Fever in the postoperative period of hip and knee arthroplasties: integrative review

Objective: To seek the best evidence in the literature on fever as a marker of infection in the postoperative period of patients submitted to hip and knee arthroplasty surgery. Method: Integrative review with the following guiding question: What are the evidences on fever as a marker of infection after hip and knee arthroplasty surgery in adults? Searches were performed in EMBASE, LILACS, MEDLINE, and CINAHL databases, and SciELO electronic library from 2001 to 2011. After the identification of 146 studies, eight articles were selected. The analysis was carried out by two researchers using a tool to extract the data and perform the classification according to levels of evidence and degrees of recommendation. Results: Fever was identified as a common event in the first 72 hours of postoperative period and laboratory research on the origin of the fever is a routine procedure. Conclusion: Fever in the first 72 hours of postoperative period of knee and hip arthroplasty surgery is not a marker of infection. Descriptors: Fever; Orthopedics; Postoperative period; Review.

RESUMEN
Objetivo: buscar la mejor evidencia en la literatura sobre fiebre como marcador de infección postoperatorio de los pacientes sometidos a arthroplastia de cadera y rodilla. Método: revisión integradora con la siguiente pregunta como guía: ¿Cuáles son las evidencias sobre fiebre como marcador de infección después de arthroplastia de cadera y rodilla en adultos? Las búsquedas fueron guiadas por las bases de datos EMBASE, LILACS, MEDLINE, y CINAHL y por la biblioteca electrónica SciELO en el periodo comprendido entre 2001 y 2011. Después de la identificación de 146 estudios se procedió a la selección de ocho artículos. El análisis fue realizado por dos investigadores usando una herramienta para extraer los datos y efectuar la clasificación según los niveles de evidencia y grados de recomendación. Resultados: la fiebre fue identificada como un evento común en las primeras 72 horas postoperatorio siendo de rutina la investigación de laboratorio sobre el origen de la fiebre. Conclusión: la fiebre en las primeras 72 horas del postoperatorio en arthroplastias de rodilla y cadera no es un marcador de infección. Descriptores: Fiebre; Ortopedia; Periodo Pós-operatorio; Revisión.

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Fever is considered the oldest sign used as indicative of an infectious state. It is a reaction of the host organism against an invading agent. In this way, it can be considered as a clinical parameter that draws attention among patients and health professionals.1

This signal can be caused by abnormalities in the brain itself or by toxic substances that affect the thermal control centers. Many products of protein degradation and some other substances—in particular lipopolysaccharides released from bacterial cell membranes—may raise the set point of the hypothalamic thermostat. Substances that cause this effect are called pyrogens. These substances released by toxic bacteria or by body tissues in degeneration cause fever.2

When the set point of the hypothalamus thermoregulatory center increases and reaches a level above normal, all the mechanisms for the increase of body temperature come into action, including the conservation of heat and increased heat production and, within a few hours after the increase of the set point to a higher level, the body temperature also approaches this level.2

In the clinical context, the presence of this signal causes some forms of assessment in search of an infectious etiology by using laboratory tests, images and cultures on a routine basis. However, studies suggest that many elements of an infectious search can be unnecessary and costly for the patients and healthcare institutions.3,4

Hip and knee arthroplasties are surgical procedures that relieve pain and restore the function of the joints operated. Studies describe hip prostheses surviving more than 15 years and knee prostheses for 20 years. The challenge for professionals as well as for health services consists in arthroplasty failure, which can occur and lead to a surgical revision. Two studies that investigated the causes of hip arthroplasty revision identified infection in 8% of cases. Aseptic loss indicated the review on 51 and 91% respectively.5,6 The most feared complication of total knee prosthesis is deep infection and its incidence varies from 1.1 to 12.4%, and in more advanced health centers this incidence is between 0.4 and 2%.6 In this way, the nursing staff should be able to recognize all the clinical signs that show pictures of infection or inflammation and should not only consider the temperature increase as a sign of infection.7

For conducting this study, we chose the evidence-based practice as a theoretical framework, because it integrates, interacts and enables research and assistance. Faced with a problem, this type of practice involves the search and critical assessment of the latest and best evidence available, implementing it in practice and analyzing the results.9

In view of the above stated, this study aims to search the best evidence on fever in the literature as a marker of infection in the postoperative period (PO) of patients submitted to hip and knee arthroplasties.

