A Bibliometric Analysis and Visualisation of Research Trends in Toxicity of Nickel-implants

Gurpreet Thind [a]

[a] Department of Mechanical Engineering, Chandigarh University, Gharuan,Punjab,India. 140413

Article History: Received: 11 January 2021; Accepted: 27 February 2021; Published online: 5 April 2021

Abstract: Nickel is one of the most used metals for implants. The bibliometric analysis had been conducted to understand the active authors, organizations, journals, and countries involved in the research domain of "Toxicity of Nickel-implants". All published articles related to "Toxicity of Nickel-implants" from "Scopus", were analyzed using the VOS viewer to develop analysis tables and visualization maps. This article had set the objective to consolidate the scientific literature regarding "Toxicity of Nickel-implants" and also to find out the trends related to the same. The most active journals in this research domain biomaterial. The most active country was the United States of America and United Kingdom. The leading organization engaged in the research regarding the toxicity of Nickel implants was the Rush University Medical Center, United States of America. The most active author who had made valuable contributions related to the toxicity of Nickel implants was Hallab N.J.

Keywords: Toxicity, Nickel-implants, Material engineering, Bibliometric analysis, VOS viewer,

1. Introduction

An engineered medical device to replace a missing or damaged biological structure is known as an implant. Different types of metals and materials are used to create implants and the most popularly used metals and alloys for bio-implants are stainless steel, cobalt-chromium alloy, and various types of implants had been used in modern medicine and include sensory implants, neurological implants, cardiovascular implants, orthopedic implants, contraceptive implants, and cosmetic implants.

The major issues related to Nickel implants are the toxicity of the metal, failure of nickel implants, allergy or hypersensitivity, and corrosion of nickel implants. The various adverse effects of Nickel implants are described (Nwashindi and Dim, 2014). Similarly, several Nickel based alloys were being used for surgical implants (Cahoon and Hill, 1978)(Er and Unsaldi, 2013)(Li et al., 2014)(Marek and Treharne, 1982)(Mikhailov, 2002). Moreover there are several cases of Nickel implant failure (Averbeck et al., 2009). Material engineering and surface engineering play a very important role in providing solutions to diversified issues connected with toxicity and allergy, corrosion, and failure of Nickel-based implants (Nagaraja et al., 2017)(Ozkomur, Erbil and Akova, 2013). The toxicity of Nickel implants is a serious issue to be addressed for the safe usage of Nickel-based implants. Chances for postoperative hypernickelemia and nickeluresis should be counted in cases of the nickel-based porous-coated knee or hip prostheses (Sunderman F.W. et al., 1989). Increasing serum Nickel concentration after total hip replacement is another issue to be considered in cases of Nickel-based hip implants (Black et al., 1983)(Dahlstrand et al., 2009)(Hennig et al., 1992). Similarly, Nickel affects the tissues of hip joints (Brodziak-Dopierała et al., 2011).

Future research can be on research niches of researching on allergic issues due to Nickel-based implants, measures for reducing the toxicity of Nickel-based implants. Issues connected with corrosion and failure of Nickel-based implants are also equally important. This bibliometric analysis will be a useful platform for future researchers by realizing the top researchers, organizations, and countries involved in research regarding bio-implants. This article is arranged into four sections. The first section is the introduction, followed by the discussion of the methodology by which the research was conducted. The third section deals with results and discussion. The fourth section deals with the conclusion. The following research objectives and research questions were framed for conducting bibliometric analysis systematically.

1.1 Research Objectives

a) To consolidate the literature regarding the Toxicity of Nickel-implants
b) To find out the trends related to research in the Toxicity of Nickel-implants

1.2 Research Questions

a) Who are the active researchers working on the Toxicity of Nickel-implants?
b) Which are the main organizations and countries working on the Toxicity of Nickel-implants?
c) Which are the main journals related to the Toxicity of Nickel-implants?

2. Research Methodology

Scopus files had been used for this article. For the article selection, the Boolean used was TITLE-ABS (Toxicity Nickel-implants) on 28/02/2021. All the tables in this paper were created by using Microsoft Excel and VOS Viewer. Grammarly was used for spelling and grammar checks. Mendeley was used for article review and citation. This paper had been inspired by bibliometric analysis in its presentation style, analysis, and methodology

from the works (Farhat et al., 2013; Liao et al., 2016; Kolkailah et al., 2019; Rodríguez-Padial et al., 2019; Tran et al., 2019; Ullah et al., 2019; Shahid et al., 2020).

