinsic factors associated with the operation and the patient comprise skin preparation, appropriate clothes, preparation of the surgical team’s hands, duration of the operation, surgical technique, processing of materials and articles, preparation of the antibiotic and preparation of the surgical site. Control over these factors is essential for minimizing the contamination of the surgical site.\(^5\) Studies have emphasized the need to prioritize care for patients with femoral fractures, especially in relation to the time that elapsed between the fracture and the surgical procedure.\(^6\)

Here, we investigated the preoperative factors and the operational parameters that are associated with SSI after open reduction of femoral fractures. The aim of our study was to answer five questions: (1) What is the risk of infection of the operative wound among patients undergoing open reduction of femoral fractures? (2) What are the main etiological agents of SSI after open reduction of femoral fractures? (3) Does SSI...
increase the patient’s risk of death after the surgery? (4) Does SSI increase the patient’s length of hospital stay? and (5) What are the risk factors associated with SSI after open reduction of femoral fractures?

Materials and methods

This was a prospective cohort study conducted to analyze SSI and its risk factors among patients who underwent correction of fractures of the hip and femur, between July 2007 and July 2009. The study was conducted in a large-sized hospital, with a capacity for around 350 beds, which is a referral center for accidents and emergencies in the state of Minas Gerais, Brazil. The sample was composed of 432 patients who underwent elective surgery to correct femoral fractures. The response variables comprised surgical site infection and hospital death. The preoperative and operative parameters were divided into categorical and continuous variables. The continuous variables studied were age, duration of preoperative hospitalization and duration of the operation. The categorical variables were sex, type of surgery, shift during which the operation was performed (morning, afternoon or night), type of anesthesia, preoperative assessment score of the American Society of Anesthesiology (ASA), Nosocomial Infection Surveillance index, fracture classification, type of injury, type of osteosynthesis and type of surgery (elective or emergency). The comorbidities studied were diabetes mellitus (DM), congestive heart failure (CHF), systemic arterial hypertension (SAH), chronic obstructive pulmonary disease (COPD), heart diseases, hypercholesterolemia, alcohol abuse, psychiatric disorders, cancer of metabolic disease, stroke and anemia. The type of anesthesia was classified according to the combination of two or more procedures with or without sedation. Hospitalization before surgery was defined as up to four days before it or more than four days before it. The duration of the surgery was stratified as less than or equal to 138 min of more than this duration. The ASA score was categorized into levels I, II, III and IV: ASA I for healthy patients; II for patients with moderate systemic disease; III for patients with severe preexisting systemic diseases that were not incapacitating; and IV for patients with life-threatening systemic disease. Category V-5, for individuals with life expectancy of a maximum of 24 h, was not identified in any of the patients of this study. For the index of surgical risk of infection, the score zero was used and the grouped score of 1 or 2 was used only for clean surgery. The prophylactic antibiotic was tested for use before or during the surgery. The classification of femoral fractures was based on regions of the femur: fractures of the femoral neck, trochanteric fractures or subtrochanteric fractures. For fractures of the diaphysis, the AO classification was used. For some operations, the classification was not shown. We used the ICD-10 to code and group this variable. Five types of osteosynthesis were used: plate, nail, screw, cement and others. The patients included were hospitalized and underwent clean surgical correction of femoral fractures between July 2007 and July 2009.

Continuous variables were evaluated using Student’s t test or a nonparametric test, and categorical variables were analyzed using the chi-square or Fisher exact test (when necessary). For each factor under analysis, a point analysis and 95% confidence interval (95% CI) for the relative risk were obtained. In the last phase of the study, multivariate analysis was conducted using logistic regression. The variables tested in the logistic model were selected when the univariate analysis generated a value of \( p \leq 0.25 \).

This study was approved by the hospital involved, under report no. 18 and by the research ethics committee, under CAEE report no. 0108.0.203.000-11, which was approved on May 5, 2011, in conformity with resolution 196/96.