**METHOD**

The review method selected to conduct this study was the integrative review (IR). The steps followed to carry out the research were: elaboration of the research project; formulation of the guiding research question; search of primary studies; selection of studies; data extraction; quality assessment; and synthesis of the available evidences.9

The IR allows the simultaneous inclusion of experimental and semi-experimental research, providing a more complete understanding of the focus of interest. It is also possible to target the definition of concepts, review of theories and methodological analysis. In addition, it provides important data, which can be directly interlinked to professional or clinical practice.9 In addition to what has been already pointed out, the IR allows the dissemination of knowledge, because a single study provides the results of several researches to the reader.

- Guiding question and criteria for inclusion and exclusion of primary studies

The question formulated as a guide for the study was << What are the evidences on fever as a marker of infection after hip and knee arthroplasty surgery in adults? >>

The inclusion criteria used were: articles published in English, Spanish and Portuguese, in the period from January 2001 to December 2011; sample composed of patients aged 18 years or over and submitted to hip and knee arthroplasties; and fever regarded as the temperature equal to or greater than 38 °C.2 The exclusion criteria used were: articles of limited access; sample composed of pediatric patients; and studies that did not measure body temperature.

- Search of primary studies

The search of the primary studies was carried out in the following electronic databases: Cumulative Index to Nursing and Allied Health Literature (CINAHL); Medical...
Literature Analysis and Retrieval System Online (MEDLINE); Biomedical Database - Elsevier (EMBASE); Latin American literature and Caribbean Health Sciences (LILACS); and the electronic library Scientific Electronic Library Online (SciELO). For the direction of the search we used a combination of controlled descriptors (fever, postoperative period, orthopedic) and uncontrolled descriptors (pyrexia, hyperthermia, orthopedic surgery, orthopedic surgery), in accordance with each electronic database consulted.

In the search of primary studies for conducting the IR, we identified 146 articles in the selected electronic databases and the electronic library, of which 45 recurred between the bases, leaving 101 suitable studies. After this preliminary survey, we read the titles and abstracts and, with the application of the inclusion criteria previously adopted, we selected 26 articles for reading in full. After reading these articles, eight were selected to compose the corpus of this study.

The exclusion of the primary articles took place due to the following reasons: articles in another language; not available in full for free access; repeated articles in the databases; review articles; articles that dealt with patients submitted to other types of surgeries; and articles with other population.

● Data extraction from primary studies

The extraction of data from the primary studies included in the IR was performed by two researchers independently, as a strategy to ensure the legitimacy of analysis content. For data collection, an instrument built by the authors was filled out in order to synthesize the information of interest with the following variables: publication title, journal, year of publication, and authors; type of study; purpose of the study; value considered as fever; monitoring period of fever in the PO period; main findings and recommendations; levels of evidence and degrees of recommendation; and focus on the presence of fever as a marker of infection after hip and knee arthroplasty in adult patients.

● Assessment and presentation of primary studies

The assessment of the studies was carried out from the records in the instrument, which enabled the identification of levels of evidence and the existence of possible bias. In order to classify the studies according to the level of evidence and degrees of recommendation, we used Oxford scoring\(^1\), namely: level 1A: systematic review studies with homogeneity of controlled and randomized clinical trials; level 1B: controlled and randomized clinical trials with narrow confidence interval with homogeneity; level 1C: therapeutic results of ‘all or nothing’ type; level 2A: systematic review of cohort studies; level 2B: cohort studies including randomized clinical trials of lower quality; level 2C: observation of therapeutic results and ecological studies; level 3A: systematic review with homogeneity of case-control studies; level 3B: case-control studies; level 4: case reports, including cohort and case-control of lower quality; level 5: opinion with no critical assessment or based on basic matters, such as physiological studies or studies on animals.

The presentation and discussion of the results were performed in a descriptive form, providing subsidies to the reader to assess the quality of nursing practice and guide the decision-making in situations of fever in the PO period experienced by nurses.