3. Results and discussion

3.1 Results

This first round of search produced an outcome of 60 documents, in 3 languages, out of which 58 documents were in English. The classification of document categories is shown in Figure 1. For improving the quality of the analysis, we had selected only the peer-reviewed articles and all other documents had not been considered. Thus after using filters "Article" and "English" the second round search produced an outcome of 35 English articles (both open access and others) and had been used to conduct bibliometric analysis and visualization using VOS Viewer. The English research articles in this domain since 1981 had been shown in Figure 2.

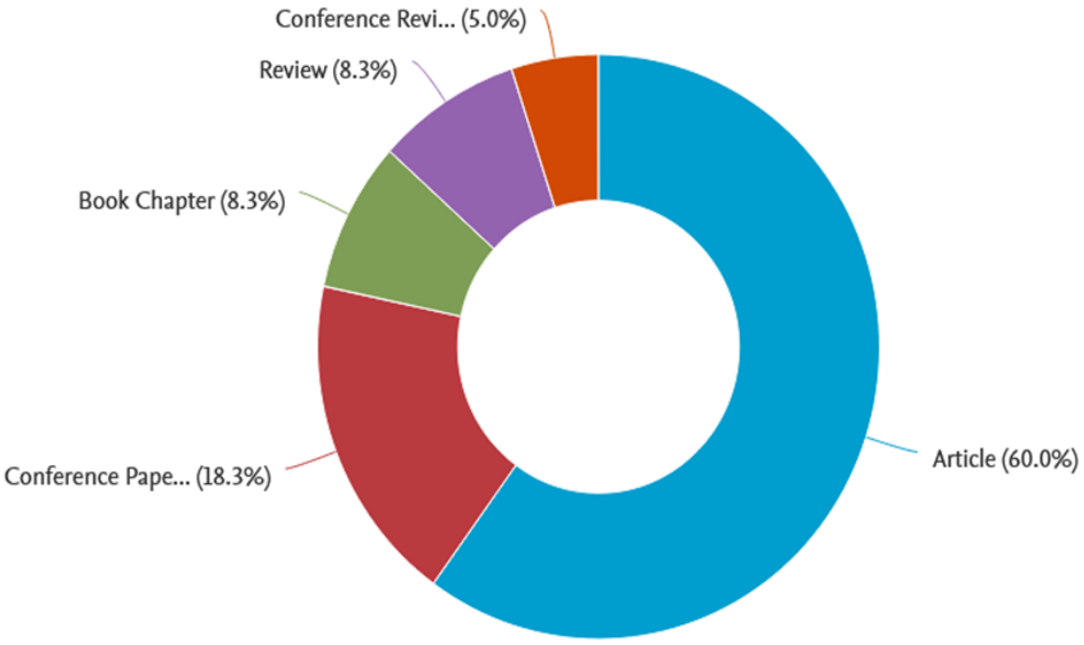

Figure 1: Classification of the documents on "Toxicity of Nickel implants", Source: www.scopus.com

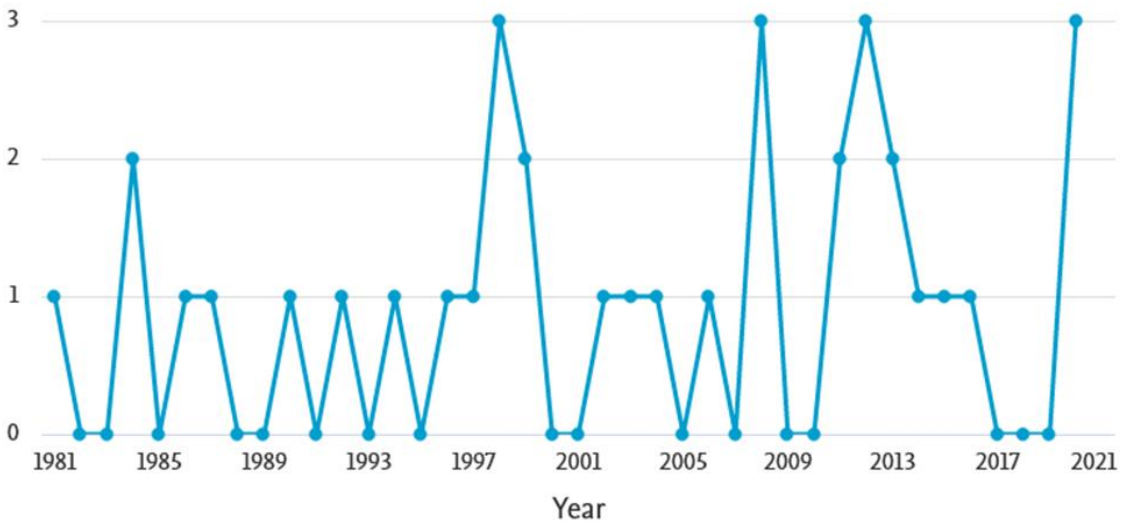

Figure 2: Period wise publication of articles, Source: WWW.scopus.com

Co-authorship analysis of top authors had been shown in figure 3. For a better presentation of the analysis, the parameters used were the minimum number of documents of an author as one and the minimum number of citations of authors as seventy-five. This combination plotted the map of 32 authors, in 6 clusters. The overlay visualization map of co-authorship analysis plotted in Figure 3, points out the major researchers with their strong co-authorship linkages and clusters involved.