Results

This study included 432 patients who underwent open reduction of femoral fractures between July 2007 and July 2009. Falling from a standing position, falling from a bed and falling from a staircase were the most frequent types of trauma among the patients with femoral fractures who were evaluated. These patients accounted for 59% of the cases and were followed by those involved in motorcycle accidents (15.5%). The patients’ length of hospital stay ranged from one to 139 days, with a median of eight days. The mean time spent in hospital before the surgery was five days and 43% of the patients were in hospital for up to four days. The patients’ mean length of stay in the surgical center was six hours. The mean duration of the operation was one hour and 50 min and more than 70% of the operations lasted for not more than 138 min. Most of the patients were over the age of 60 years; 36% came to the hospital via an emergency unit; and 5% presented more than two diagnoses at the time of hospital admission (Tables 1–3).

Among the 432 patients who underwent correction of clean fractures of the femur, 21 patients were recorded as presenting SSI. The risk of infection was 4.9%.

Stroke and length of stay greater than four days presented statistically significant associations with SSI (Table 4). It was found that for the patients with stroke who remained in hospital for more than four days, the expected risk of acquiring infection was almost three times greater than the risk among those who had this disease but were in hospital for not more than four days. Stroke and length of hospital stay until the surgery were the variables associated with SSI (Table 5).

Regarding hospital mortality after surgical correction of the femoral fracture, SSI was not associated with the chance of death \( (p = 0.125) \) (Table 6).

In 10 of the 21 cases of infection registered, the etiological agent remained unidentified. *Staphylococcus aureus* and *Acinetobacter baumannii* were the microorganisms most frequently identified. Only 2% of the 432 patients presented preoperative colonization, which was mostly detected by means of nasal and axillary swabs (Table 7).

Discussion

The risk of SSI of 4.9% that was recorded in this study among patients who underwent clean surgery on femoral fractures was greater than what was cited by Camargo. It is worth
emphasizing that the rate of SSI in clean surgery in this hospital over the same period of July 2007 to July 2009, taking into account all body areas and specialties, such as orthopedics, plastic surgery, general surgery and neurosurgery, was approximately 2.2%. It is necessary to investigate the rates of SSI per surgeon and to monitor the risk factors relating to patients and to the surgical procedure. Efficient monitoring systems and information for surgeons regarding their infection rates have demonstrated better prevention of SSI. The infection rates can be reduced by more than one third through programs and personnel who are trained in monitoring and infection control.\(^{13}\)

The study population was composed of patients who were mostly male, including adolescents, young adults and elderly individuals over the age of 60 years, perhaps because this is a referral hospital for attending to emergencies. However, many authors consider that women are the group most subject to femoral fractures,\(^{7}\) and that study showed a greater risk of SSI. Pereira\(^{34}\) studied groups of elderly people and found that the rate of incidence of hip fractures among women was 72.76%.

The classification for the femoral fractures was established in accordance with the region affected: femoral neck, trochanter or subtrochanteric diaphysis. Muniz et al.\(^{15}\) showed that the main types of fracture were transtrochanteric (58.73%) and femoral neck (38.20%), which are considered to be due to low-energy trauma. In the present study, trochanteric fractures had higher frequency, but diaphyseal fractures presented higher risk of SSI, albeit without statistical significance.

The length of hospital stay after the operation (four days) was statistically significant in our univariate analysis \((p=0.018)\). This association was maintained in the multivariate analysis, thus confirming the presence of this risk factor for SSI. Prolonged preoperative hospital stay has been correlated with a risk of SSI.\(^{4}\) The duration of the operation was assessed based on the cutoff point of the NHSN/CDC methodology,\(^{16}\) in

---

**Table 1 – Open surgery for correcting femoral fractures in a tertiary-level hospital: patients’ characteristics and surgical characteristics (July 2007–July 2009).**

