Top 100 cited articles on infection in orthopaedics
A bibliometric analysis

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Abstract
Purpose: The infection is an essential problem in the clinical practice in orthopedics. The bibliometric analysis was conducted to evaluate the top 100 cited articles on infection in orthopedics.

Methods: The Web of Science (WoS) Core Database was comprehensively searched from 1975 to 2017, and the literature search was limited in Science Citation Index Expanded (SCI-E). The subject terms included “infection”, “infectious”, and “infect”. All retrieved articles were filtrated by selecting the subspecialty of “Orthopedics”. The searching results were listed by citation times to identify the top 100 cited articles. Significant information was elicited, including the authors, journals, countries, institutions, published year, and types of publication.

Results: A significant increase was observed in the number of annual publications focusing on infection in orthopaedics worldwide. Each of the top 100 cited articles was cited more than 150 times. Total citation times was positively associated with citation times in 2016 (P < .01) and mean citation times per year (P < .01). Conversely, age of the article was negatively associated with citation times in 2016 (P < .01) and mean citation times per year (P < .01). Besides, citation times in 2016 was positively related to mean citation times per year (P < .01). The United States was the most productive country, surgery was the most popular subspecialty and Journal of Bone and Joint Surgery American Volume was the most popular journal.

Conclusion: Infection in orthopaedics has attracted more and more researchers’ concern. As for the top 100 cited articles, there were significant relationships among total citation times, citation times in 2016 and mean citation times per year as well as age of the article. The United States was the most productive country, surgery was the most popular subspecialty and Journal of Bone and Joint Surgery American Volume was the most popular journal.

Abbreviation: WoS = Web of Science.

Keywords: bibliometric analysis, infection, orthopedics

1. Introduction
Infection is a tangible problem in the clinical practice in orthopedics, and the gold diagnostic standard for infection has typically been cultivation and subsequent identification of a bacterial sample from the wound or liquid substance from bone tissue. A large number of patients face the risk of infection while undergoing an orthopedic procedure, as a matter of fact, the incidence of infection in trauma patients even has reached up to 10% in orthopaedics. Infection increases financial costs and prolongs course of diseases, and it even decreases the compliance of patients. Although great progress to prevent infection in orthopedics has been made, the understanding of infection remains unclear. In view of the aforesaid importance, a growing number of researchers pay attention to the developments of infection research in orthopedics. As a result, plenty of articles relevant to infection in orthopedics have been published, which increase the difficulty of catching the critical information for followers in this filed.

Citation number of one article is commonly used to assess the academic influence of the study. Bibliometric analysis is frequently used to evaluate the academic developments of specific specialties, including cancer, neuroscience, urology, emergency medicine and medical imaging. In recent years, bibliometric analysis becomes increasing popular in orthopedics, which mainly focus on spinal cord tumors, anterior cruciate ligament injuries, back pain, orthopedic surgeries, knee research, and hand surgeries. However, to our knowledge, no bibliometric analysis focusing on infection in orthopedics has been published up to this date. In consideration of this fact, the aim of this bibliometric analysis was to help followers to catch the most important developments of research on infection in orthopedics by assessing the top 100 cited articles.

2. Materials and methods

2.1. Literature searching
This study was approved by Institutional Review Board of Wuxi Second Hospital. Similar to other bibliometric analyses,
Web of Science (WoS) Core Collection (Thomson Reuters, NY) was comprehensively searched, and the literature search was limited in Science Citation Index Expanded (SCI-E). The keywords included “infection”, “infectious”, and “infect∗”. The articles published from 1975 to 2017 were all elicited, without the restriction on language. Then, all retrieved articles were filtrated by the subspecialty of “Orthopedics”. The top 100 cited articles were finally identified and included into this bibliometric analysis.

2.2. Bibliometric analysis
This bibliometric analysis was performed based on a mature methodology used in other bibliometric studies.[13,15,16,18] The following information was extracted: total publications, published year, top 100 cited articles, countries, journals, types of article, top productive institutions and authors.