### RESULTS

In his IR, we examined eight articles that met the inclusion criteria established in advance. We present an overview of articles assessed in Table 1 with the designs of the studies, types of arthroplasty, number of subjects, level of evidence, and degree of recommendation.

<table>
<thead>
<tr>
<th>No.</th>
<th>Author</th>
<th>Year</th>
<th>Type of Study</th>
<th>Arthroplasty</th>
<th>No. of Subjects</th>
<th>Level of Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1</td>
<td>Ward et al.</td>
<td>2010</td>
<td>Retrospective cohort</td>
<td>Hip and Knee</td>
<td>1,100</td>
<td>2B</td>
</tr>
<tr>
<td>E2</td>
<td>Tai et al.</td>
<td>2009</td>
<td>Retrospective cohort</td>
<td>Hip and Knee</td>
<td>186</td>
<td>2B</td>
</tr>
<tr>
<td>E3</td>
<td>Athanasious et al.</td>
<td>2011</td>
<td>Retrospective cohort</td>
<td>Hip and Knee</td>
<td>341</td>
<td>2B</td>
</tr>
<tr>
<td>E4</td>
<td>Czaplicki et al.</td>
<td>2011</td>
<td>Retrospective cohort</td>
<td>Hip and Knee</td>
<td>426</td>
<td>2B</td>
</tr>
<tr>
<td>E5</td>
<td>Ghosh et al.</td>
<td>2006</td>
<td>Retrospective cohort</td>
<td>Hip and Knee</td>
<td>170</td>
<td>2B</td>
</tr>
<tr>
<td>E6</td>
<td>Uckay et al.</td>
<td>2011</td>
<td>Prospective cohort</td>
<td>Arthroplasties</td>
<td>418</td>
<td>2B</td>
</tr>
<tr>
<td>E7</td>
<td>Saavedra et al.</td>
<td>2008</td>
<td>Prospective cohort</td>
<td>Hip and Knee</td>
<td>148</td>
<td>2B</td>
</tr>
<tr>
<td>E8</td>
<td>Andres et al.</td>
<td>2003</td>
<td>Prospective cohort</td>
<td>Knee</td>
<td>20</td>
<td>2B</td>
</tr>
</tbody>
</table>

Table 1. Summary of the studies according to authors, year of publication, type of study, arthroplasty, number of subjects, level of evidence, and degree of recommendation.

With respect to the articles included, all of them were authored by orthopedic surgeons and conducted in unique hospitals. According to the year of publication, three studies were published in 2011, one in 2010, one in 2009, one in 2008, one in 2006, and one in 2003. As for the place of origin of the studies, four were from the United States, one from Taiwan, one from England, one from France, and one from Argentina.
The objectives of the studies were: to describe the incidence, characteristics and cost of diagnosis of fever in the PO of knee arthroplasty (E1); to determine the tendency of body temperature of patients during the PO of knee arthroplasty and to determine the factors influencing this tendency (E2); to assess the incidence of fever in the PO of hip and knee arthroplasties (E3); to determine the incidence of fever and leukocytosis after hip and knee arthroplasties and to determine the use of examinations and their correlation with infection (E4); to determine the incidence of fever after knee arthroplasty and to identify the factors associated with fever in the PO (E5); to assess the epidemiological fever profile during the first week of the PO of orthopedic surgery and to determine the risk factors (E6); to establish the incidence of fever in orthopedic and urologic prosthetic surgery, to identify the etiology of fever, to relate the time of fever outbreak with the cause and to determine the usefulness of exams for the investigation of fever (E7); to determine whether the concentration of cytokines Interleukin 1β (IL-1β), tumor necrosis factor-α (TNF-α) and Interleukin-6 (IL-6) increase in the secretion of wound drain and blood after knee arthroplasty, to determine whether cytokine levels were increased in patients with fever (E8).