| Variable                        | Frequency | %   | Mean | Median | Minimum | Maximum | SD  |
|---------------------------------|-----------|-----|------|--------|---------|---------|-----|
| Sex                             |           |     |      |        |         |         |     |
| Female                          | 208       | 48.1|      |        |         |         |     |
| Male                            | 224       | 51.9|      |        |         |         |     |
| **Age (years)**                 |           |     |      |        |         |         |     |
| <20                             | 55        | 12.7|      |        |         |         |     |
| 20–39                           | 80        | 18.5|      |        |         |         |     |
| 40–59                           | 55        | 12.7|      |        |         |         |     |
| 60–79                           | 122       | 28.2|      |        |         |         |     |
| ≥80                             | 120       | 27.8|      |        |         |         |     |
| **Length of hospital stay (days)** |           |     |      |        |         |         |     |
| (Mean)                          | 14        |     | 8    |        | 1       | 139     | 19.4|
| **Length of hospital stay before surgery (days)** |           |     |      |        |         |         |     |
| (Mean)                          | 8         |     | 5    |        | 0       | 234     | 14.1|
| **Length of hospital stay before surgery (days)** |           |     |      |        |         |         |     |
| (Mean)                          | 8         |     | 5    |        | 0       | 234     | 14.1|
| **Duration of surgery (h)**     |           |     |      |        |         |         |     |
| (Mean)                          | 1:50      |     | 1:40 |        | 0:10    | 8:20    | 1:01 |
| **Duration of surgery (min)**   |           |     |      |        |         |         |     |
| (Mean)                          | 320       |     | 74.1 |        |         |         |     |
| **ASA – American Society of Anesthesiology (score)** |           |     |      |        |         |         |     |
| I                               | 174       |     | 42.8 |        |         |         |     |
| II                              | 156       |     | 38.3 |        |         |         |     |
| III                             | 70        |     | 17.2 |        |         |         |     |
| IV                              | 7         |     | 1.7  |        |         |         |     |
| **Type of surgery**             |           |     |      |        |         |         |     |
| Elective                        | 373       |     | 86.3 |        |         |         |     |
| Emergency                       | 59        |     | 13.7 |        |         |         |     |
| **Time of day of the surgery**  |           |     |      |        |         |         |     |
| Morning                         | 216       |     | 50   |        |         |         |     |
| Afternoon                       | 195       |     | 45.1 |        |         |         |     |
| Night                           | 21        |     | 4.9  |        |         |         |     |
| **Type of osteosynthesis**      |           |     |      |        |         |         |     |
| Plate                           | 224       |     | 52.2 |        |         |         |     |
| Nail                            | 105       |     | 24.5 |        |         |         |     |
| Screw                           | 51        |     | 11.9 |        |         |         |     |
| Other                           | 27        |     | 6.3  |        |         |         |     |
| Cement                          | 22        |     | 5.1  |        |         |         |     |

SD, standard deviation.
Table 2 – Univariate analysis on the categorical variables: length of preoperative hospital stay greater than four days and stroke were risk factors for SSI, after surgery to correct femoral fractures, at the 5% significance level ($p < 0.05$) (July 2007–July 2009).