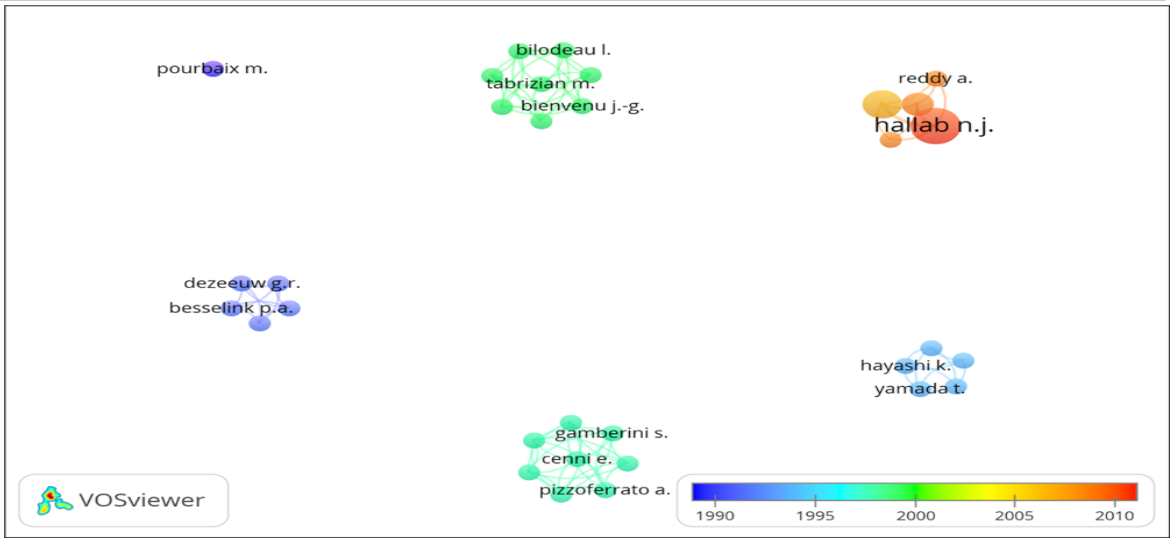

Figure 3: Co-authorship analysis on basis of authors

The citation analysis of top authors had been shown in table 1, along with co-authorship links. For the citation analysis, the parameters used were the minimum number of documents of an author as one and the minimum citations of an author as two

Table 1: Highlights of most active authors

Description	Authors	Documents	Citations	Average citations per documents	Link strength
Authors with the highest publication, citations, and co-authorship links	Hallab N.J	5	297	59.4	23

In Co-occurrence analysis, we had used all keyword analyses, by keeping the minimum number of occurrences of a keyword as seven. This combination plotted the map of 27 thresholds, in three clusters. The overlay visualization of co-occurrence analysis of keywords has been shown in Figure 4.