2.3. Statistical analysis
All statistical analyses were performed using SPSS software version 20.0 (SPSS Inc., Chicago, IL). The statistical significance of the correlations among total citation times, citation times in 2016 and mean citation times per year, as well as age of the article, were determined by Spearman test. \( P<.05 \) was considered to be statistically significant.

3. Results

3.1. The top 100 cited articles
As shown in Figure 1, a total of 17,040 articles focusing on infection in orthopedics were identified from WoS. The number of publications concerning infection in orthopedics had an annually significant increase worldwide.

Top 100 cited articles were listed in Table 1. The top 1 cited article, an original study, was published in Journal of Bone and Joint Surgery American Volume in 1976 and entitled “Prevention of infection in treatment of 1000 and 25 open fractures of long bones—retrospective and prospective analyses”, and this paper was totally cited 1770 times. The mean citation times per year and citation times in 2016 of this article were 42.14 and 92, respectively. Besides, this article was also the oldest article among the top 100 cited articles. Each of the top 100 cited articles was cited more than 150 times.

We further explored the associations among total citation times, mean citation times per year, citation times in 2016 and age of the article. The results demonstrated that total citation times was positively associated with citation times in 2016 \( (r=0.412, P<.001) \) (Fig. 2a) and mean citation times per year \( (r=0.701, P<.001) \) (Fig. 2b). However, no significant relationship was observed between total citation times and age of the article \( (r=-0.042, P=.681) \) (Fig. 2c). In additions, age of the article was negatively associated with citation times in 2016 \( (r=-0.662, P<.001) \) (Fig. 2d) and mean citation times per year \( (r=-0.679, P<.001) \) (Fig. 2e). Moreover, citation times in 2016 was positively related to mean citation times per year \( (r=0.789, P<.001) \) (Fig. 2f).

3.2. Journals with no less than 3 of the top 100 cited articles
Regarding to the journals of the top 100 cited articles, we analyzed the journals with no less than 3 top cited articles. As shown in Table 2. Journal of Bone and Joint Surgery American Volume was the most popular journal, with 48 articles, followed by Clinical Orthopedics and Related Research with 14 articles, Spine with 12 articles, Journal of Bone and Joint Surgery British Volume with 9 articles, Acta Orthopedic Scandinavica with 3 articles, and Journal of Arthroplasty with 3 articles. Besides, the Journal of Bone and Joint Surgery American Volume also had the highest total citation times, mean citation times per year and citation times in 2016. However, Clinical Orthopedics and Related Research had the highest mean citation times per article.

Figure 1. Publications focusing on infection in orthopedics distributing in each year.
Table 1
Top 100 cited articles focusing on infection in orthopaedics.