| Variable                                              | Total number of patients | Total number of cases with SSI | Risk of SSI (%) | Relative risk | 95% CI          | p value |
|-------------------------------------------------------|--------------------------|-------------------------------|-----------------|---------------|-----------------|---------|
| **Length of hospital stay before surgery (days)**      |                          |                               |                 |               |                 |         |
| Up to 4                                               | 185                      | 4                             | 2.2             |               |                 | 0.018   |
| More than 4                                           | 247                      | 17                            | 6.9             | 3.2           | [1.09–9.30]     |         |
| **Stroke**                                            |                          |                               |                 |               |                 |         |
| Yes                                                   | 22                       | 4                             | 18.2            | 4.4           | [1.61–11.93]    | 0.017   |
| No                                                    | 410                      | 17                            | 4.1             |               |                 |         |
| **Sex**                                               |                          |                               |                 |               |                 |         |
| Female                                                | 208                      | 14                            | 6.7             | 2.2           | [0.89–5.23]     | 0.064   |
| Male                                                  | 224                      | 7                             | 3.1             |               |                 |         |
| **Type of trauma (ICD-10)**                           |                          |                               |                 |               |                 |         |
| V87                                                   | 29                       | 2                             | 6.9             | 1             | –               | 0.734   |
| W01                                                   | 230                      | 12                            | 5.2             | 0.8           | [0.31–5.61]     |         |
| W06.0                                                 | 14                       | 1                             | 7.1             | 1             | [0.10–9.77]     |         |
| W10                                                   | 11                       | 0                             | 0.0             | 0.            | –               |         |
| Y30                                                   | 20                       | 2                             | 10.0            | 1.5           | [0.11–4.50]     |         |
| V23                                                   | 67                       | 3                             | 4.5             | 0.6           | [0.27–8.73]     |         |
| Other                                                 | 61                       | 1                             | 1.6             | 0.2           | [0.40–44.53]    |         |
| **Fracture classification**                           |                          |                               |                 |               |                 |         |
| Tronzo                                                | 150                      | 4                             | 2.7             | 1             | –               | 0.475   |
| Garden                                                | 105                      | 7                             | 6.7             | 2.5           | [0.12–1.33]     |         |
| AO                                                    | 100                      | 7                             | 7.7             | 2.6           | [0.11–1.27]     |         |
| Seinsheimer                                           | 32                       | 1                             | 3.1             | 1.2           | [0.10–7.38]     |         |
| Other                                                 | 45                       | 2                             | 4.4             | 1.7           | [0.11–3.17]     |         |
| **Duration of the operation (min)**                    |                          |                               |                 |               |                 |         |
| Up to 138                                             | 320                      | 13                            | 4.1             | 0.6           | [0.24–1.34]     | 0.147   |
| More than 138                                         | 112                      | 8                             | 7.1             |               |                 |         |
| **ASA**                                               |                          |                               |                 |               |                 |         |
| I                                                     | 174                      | 6                             | 3.4             | 1             | –               | 0.169   |
| II                                                    | 156                      | 12                            | 7.7             | 2.2           | [0.17–1.17]     |         |
| III                                                   | 70                       | 2                             | 2.9             | 0.8           | [0.25–5.84]     |         |
| IV                                                    | 7                        | 1                             | 14.3            | 4.1           | [0.03–1.74]     |         |
| **Type of surgery**                                   |                          |                               |                 |               |                 |         |
| Elective                                              | 373                      | 20                            | 5.4             | 3.2           | [0.43–23.13]    | 0.191   |
| Emergency                                             | 59                       | 1                             | 1.7             |               |                 |         |
| **Time of day of the surgery**                        |                          |                               |                 |               |                 |         |
| Morning                                               | 216                      | 9                             | 4.2             | 1             | –               | 0.367   |
| Afternoon                                             | 195                      | 12                            | 6.2             | 1.5           | [0.29–1.57]     |         |
| Night                                                 | 21                       | 0                             | 0.0             | 0             | –               |         |
| **Diabetes mellitus (DM)**                            |                          |                               |                 |               |                 |         |
| Yes                                                   | 26                       | 2                             | 7.7             | 1.6           | [0.40–6.68]     | 0.365   |
| No                                                    | 406                      | 19                            | 4.7             |               |                 |         |
| **Congestive heart failure**                          |                          |                               |                 |               |                 |         |
| Yes                                                   | 9                        | 0                             | 0.0             | 0             | –               | 0.635   |
| No                                                    | 423                      | 21                            | 5               |               |                 |         |
| **Cardiopathy**                                       |                          |                               |                 |               |                 |         |
| Yes                                                   | 16                       | 0                             | 0.0             | 0             | –               | 0.444   |
| No                                                    | 416                      | 21                            | 5               |               |                 |         |
| **Hypertension**                                      |                          |                               |                 |               |                 |         |
| Yes                                                   | 148                      | 9                             | 6.1             | 1.4           | [0.62–3.34]     | 0.264   |
| No                                                    | 284                      | 12                            | 4.2             |               |                 |         |
| **Chronic obstructive pulmonary disease (COPD)**       |                          |                               |                 |               |                 |         |
| Yes                                                   | 8                        | 0                             | 0.0             | 0             | –               | 0.668   |
Table 2 – (Continued)