With respect to the design of the studies, all of them had a quantitative approach, of which five (E1, E2, E3, E4, E5) were retrospective and three (E6, E7, E8) prospective types. Regarding the sample, the retrospective studies assessed clinical records; they were E1: 1,100, E2: 186, E3: 341, E4: 426, and E5: 170. The prospective studies assessed patients; they were E6: 418, E7: 148, and E8: 20.

As to temperature, fever was considered as T ≥ 38.5 °C in the studies E1 and E8; the other studies considered fever as T ≥ 38 °C. The site of temperature measurement was tympanic in the studies E2 and E5, axillary in E6 and E7, and oral in E8. The site of temperature measurement was not mentioned in three studies: E1; E3; and E4.
From the articles included, we identified homogeneity in relation to the objective proposed in five studies (62.5%), i.e., to assess the incidence of fever in the PO period after arthroplasties. Regarding the procedure performed, four (50%) articles addressed knee arthroplasty, three (37.5%) included hip and knee arthroplasties, and one (12.5%) did not specify the type of arthroplasty performed. It is necessary to emphasize that in E6, we chose to include only elective arthroplasties in this IR, since the study assessed the occurrence of fever after orthopedic surgeries in general. In E7, we also decided to include hip and knee arthroplasties in this IR, because the study contemplated urologic and orthopedic surgeries.

With respect to fever, there seems to be agreement among the authors of the articles included in this IR that patients submitted to both hip and knee arthroplasties go through a period of fever within the first 72 hours of the PO. In this IR, fever incidence ranged from 8.4 to 50% in patients after hip and knee arthroplasties during the first five days of the PO period.