| Rank | Citation | Article |
|------|----------|---------|
| 1    | 2004     | Prevention of infection in treatment of 1000 and 25 open fractures of long bones—retrospective and prospective analyses |
| 2    | 2002     | Recombinant human bone morphogenetic protein-2 for treatment of open tribular fractures—a prospective, controlled, randomized study of 450 patients |
| 3    | 1995     | Iliac crest bone-graft harvest donor site morbidity—a statistical evaluation |
| 4    | 1996     | Complications of iliac crest bone graft harvesting |
| 5    | 2002     | Why are total knee arthroplasties failing today? |
| 6    | 2011     | A critical review of recombinant human bone morphogenetic protein-2 trials in spinal display managing, safety concerns and lessons learned |
| 7    | 1999     | Osteogenic activity of the 14 types of human bone morphogenetic proteins (BMPs) |
| 8    | 2001     | Evolution of the internal fixation of long bone fractures—the scientific basis of biological internal fixation: choosing a new balance between stability and biology |
| 9    | 1999     | An analysis of blood management in patients having a total hip or knee arthroplasty |
| 10   | 1998     | A prospective, randomized study of lumbar fusion—preliminary results |
| 11   | 1998     | Prognosis of total hip-replacement in sweden—follow-up of 92,675 operations performed 1990 |
| 12   | 1997     | Autogenous iliac crest bone graft—complications and functional assessment |
| 13   | 2009     | The Epidemiology of Revision Total Hip Arthroplasty in the United States |
| 14   | 2003     | Autologous osteochondral mosaicplasty for the treatment of full-thickness defects of weight-bearing joints—10 years of experimental and clinical experience |
| 15   | 1981     | Management of deep infection of total hip-replacement |
| 16   | 2005     | Pathophysiology of polytrauma |
| 17   | 1996     | Infection after total hip arthroplasty—a study of the treatment of 106 infections |
| 18   | 2005     | United States trends in lumbar fusion surgery for degenerative conditions |
| 19   | 1993     | The outcome of charnley total hip-arthroplasty with cement after a minimum 20-year follow-up |
| 20   | 2003     | Rates and outcomes of primary and revision total hip replacement in the United States Medicare population |
| 21   | 2001     | Association between hospital and surgeon procedure volume and outcomes of total hip replacement in the United States Medicare population |
| 22   | 2001     | Prospective analysis of preoperative and intraoperative investigations for the diagnosis of infection at the sites of 202 revision total hip arthroplasties |
| 23   | 1999     | The effect of regional gene therapy with bone morphogenetic protein-2-producing bone-marrow cells on the repair of segmental femoral defects in rats |
| 24   | 1993     | Complications associated with the technique of pedicle screw fixation—a selected survey of 60 members |
| 25   | 2003     | Necrotizing fasciitis: clinical presentation, microbiology, and determinants of mortality |
| 26   | 2001     | The Insall Award paper—infection in total knee replacement—a retrospective review of 6489 total knee replacements |
| 27   | 1996     | Long-term results of allograft replacement in the management of bone tumors |
| 28   | 2008     | Periprosthetic joint infection: The incidence, timing, and predisposing factors |
| 29   | 2005     | Birmingham hip resurfacing arthroplasty—a minimum follow-up of 5 years |
| 30   | 1993     | Long-term results of the total condylar knee arthroplasty—a 15-year survivorship study |
| 31   | 1994     | The effect of recombinant human osteogenic protein-1 on healing of large segmental bone defects |
| 32   | 2008     | Infection burden for hip and knee arthroplasty—a statistical evaluation of 11 years and 73,000 arthroplasties |
| 33   | 2000     | Morbidity and mortality in association with operations on the lumbar spine—The influence of age, diagnosis, and procedure |
| 34   | 2005     | Reversal shoulder arthroplasty: a review of results according to etiology |
| 35   | 1995     | The surgical and medical perioperative complications of anterior spinal-fusion surgery in the thoracic and lumbar spine in adults—a review of 1223 procedures |
| 36   | 2006     | New Award 2006: the Grammont reverse shoulder prosthesis: results in cuff tear arthritis, fracture sequelae, and revision arthroplasty |
| 37   | 1998     | Effect of recombinant human osteogenic protein-1 on healing of segmental defects in nonhuman-primates |
| 38   | 1988     | Infection in bone allografts—incidence, nature, and treatment |
| 39   | 1998     | The Bagby and Kuslich method of lumbar interbody fusion—history, techniques, and 2-year follow-up results of a United States prospective, multicenter trial |
| 40   | 1993     | Operative versus nonoperative treatment of achilles-tendon rupture—a prospective randomized study and review of the literature |
| 41   | 2010     | The Epidemiology of Revision Total Knee Arthroplasty in the United States |
| 42   | 2005     | The reverse shoulder prosthesis for glenohumeral arthritis associated with severe rotator cuff deficiency—a minimum 2-year follow-up study of 60 patients |
| 43   | 2011     | New Definition for Periprosthetic Joint Infection: From the Workgroup of the Musculoskeletal Infection Society |
| 44   | 1995     | Current concepts review infection after total hip-arthroplasty past, present, and future |
| 45   | 1990     | Infection as a complication of total knee-replacement arthroplasty—risk-factors and treatment in 67 cases |
| 46   | 1997     | Total knee replacement in young, active patients—long-term follow-up and functional outcome |
| 47   | 2004     | Association between hospital and surgeon procedure volume and the outcomes of total knee replacement |
| 48   | 2006     | Hematogenous pyogenic spinal infections and their surgical management |
| 49   | 2006     | Complications of total shoulder arthroplasty |
| 50   | 1983     | 2-stage reimplantation for the salvage of infected total knee arthroplasty |
| 51   | 2008     | Risk factors for surgical site infection following orthopaedic spinal operations |