| Variable                          | Total number of patients | Total number of cases with SSI | Risk of SSI (%) | Relative risk | 95% CI       | p value |
|-----------------------------------|--------------------------|-------------------------------|-----------------|--------------|---------------|---------|
| No                                | 424                      | 21                            | 5               |              |               |         |
| Hypercholesterolemia              |                          |                               |                 |              |               |         |
| Yes                               | 3                        | 0                             | 0               | 0            | [0.15–7.68]  | 0.860   |
| No                                | 429                      | 21                            | 4.9             |              |               |         |
| Alcohol abuse                     |                          |                               |                 |              |               |         |
| Yes                               | 19                       | 1                             | 5.3             | 1.1          | [0.16–8.10]  | 0.599   |
| No                                | 413                      | 20                            | 4.8             |              |               |         |
| Psychiatric disorders             |                          |                               |                 |              |               |         |
| Yes                               | 18                       | 1                             | 5.6             | 1.2          | [0.04–4.20]  |         |
| No                                | 414                      | 20                            | 4.8             |              |               |         |
| Metabolic disorders               |                          |                               |                 |              |               |         |
| Yes                               | 9                        | 0                             | 0               | 0            | –             | 0.635   |
| No                                | 423                      | 21                            | 5               |              |               |         |
| Cancer                            |                          |                               |                 |              |               |         |
| Yes                               | 12                       | 0                             | 0               | 0            | –             | 0.545   |
| No                                | 420                      | 21                            | 5               |              |               |         |
| Type of osteosynthesis            |                          |                               |                 |              |               |         |
| Plate                             | 224                      | 15                            | 6.7             | 1            | –             | 0.246   |
| Nail                              | 105                      | 2                             | 1.9             | 0.3          | [0.62–15.09] |         |
| Screw                             | 51                       | 1                             | 2               | 0.3          | [0.46–25.27] |         |
| Other                             | 27                       | 1                             | 3.7             | 0.6          | [0.03–8.14]  |         |
| Cement                            | 22                       | 2                             | 9.1             | 1.4          | [0.04–4.20]  |         |
| Anesthesia: spinal anesthesia with sedation |               |                               |                 |              |               |         |
| Yes                               | 224                      | 14                            | 6.3             | 1.9          | [0.76–4.71]  | 0.120   |
| No                                | 208                      | 7                             | 3.4             |              |               |         |
| Surgical infection risk index     |                          |                               |                 |              |               |         |
| Score 0                           | 246                      | 11                            | 4.5             | 0.7          | [0.31–1.66]  | 0.585   |
| Score up to 2                     | 161                      | 10                            | 6.2             |              |               |         |
| Anemia                            |                          |                               |                 |              |               |         |
| Yes                               | 178                      | 10                            | 5.6             | 1.4          | [0.59–3.43]  | 0.288   |
| No                                | 228                      | 9                             | 3.9             |              |               |         |
| Hematocrit less than 36 mg/dL     |                          |                               |                 |              |               |         |
| Yes                               | 259                      | 15                            | 5.8             | 2.1          | [0.72–6.29]  | 0.120   |
| No                                | 147                      | 4                             | 2.7             |              |               |         |
| Skin colonization                 |                          |                               |                 |              |               |         |
| Yes                               | 17                       | 1                             | 5.9             | 1.2          | [0.17–8.57]  | 0.578   |
| No                                | 415                      | 20                            | 4.8             |              |               |         |
| General anesthesia                |                          |                               |                 |              |               |         |
| Yes                               | 41                       | 2                             | 4.9             | 1            | [0.24–4.16]  | 0.620   |
| No                                | 391                      | 19                            | 4.9             |              |               |         |

ASA, American Society of Anesthesiology; 95% CI, 95% confidence interval; SSI, surgical site infection; RR, relative risk; ICD-10, international classification of diseases.

which the number of minutes defined for this type of operation was 138. Although this is a variable classically associated with SSI, it was not associated with surgical infection in the present study. Long duration of an operation in a contaminated environment favors surgical contamination and, consequently, development of infection.17

The ASA variable, which assesses the patient’s preoperative clinical state was not considered to be a risk factor for SSI in the present study. Although the patients were predominantly graded as ASA I, those with ASA IV presented a risk of SSI that was four times higher. Many authors have considered that the ASA score is a risk factor for SSI that relates directly to the severity of the patient’s condition and the risk of infection.18 Plates were the synthesis material most used, in 224 cases (51%). Sakaki et al.,1 stated that the treatment for the majority of femoral fractures should be surgical. Conservative treatment should be reserved only for some incomplete or non-displaced fractures. The aim of the surgery is to reduce the fracture and fix it in a stable manner, using a variety of osteosynthesis methods. Spinal anesthesia with sedation is the anesthetic procedure most used and the risk of infection in relation to patients for whom this was not used has been found to be 1.9%. Ercole and Chianca19 showed that patients who underwent associated anesthesia
presented 3.4 times greater risk of infection than those who underwent blocking. The data from the present study were insufficient to characterize antibiotic as a protection factor, although these data signaled that there were patients who received cefazolin and who presented a risk of SSI that was around four times lower. In a meta-analysis, it was observed that in surgery to fix closed fractures, prophylaxis with a single dose of antibiotics reduced the severity of deep-ward, surface-ward, urinary-tract and respiratory-tract infections. That analysis also showed multiple-dose prevention had a similar effect on the size of deep-ward infection, but no significant effect on urinary or respiratory infections was confirmed.20