Regarding the level of evidence and degree of recommendation, the eight studies

<table>
<thead>
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<th>E</th>
<th>Results</th>
<th>Considerations</th>
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<tr>
<td>E13</td>
<td>Fever appeared in 161 (14.6%) patients, with a peak between the 2nd and 3rd postoperative day (POD). Laboratory tests were conducted in 69 (42.9%) patients and there was change of treatment only in 9 (41%). There was no association between the sociodemographic variables and fever in the PO period. Average cost per patient: USD 959.45.</td>
<td>In the absence of clinical signs of infection laboratory exams are unnecessary. T ≥ 39 °C increases the chances of the patient to develop infection.</td>
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<tr>
<td>E211</td>
<td>Fever was evidenced in the first five days of the PO period. However, most patients had high temperature peak between the 1st and 2nd POD (45% and 36%, respectively). Fever lasted ≤ 2 days in 174 (93.5%) patients and ≥ 3 days in 12 (6.5%) patients, of whom four (33%) evolved to infection whose temperature was ≥ 39 °C. There was a negative correlation between low levels of fever.</td>
<td>The authors conclude that the possible cause of the fever in the PO period was the release of endogenous pyrogens. One should pay attention to patients with body temperature ≥ 39 °C, especially after the 2nd POD, because it can be evidence of development of any complication.</td>
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<tr>
<td>E312</td>
<td>Fever occurred in 36% of the patients. In 165 (55%) the high temperature peak occurred on the 2nd POD. After a year of surgery, 9 (3%) developed deep infections; therefore, it was not possible to associate the fever to the deep infection in the PO period.</td>
<td>The authors point out that after physical assessment no physiological changes are observed; fever is a normal variation of temperature in the immediate PO period. In the PO period (72 hours), laboratory tests were not required for patients with fever.</td>
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<tr>
<td>E413</td>
<td>Of 214 patients, after knee arthroplasty, 123 (57.5%) had leukocytosis (18 (8.4%) fever, and 13 (6.1%) leukocytosis + fever. Of 212 patients, after hip arthroplasty, there were 122 (57.5%) with leukocytosis, 49 (23.1%) with fever, and 22 (10.4%) with fever + leukocytosis. The incidence of fever was high on the 1st POD of patients after hip arthroplasty and on the 2nd POD of patients after knee arthroplasty. In both cases, there was a tendency to decrease the fever after the 2nd POD.</td>
<td>Fever may be a result of endogenous pyrogens release as part of the inflammatory response after hip and knee arthroplasties. The authors conclude that laboratory tests for patients with fever and leukocytosis without a specific physical assessment are not required and should not be performed routinely.</td>
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<tr>
<td>E514</td>
<td>During the first five POD, 62 (36.4%) patients had fever, with feverish peak on the 1st and 2nd POD. In this study, 14 (8.2%) patients developed infection and of these only 4 (28.6%) had fever. There was no association between fever and variables such as blood transfusion, indwelling vesical catheterization, arthritis and the type of anesthesia. None of these patients evolved to infection.</td>
<td>Fever is an inflammatory response of the body to surgical traumas. Therefore, fever in the first five POD has little diagnostic value for infection. The authors state that prescriptions of antibiotics are made without evidence of infectious processes.</td>
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<tr>
<td>E615</td>
<td>Of 1,073 patients submitted to orthopedic surgery, 209 (19.5%) had elective knee arthroplasties and 91 (44%) had fever. Most of them had occasional feverish peaks during the first five POD.</td>
<td>Fever is not evidence of infection in the surgical site or any other infection, but an inflammatory response. Therefore, it does not help in the diagnosis of infection during the first five POD.</td>
</tr>
<tr>
<td>E71</td>
<td>Of the 303 patients submitted to orthopedic and urologic surgeries, 149 (49%) had hip and knee arthroplasty surgeries. Incidence of PO fever was identified in 42 (14%) patients, of which in 34 (81%) no infectious focus was identified. Fever in the first 48 hours of the PO had non-infectious origin.</td>
<td>Fever is the body’s response to endogenous pyrogens, released when there is tissue injury. Fever before 48 hours in the PO period has no infectious origin. The authors point out that the diagnosis of infection after 48 hours should be based on physical and clinical assessment of the patient in addition to high temperature.</td>
</tr>
<tr>
<td>E816</td>
<td>Fever was identified in 10 (50%) patients, with feverish peaks on the 1st POD. IL-6 levels increase gradually during 24-48 hours of the PO period of feverish patients. Leukocytes levels had peaked on the 2nd POD, attributed to an acute inflammatory response. The arthroplasty procedure is followed by the increase of cytokines IL-1β, TNFα IL-6.</td>
<td>The feverish response is not attributed to a pathological process, but a postoperative inflammatory response. The inflammatory response may vary from one patient to another. The expense caused by laboratory tests to investigate the etiology of fever within 72 hours after arthroplasty is not justified, unless the findings of physical examination suggest a specific source.</td>
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</table>
consisted of cohort classified at 2B level and the results recommend the body temperature control in the PO. However, if fever is present in the first 72 hours, it does not necessarily mean infection and dispenses laboratory exams. It is worth mentioning that three studies (E1, E2, E5) assessed the association of sociodemographic and clinical variables with fever, but no statistical significance was observed. With respect to costs, only one study (E1) estimated expenses caused by the requested exams and the average cost was USD 959.45 per patient.

**DISCUSSION**

The term fever refers to a condition in which the body determines an increase in core temperature, as an organized and coordinated response to a disease or harm. However, not every temperature increase is pathological. The data from the literature indicate that fever is part of the normal physiological response of the body after hip and knee arthroplasties, mediated by inflammatory cytokines, especially in the first 48 hours of the PO period, which was evidenced in these studies.17-18

In this scenario, there is a need to train nurses for care practice through the nursing process. Fever is a nursing problem that can be identified by nurses during the assessment of patients in the PO period and generate a series of systematized actions, without treating it as a sign of infection.

Temperature increase is attributed to tissue injury caused by hip and knee arthroplasty, which triggers the release of cytokines by monocytes or tissue macrophages, such as: interleukin 1β (IL-1β), tumor necrosis factor-α (TNFα) and interferon-α, all with pyrogenic activity. These cytokines, in turn, stimulate the production and secretion of interleukin 6 (IL-6), main responsible for the acute inflammatory response. When this cytokine IL-6 enters the bloodstream and reaches the brain tissue synthesizes prostaglandin E2, responsible for sending the signal to the preoptic nucleus of the hypothalamus raising the body temperature set point. Nurses' knowledge on the pattern of the inflammatory response that occurs in the PO of arthroplasties would allow elaborating a care plan. Starting from fever as a nursing problem, it is necessary to define diagnoses in order to determine expected results that guide the choice of nursing interventions.