(continued)
Table 1
(continued)

| Rank | Article | Author | Journal | Year | Total citation | Mean citation per year | Citation in 2016 |
|------|---------|--------|---------|------|---------------|------------------------|-----------------|
| 53   | Incidence rates of dislocation, pulmonary embolism, and deep infection during the first 6 months after elective total hip replacement | Phillips, CB | JBJS A | 2003 | 245 | 16.33 | 12 |
| 54   | Tuberculosis of bones and joints | Watts, HG | JBJS A | 1996 | 245 | 11.14 | 12 |
| 55   | The effect of pedicle screw instrumentation on functional outcome and fusion rates in posterior lateral lumbar spinal fusion: a prospective, randomized clinical study | Thomsen, K | Spine | 1997 | 244 | 11.62 | 11 |
| 56   | Semiconstrained arthroplasty for the treatment of rheumatoid-Arthritis of the elbow | Morrey, BF | JBJS A | 1992 | 244 | 9.38 | 12 |
| 57   | Anterior cervical disc fusion and fusion of total knee complications | Fountas, Kostas N | Spine | 2007 | 241 | 21.91 | 43 |
| 58   | Thoracic pedicle screw fixation in spinal deformities—are they really safe? | Suk, S | Spine | 2001 | 240 | 14.12 | 17 |
| 59   | Internal fixation compared with arthroplasty for displaced fractures of the femoral neck—a meta-analysis | Bhandari, M | JBJS A | 2003 | 239 | 15.93 | 17 |
| 60   | Perioperative complications of posterior lumbar decompression and arthrodesis in older adults | Cameron, LY | JBJS A | 2003 | 238 | 15.87 | 36 |
| 61   | Early failures in total knee arthroplasty | Felting, TK | CORR | 2001 | 236 | 13.88 | 25 |
| 62   | Accurate pedicle screw insertion with and without computer assistance: a randomised controlled clinical study in 100 consecutive patients | Laine, T | Eur Spine J | 2000 | 231 | 12.63 | 11 |
| 63   | Studies of the mechanism by which the mechanical failure of polymethylmethacrylate leads to bone resorption | Hornertz, SM | JBJS A | 1993 | 231 | 9.24 | 1 |
| 64   | Systemic inflammation after trauma | Lenz, Andreas | Injury | 2007 | 228 | 20.73 | 29 |
| 65   | Fix and flip: the radical orthopaedic and plastic treatment of severe open fractures of the tibia | Gopal, S | JBJS B | 2000 | 221 | 12.28 | 23 |
| 66   | The incidence of deep prosthetic infections in specialist orthopaedic hospital—a 15-year prospective survey | Phillips, J E | JBJS B | 2006 | 214 | 17.83 | 30 |
| 67   | Regional gene therapy with a BMP-2-producing murine stromal cell line induces heterotopic and orthotopic bone formation in rodents | Lieberman, JR | J Orthop Res | 1998 | 214 | 10.7 | 1 |
| 68   | Infection after total knee arthroplasty—a retrospective study of the treatment of 81 infections | Segawa, H | JBJS A | 1999 | 213 | 11.21 | 19 |
| 69   | Pyogenic vertebral osteomyelitis | Caragee, EJ | JBJS A | 1997 | 213 | 10.14 | 10 |
| 70   | Obesity and perioperative morbidity in total hip and total knee arthroplasty patients | Namba, RS | JOA | 2005 | 207 | 15.92 | 36 |
| 71   | The incidence of complications in endoscopic anterior thoracolumbar spinal reconstructive surgery—a prospective multicenter study comprising the first 100 consecutive cases | McIlree, PC | Spine | 1995 | 207 | 9 | 3 |
| 72   | The impact of infection after total hip arthroplasty on hospital and surgeon resource utilization | Bacz, KJ | JBJS A | 2005 | 204 | 15.69 | 25 |
| 73   | Economic Burden of Periprosthetic Joint infection in the United States | Kurz, Steven M | JOA | 2012 | 201 | 33.5 | 71 |
| 74   | 2-stage revision for the salvage of total knee arthroplasty complicated by infection—further follow-up and refinement of indications | Windsor, RE | JBJS A | 1990 | 199 | 7.11 | 5 |