The etiological agents identified in SSI cases were Staphylococcus aureus, Acinetobacter baumannii and Enterococcus sp. In some cases, more than one microorganism was identified from cultures. It should be noted that etiological agents were only identified in 11 of the 21 cases that presented SSI. This low proportion of findings from the cultures performed explains the absence of treatments guided by laboratory results.

The multivariate analysis confirmed that stroke before the clean surgical correction of femoral fractures was characterized as a risk factor for SSI. In a cohort study involving 1379 victims of proximal femoral fractures, Feng et al.21 reported that the higher ASA scores found in cases of hemiplegia signified that these patients would be more likely to have three

### Table 3 – Univariate analysis on the continuous variables: only the length of hospital stay before the operation (days) was associated with SSI after the operation to correct femoral fractures (July 2007–July 2009).

| Variable | SSI | Number of patients | Mean | Median | Standard deviation | p value |
|----------|-----|-------------------|------|--------|-------------------|---------|
| Length of hospital stay before operation (days) | Yes | 9 | 31 | 21 | 24.9 | 0.008 |
|          | No | 193 | 13 | 8 | 18.8 |        |
| Age (years) | Yes | 21 | 63 | 73 | 27.5 | 0.329 |
|          | No | 411 | 57 | 66 | 27.3 |        |
| Duration of operation (h) | Yes | 21 | 2.14 | 1.44 | 0.1 |        |
|          | No | 411 | 1.49 | 1.39 | 0 |        |
| Hemoglobin | Yes | 19 | 11.0 | 10.6 | 1.2 | 0.298 |
|          | No | 387 | 11.4 | 11.3 | 2 |        |
| Hematocrit | Yes | 19 | 33.0 | 32.5 | 4.1 | 0.323 |
|          | No | 387 | 34.3 | 33.9 | 6 |        |
| Glycemia | Yes | 11 | 122.2 | 106.0 | 34.7 | 0.913 |
|          | No | 167 | 126.9 | 114.0 | 62 |        |

SSI, surgical site infection.

### Table 4 – Analysis of variance: in the final model, the length of hospital stay before the operation and stroke were independently associated with surgical site infection after the operation to correct femoral fractures. Preoperative length of hospital stay greater than four days increased the chance that a patient would be infected almost threefold (OR = 3.3; p = 0.037) (July 2007–July 2009).

| Variable | Regression coefficient | Standard error of the regression coefficient | Odds ratio | p value |
|----------|------------------------|------------------------------------------|------------|---------|
| Preoperative length of hospital stay greater than 4 days | 1.19 | 0.57 | 3.3 | 0.037 |
| Stroke | 1.60 | 0.62 | 5 | 0.009 |
| Constant | −3.96 | 0.52 |        |        |

### Table 5 – Simulation of risk of SSI: length of hospital stay before the surgery and stroke.

| Type of patient | Expected risk of SSI (%) | Number of patients | Observed SSI | Observed risk of SSI (%) |
|----------------|--------------------------|--------------------|--------------|--------------------------|
| No stroke and length of stay up to 4 days | 1.9 | 177 | 2 | 1.1 |
| No stroke and length of stay more than 4 days | 5.9 | 233 | 15 | 6.4 |
| Previous stroke and length of stay up to four days* | 8.6 | 8 | – | – |
| Previous stroke and length of stay more than four days* | 23.6 | 14 | – | – |

* Small sample size.