The findings of this IR are supported by other studies19-20 performed in adult patients submitted to abdominal and gynecologic surgeries, in which the authors conclude that fever is caused by cytokines (IL-1β, TNFα, IL-6) that act as endogenous pyrogens and are released in the presence of tissue damage, and its presence should not be considered as a sign of infection. However, the performance of nursing through systematized actions seeks the reduction of body temperature and patients' comfort.

The presence of fever in patients after surgical procedures often suggests concern among health professionals. This motivates the most comprehensive assessment of patients, including laboratory tests. The authors of the studies which composed this IR claim that, up to 72 hours of the PO period, the results of laboratory tests are not determining factors in the diagnosis of infection and that, on the contrary, they cause costs to the patients and to the hospital, as well as extending the length of hospital stay. A study that assessed the cost of fever investigation in the PO period of hip and knee arthroplasties observed values of USD 959.45 per febrile patient.3

Monitoring core temperature is of fundamental importance to clinical practice, and it is possible to be measured in the tympanic membrane, pulmonary artery, distal esophagus, and nasopharynx. In the unit of surgical clinic, since it is not possible to measure the core temperature of patients through these body sites, it is necessary to seek other sites for measurement, such as: mouth; axilla; rectum; and skin surface. One option would be the measurement of temperature in the tympanic membrane, which constitutes a good alternative due to the speed, ease of use, proximity to the hypothalamus, and measurement accuracy.21-22

Axillary and oral measurements can also be performed; however, oral measurement can be influenced by thermal changes, such as mouth breathing or recent ingestion of hot or cold food. For axillary temperature measurement, the thermometer should be preferably placed on the axillary artery and the arm must be positioned next to the patient's body.21 Nurses must consider the specific needs of patients and through a quality healthcare practice contribute to the achievement of positive results and an efficient performance together with the multidisciplinary team.

From the studies selected, three (37.5%) did not mention the temperature measurement site. This information is very important considering that the values may vary according to the site. The instruments used in the other studies were tympanic...
thermometer with infrared sensor and mercury or electronic thermometer for axillary or oral use.

Fever in the PO period can also be triggered by other factors such as use of medicines, blood transfusion and deep vein thrombosis, although these cases are not related to surgical trauma.23 The results of the studies E1 and E5 showed insignificant association between sociodemographic variables and fever, type of anesthesia, blood transfusion, and diabetes. These are findings that were corroborated by other studies.24-25

In view of what has been exposed, all large surgical procedure can induce inflammatory response with varying degrees of severity, whose etiology is not necessarily linked to infection.24 It is necessary to point out that this inflammatory response can vary from one patient to another, hence the importance of nurses to perform clinical and physical assessment of patients systematically. In the assessment of the PO period, nurses have to measure the body temperature and monitor the febrile curve, mainly during the first five days by implementing appropriate nursing actions.

A review study identified low scientific production in the Brazilian context regarding nursing care in arthroplasties.26 The development of research by nurses, producing evidence in support of the healthcare practice is of great importance. In addition, nursing interventions for maintaining body temperature within a normal parameter consist of activities that apply physical cooling methods whose effectiveness could be better evaluated by well-conducted clinical studies. Even though these methods consist of common practice, there is little evidence that support them. It is suggested to nurses to develop clinical studies in order to evaluate the physical methods for treating fever in patients submitted to arthroplasties.

CONCLUSION

Among the studies that have addressed the topic of interest, most showed that fever in the first 72 hours is an inflammatory response triggered by the surgical trauma. However, the use of diagnostic investigation, in order to determine the etiology of fever, is still routinely predominant. It does not contribute to the diagnosis of infection in the PO period; therefore, the physical and clinical assessment of patients is strongly recommended. This evaluation must be careful and individualized for each surgical patient and professionals should have updated knowledge in order to intervene effectively and meet the real needs of the patients.

Although the sample of publications was small, this study allowed to observe both the state of the art in fever as a marker of infection in the PO of hip and knee arthroplasties and the nurses’ area of activity to establish a quality assurance practice.

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