| 75   | Improved detection of infection in hip replacements—a currently underestimated problem | Tunney, MM | JBJS B | 1998 | 198 | 9.9 | 9 |
| 76   | Infection-rates after 3175 total hip and total knee replacements performed with and without a horizontal unidirectional filtered air-flow system | Saklat, EA | JBJS A | 1982 | 196 | 5.44 | 4 |
| 77   | Nurophy of the femoral diaphysis—the influence of reaming and non-steroidal anti-inflammatory drugs | Giannoudis, PV | JBJS B | 2000 | 195 | 10.83 | 17 |
| 78   | Survival and clinical-results with use of large-segment replacements in the treatment of high-grade bone sarcomas | Malawer, MM | JBJS A | 1995 | 194 | 8.43 | 7 |
| 79   | Risk factors for infection after spinal surgery | Fang, A | Spine | 2005 | 193 | 14.85 | 33 |
| 80   | The Cephal-Morrey total elbow arthroplasty in patients with rheumatoid arthritis—a 10 to 15-year follow-up study | Gill, DRU | JBJS A | 1998 | 189 | 9.45 | 10 |
| 81   | Diagnosis of periprosthetic infection | Bauer, TW | JBJS A | 2006 | 187 | 15.58 | 14 |
| 82   | Biofilm theory can guide the treatment of device-related orthopaedic infections | Costaragan, JW | CORR | 2005 | 184 | 14.15 | 12 |
| 83   | Latisimus-dorsi transfer for the treatment of irreparable tears of the rotator cuff | Gerber, C | CORR | 1992 | 184 | 7.08 | 9 |
| 84   | Open reduction and internal-fixation of tibial plateau fractures—variables contributing to poor results and complications | Teeny, SM | CORR | 1993 | 183 | 7.32 | 18 |
| 85   | Total knee arthroplasty in mortally obese patients | Winkins, R | JBJS B | 1998 | 182 | 9.1 | 16 |
| 86   | Infection of the surgical site after arthroplasty of the hip | Ridgeway, S | JBJS B | 2005 | 181 | 13.92 | 25 |
| 87   | The pathology of total joint arthroplasty—Ilb. Mechanisms of implant failure | Bauer, TW | Skeletal Radiology | 1999 | 181 | 9.53 | 9 |
| 88   | The influence of skeletal implants on incidence of infection—experiments in a canine model | Petty, W | JBJS A | 1985 | 181 | 5.48 | 9 |
| 89   | Treatment of acute achilles tendon ruptures—a meta-analysis of randomized, controlled trials | Khan, RJK | JBJS A | 2005 | 179 | 13.77 | 16 |
| 90   | Epidemiology of total knee replacement in the United States Medicare population | Mahomed, NN | JBJS A | 2005 | 179 | 13.77 | 22 |
| 91   | Factors influencing the incidence and outcome of infection following total joint arthroplasty | Poss, R | CORR | 1984 | 179 | 5.36 | 12 |
| 92   | Revision with gentamicin-impregnated cement for deep infections in total hip arthroplasties | Carlson, AS | JBJS A | 1976 | 179 | 4.7 | 1 |
| 93   | Postoperative superficial wound infection: a review of 2,391 consecutive index procedures | Weinstein, MA | JSD | 2000 | 178 | 8.98 | 17 |
| 94   | The swedish knee arthroplasty register—a nationwide study of 30,003 knees 1976 to 1990 | Knutson, K | AOS | 1994 | 178 | 7.42 | 1 |
| 95   | Perioperative testing for joint infection in patients undergoing revision total hip arthroplasty | Schinsky, Mark F | JBJS A | 2008 | 175 | 17.5 | 19 |
| 96   | Factors associated with prolonged wound drainage after primary total hip and knee arthroplasty | Patel, Vipul P | JBJS A | 2007 | 175 | 15.91 | 22 |
| 97   | Illocrural screw fixation: early complications of the percutaneous technique | Raut, MLC | JOT | 1997 | 175 | 8.33 | 18 |
| 98   | Predisposing factors for infection in spine surgery: a survey of 850 spinal procedures | Wimmert, C | JSD | 1998 | 173 | 8.65 | 14 |
| 99   | Treatment of open fractures of the tibial shaft with the use of interlocking nailing without reaming | Whitley, A | JBJS A | 1992 | 173 | 6.65 | 6 |
| 100  | Pyogenic non-tuberculous spinal infection—analysis of 30 cases | Diggik, JM | JBJS A | 1979 | 173 | 4.44 | 4 |