### Table 6 – Hospital mortality after surgery to correct femoral fractures: surgical site infection was not associated with the chance of death (p = 0.125) (July 2007–July 2009).

| SSI | Number of patients | Hospital mortality | Risk of hospital death (%) | Relative risk | 95% confidence interval | p value |
|-----|--------------------|-------------------|----------------------------|---------------|-------------------------|---------|
| Yes | 21                 | 3                 | 14.3                       | 2.6           | [0.83–7.83]             | 0.125   |
| No  | 411                | 23                | 5.6                        |               |                         |         |
| Total | 432               | 26                | 6                          |               |                         |         |
Table 7 – Open surgery to correct femoral fractures in a tertiary-level hospital: skin colonization and etiological agents of the surgical site infection (July 2007–July 2009).

| Variable                                         | Frequency | % |
|--------------------------------------------------|-----------|---|
| **Etiological agent identified for SSI**          |           |   |
| Yes                                              | 11        | 52|
| No                                               | 10        | 48|
| Total                                            | 21        | 100|
| **Etiological agent for SSI**                     |           |   |
| Acinetobacter baumannii                          | 2         | 18|
| Staphylococcus aureus                            | 2         | 18|
| Enterobacter cloacae + Acinetobacter baumannii    | 1         | 9 |
| Enterococcus sp.                                 | 1         | 9 |
| Escherichia coli + Acinetobacter baumannii       | 1         | 9 |
| Escherichia coli + Enterococcus sp.              | 1         | 9 |
| (ESBL-producing)                                 |           |   |
| Proteus mirabilis                                | 1         | 9 |
| Proteus mirabilis + MRSA                         | 1         | 9 |
| Staphylococcus aureus + Enterococcus sp.         | 1         | 9 |
| Total                                            | 11        | 100|
| **Skin colonization?**                           |           |   |
| Yes                                              | 9         | 2 |
| No                                               | 423       | 98|
| Total                                            | 432       | 100|
| **Skin microorganisms identified**                |           |   |
| Staphylococcus aureus                            | 5         | 55.0|
| Staphylococcus aureus + Enterobacter sp.         | 2         | 22.0|
| Proteus mirabilis                                | 1         | 11.0|
| Staphylococcus aureus + Streptococcus pyogenes   | 1         | 11.0|
| Total                                            | 9         | 100.0|

ESBL, extended-spectrum beta lactamase; MRSA, methicillin-resistant Staphylococcus aureus; SSI, surgical site infection.

or more comorbidities, lower cognitive capacity, weaker pre-fracture outpatient status, longer hospital stay and higher mortality rate.

In the present study, patients with previous stroke presented four times greater risk of developing SSI. A prospective study for evaluating the effect of the anterior passage after occurrences of femoral neck or intertrochanteric fractures showed that patients with histories of stroke were more likely to be male, have ASA grades III or IV, have three or more comorbidities, be limited to moving around at home and be dependent in activities of daily living (ADLs) and instrumental activities, before the time of the fracture. The length of hospital stay was significantly greater for these patients. 22

The limitation of the present study was that it was retrospective, with lack of information on the patients’ evolution over the course of administration of the prophylactic antibiotics and lack of definition and adherence criteria for the clinical evaluation and detailed history-taking.

**Conclusion**

The risk factors for SSI in cases of correction of femoral fractures through clean surgery that were identified in the present study were the presence of stroke before the surgery and length of hospital stay before the operation of more than four days. The combined action of these two factors contributed toward raising the rate of SSI among the patients who underwent surgery to three times the expected risk. Control over the risk factors and the time that elapses until the operation is highly desirable for reducing the risk of infection in these patients. The incidence of SSI identified in cases of clean surgery on femoral fractures presented levels greater than the infection rate recorded in the hospital. Clean surgery performed on the femur should be monitored and kept under surveillance because this is a marker for infection associated with quality control in healthcare services.

**Conflicts of interest**

The authors declare no conflicts of interest.