AJSM = American Journal of Sports Medicine, ACS = Acta Orthopaedica Scandinavica, CORR = Clinical Orthopaedics And Related Research, Eur Spine J = European Spine Journal, J Orthop Res = Journal of Orthopaedic Research, JBJS = Journal of Bone And Joint Surgery-American Volume, JBJS B = Journal of Bone And Joint Surgery-British Volume, JOA = Journal of Arthroplasty, JOT = Journal of Orthopaedic Trauma, JSAES = Journal of Shoulder And Elbow Surgery, JSD = Journal of Spinal Disorders.
3.3. Countries with no less 3 of the top 100 cited articles

As listed in Table 3, a total of 22 countries produced the top 100 cited papers. The United States was the most productive country with 75 articles, followed by England with 9 articles, Canada with 7 articles, France with 3 articles, Sweden with 3 articles and Switzerland with 3 articles. Moreover, the United States had the highest total citation times, mean citation times per year and mean citation times in 2016, France had the highest mean citation times per year.
3.4. Institutions and authors with no less than 4 articles of the top 100 cited articles

With respect to institutions (Table 4), Harvard University and Massachusetts General Hospital were both the most productive institutions with 6 articles, followed by Boston University, Brigham and Women’s Hospital, Hospital Special Surgery and The University of California San Francisco with 5 articles. As for authors (Table 5), Parvizi J, Katz JN, Losina E, and Mahomed NN were the most productive authors who published 5 articles.

3.5. Publication type and subspecialty of the top 100 cited articles

Regarding to the type of the top 100 cited articles, as shown in Table 6, 91 manuscripts in the form of “Article” and 9 manuscripts in the form of “Review” were totally cited 27,793 and 2738 times, respectively. The manuscripts in the form of “Article” had higher average citation times per article with 305.42 times than “Review” with 304.22 times. When considering the subspecialty, as listed in Table 7, surgery was the most popular subspecialty, with 74 articles, followed by Neurosciences/neurology with 16 articles and sport sciences with 3 articles. The articles in the subspecialty of surgery were with the highest total citation times, mean citation times per year and citation times in 2016. However, articles in the subspecialty of neurosciences/neurology had the highest mean citation times per article among aforesaid subspecialties.

4. Discussion

In our study, a significant increase was observed in the number of annual publications focusing on infection in orthopedics worldwide. Each of top 100 cited articles was cited more than 150 times. Total citation times were positively associated with citation times in 2016 and mean citation times per year. Conversely, age of the article was negatively associated with citation times in 2016 and mean citation times per year. Besides, citation times in 2016 was positively related to mean citation times per year. Journal of Bone and Joint Surgery American Volume was the most popular journal, the United States was the most productive country and surgery was the most popular subspecialty.
In this bibliometric analysis, the study entitled “Prevention of infection in treatment of 1000 and 25 open fractures of long bones—retrospective and prospective analyses” was the most popular article, which found that cephalosporin was the prophylactic antibiotic of choice to prevent the infection.[19]

The following reasons might account for the popularity of the study. First, this study was conducted in 1976. As is well known, articles published in earlier years were likely to be cited more frequently. Second, the severe wound and following surgery both might increase the risk of infection; therefore, infection caused by open fractures of long bones was a common and intractable problem for orthopedists. Third, the methodology of the study was scientific and strict, which guaranteed the reliability of the conclusion.