**REFERENCES**

1. Sakaki MH, Oliveira RA, Coelho FF, Garcez ELI, Suzuki I, Amatuzzi MM. Estudo da mortalidade na fratura do fêmur proximal em idosos. Acta Ortop Bras. 2004;12(4):242–9.
2. Hannan EL, Magaziner J, Wang JJ, Eastwood EA, Silberzweig SB, Gilbert M, et al. Mortality and locomotion 6 months after hospitalization for hip fracture: risk factors and risk-adjusted hospital outcomes. JAMA. 2001;285(21):2736–42.
3. Arrowsmith M. Surgical site infection. In: Emmerson AM, Arrowsmith M, editors. Infection control practices. Germany: 3 M Medical Markets Laboratory; 1998. p. 60–90.
4. Anderson DJ, Kaye KS, Classen D, Arias KM, Podgorny K, Burstin H, et al. Strategies to prevent surgical site infections in acute care hospitals. Infect Control Hosp Epidemiol. 2008;29 Suppl 1:S51–61.
5. Moran CG, Wenn RT, Sikand M, Taylor AM. Early mortality after hip fracture: is delay before surgery important? J Bone Joint Surg Am. 2005;87(3):483–9.
6. Ercole FF, Franco CML, Macieira RGT, Wenceslau CCL, Resende NIH, Chianca MCT. Risco para infecção de sitio cirúrgico em pacientes submetidos a cirurgias ortopédicas. Rev Latino-Am Enfermagem. 2011;19(6):1362–8.
7. Garden RS. The structure and function of the proximal end of the femur. J Bone Joint Surg Br. 1961;43(3):576–89.
8. Tronzo RG. Symposium on fractures of the hip. Special considerations in management. Orthop Clin North Am. 1974;5(3):571–83.
9. Seinheimer F. Fraturas subtrocantéricas do fêmur. J Bone Joint Surg Am. 1978;60(3):500–6.
10. Müller ME. AO Müller Electronic Long Bone Fracture Classification; 2003. Available in: www.aopublishing.org [accessed 25.02.12].
11. Organização Mundial da Saúde/OMS. CID-10. Classificação estatística internacional de doenças e problemas relacionados à saúde. 3a. ed. São Paulo: OMS; 1996.
12. Camargo FGC. Urgências clínicas e cirúrgicas. Rio de Janeiro: Atheneu; 2001.
13. Astur CD, Arliani GG, Balbachovsky D, Fernandes AJH, Reis BF. Fraturas da extremidade proximal do fêmur tratadas no Hospital São Paulo/UNIFESP: estudo epidemiológico. RBM: Rev Bras Med. 2011;68:11–5 (número especial).
14. Pereira SRM. Repercussões sociossanitárias da epidemia das fraturas do fêmur sobre a sobrevivência e a capacidade funcional do idoso. 2003 [tese]. Rio de Janeiro: Escola Nacional de Saúde Pública; 2003.
15. Muniz FC, Arnaut CA, Yoshida M, Trelha SC. Caracterização dos idosos com fratura de fêmur proximal atendidos em hospital-escola público. Rev Espaço Saúde. 2007;8(2):33–8.

16. Centers for Disease Control and Prevention/CDC. The National Healthcare Safety Network (NHSN) manual: patient safety component protocol. Atlanta: Division of Healthcare Quality Promotion, National Center for Preparedness, Detection and Control of Infectious Diseases; 2009, 210 p. Available in: http://www.cdc.gov/nhsn/library.html#psc [accessed 20.09.09].

17. Lew DP, Pittet D, Waldvogel FA. Infections that complicate the insertion of prosthetic devices. In: Mayhall CG, editor. Hospital epidemiology and infection control. 3rd ed. Philadelphia: Lippincott Williams & Wilkins; 2004. p. 1181–205.

18. Oliveira AC, Braz NJ, Ribeiro MM. Incidência da infecção do sítio cirúrgico em pacientes submetidos à artroplastias de quadril. Rev Latino-Am Enfermagem. 2002;10(2):157–65.

19. Ercole FF, Chianca TCM. Infeccção de sítio cirúrgico em pacientes submetidos a artroplastias de quadril. Rev Espac Saúde. 2007;8(2):33–8.

20. Gillespie WJ, Walenkamp G. Antibiotic prophylaxis for surgery for proximal femoral and other closed long bone fractures. Cochrane Database Syst Rev. 2010;3:CD000244.

21. Feng M, Zhang J, Shen H, Hu H, Cao L. Predictors of prognosis for elderly patients with poststroke hemiplegia experiencing hip fractures. Clin Orthop Relat Res. 2009;467(11):2970–8.

22. Youm T, Aharonoff G, Zuckerman JD, Koval KJ. Effect of previous cerebrovascular accident on outcome after hip fracture. J Orthop Trauma. 2000;14(5):329–34.