It is worth mentioning that our study first explored the relationships among total citation times, age of the article, mean citation times per article and citation times in 2016, which were not performed in previous studies.[12,14,18] We unexpectedly found that total citation times was not obviously associated with age of the article, which challenged the conventional viewpoint that earlier papers were more frequently cited.[20] The main reason might be that investigators paid more attention to the latest developments in this filed. In additions, another explanation for why classic papers were cited less frequently was that they had been absorbed and accepted into the body of current knowledge, therefore no longer being directly attributed to their source. Predictably, total citation times were significantly related to mean citation times per year in 2016. Our results also indicated age of the article was negatively associated with citation times in 2016, which might be explained with previous theory that peak citation usually occurred after articles were published for 3 to 10 years.

Journal of Bone and Joint Surgery American Volume had the largest number of paper, total citation times, mean citation times per year and citation times in 2016. Therefore, this journal was the most popular journal focusing on infection in orthopaedics. However, it should be noted that Clinical Orthopedics and Related Research had the highest citation times per article among top 6 journals, which demonstrated articles in this journal were of relatively higher quality. Other than that, Spine ranked third, indicating infection was also a problematic issue in spine surgeries. However, when assessing journals’ contribution, we should not ignore that those journals had different publication cycle time and circulation time. Shorter publication cycle time and longer circulation time were beneficial to increasing the citation times of articles. Furthermore, these journals were founded at different time, which also might affect the number of articles and citation times. It should be noted that none of the top 100 cited articles was published in 4 famous medical journals, including British Medical Journal, Journal of American Medical Association, Lancet and The New England Journal of Medicine. This phenomenon indicated that researchers focused on not only the impact factor but also the influence in their research field when choosing journals to publish their studies. Of course, several other factors might influence the selection process of target journal, including difficulty to be accepted, time from submission to acceptance, charges and so on, especially difficulty to be accepted.

The United States ranked first with 75 articles, which was far more than the other countries. This finding was accorded with other previous studies.[21–23] The United States had the highest total citation times, mean citation times per year and citation times in 2016. Besides, most of productive institutions and authors were in the United States. Overall, all this information supported that the United States made the greatest contribution to the developments of research on infection in orthopaedics. Besides, our study found that no developing country such as China was selected in rankings. Previous studies have proved that China made great contribution to the progress of several biomedical fields.[24,25] However, our results uncovered although developing countries such as China published a good deal of papers, the quality of many papers needed further improvement. Therefore, developing countries should try their best to improve the quality of articles in future.

To our knowledge, this study was the first bibliometric analysis to identify the top 100 cited papers focusing on infection in orthopaedics. And this study helped researchers to catch the scientific developments and promote the cooperation in this field. Nevertheless, our study was not without limitations. First,
citations time was not the “Golden Standard” when evaluating the importance of the research. The citation times could be easily affected by several factors, such as time of peer-review process and publication cycle. In recent years, increasing researchers suggested that the impact factor based on citation times should be optimized and even abandoned. Second, this bibliometric analysis was conducted based on WoS database, however, Google Scholar and Scopus were also frequently used to perform the bibliometric analysis, therefore, the results of our study might not be comprehensive. Third, despite of aforesaid methods, we could not guarantee that all retrieved articles exactly focused on this topic, which was an inherent weakness of all bibliometric analyses. Fourth, generally, joint replacement surgeries, degenerative spine surgeries, and infected non-unions were focused in clinical practice when discussing the infection in orthopedics, however, few publications concerned these topics among the top 100 cited articles. This phenomenon might be explained that many factors could affect the citation times of articles and then determine the top 100 cited articles. In spite of limitations, we believed this study could contribute to obtaining vital developments of infection in orthopedics and providing new insights into innovation in this field.

5. Conclusions

Infection in orthopaedics has attracted increasing researchers’ concern. As for the top 100 cited articles, there were significant relationships among total citation times, citation times in 2016 and mean citation times per year as well as age of the article. The United States was the most productive country, surgery was the most popular subspecialty and Journal of Bone and Joint Surgery American Volume was the most productive journal.

Author contributions

Guoxing Zhu designed the study; Guoxing Zhu and Yu Jiang conducted the statistical analysis; Yu Jiang and Renjing Hu wrote the manuscript; Guoxing Zhu revised the manuscript; All authors read and approved the final manuscript.

Conceptualization: Yu Jiang.

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