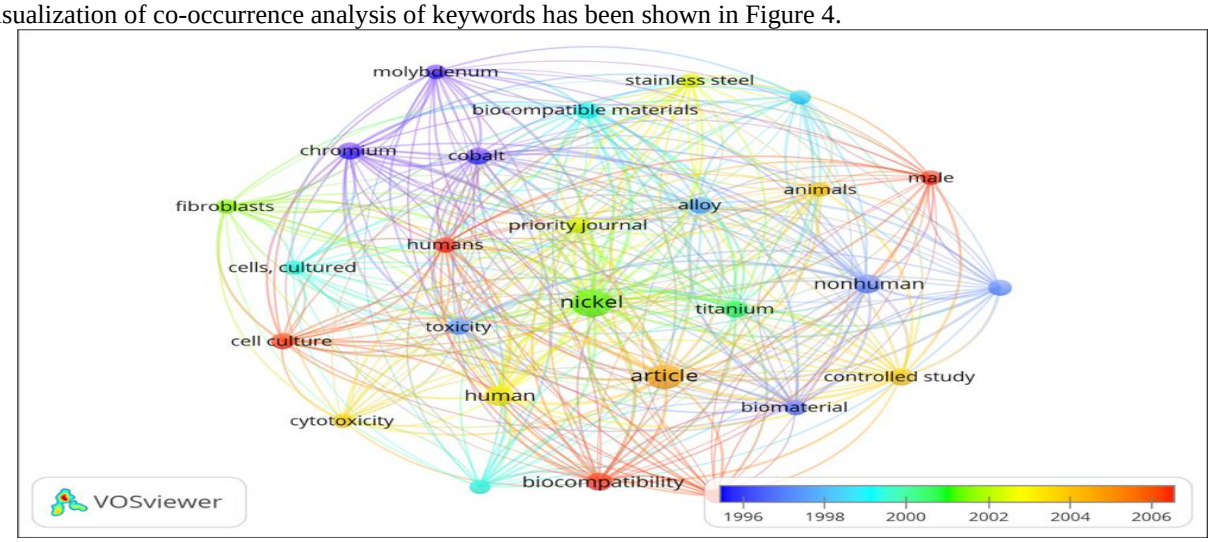

Figure 4: Co-occurrence analysis on basis of all keywords

The leading organizations engaged in research on “Toxicity of Nickel-implants” had been found out by the volume of publications and citation analysis, the parameters used are the minimum number of documents of an organization as one and the minimum number of citations of organizations as one. The leading organization in the research regarding “Toxicity of Nickel-implants”, with the highest number of publications and citations, was the Rush University Medical Center, United States of America (Refer to table 2).

Table 2: Highlights of the most active organization

Organizations	Country	Documents	Citations	Average Citations per document

Rush University Medical Center	United States of America	4	193	48.25

Co-authorship analysis of the countries engaged in the research on "Toxicity of Nickel-implants" had been shown in Figure 5. The overlay visualization map of co-authorship analysis plotted in Figure 5, points out the main countries with their strong co-authorship linkages and clusters involved.

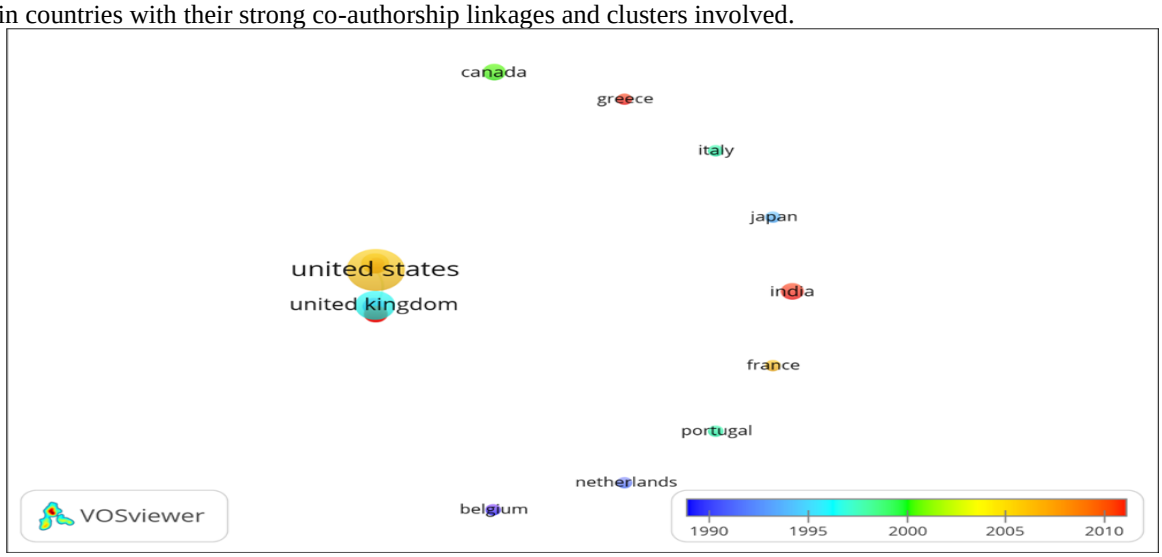

Figure 5: Co-authorship analysis on basis of countries

The citation analysis of top countries had been shown in table 3, along with co-authorship links. For the citation analysis, the parameters used were the minimum number of documents of a country as one and the minimum citations of the country as one.

Table 3: Highlights of Active Countries

Description	Country	Documents	Citations	Link strength
The country with the highest publication and citations	United States of America	13	439	4
The country with the highest co-authorship links	United Kingdom	6	224	5

The most active country in this research domain was the United States of America and the United Kingdom, with the highest number of publications, and citations; and co-authorship links respectively.

Link analysis and citation analysis were used to identify the most active journal in this research domain. We have taken the parameters of the minimum number of documents of a journal as one and the minimum number of citations of a journal as one for the link analysis and citation analysis. Highlights of the most active and relevant journals related to "Toxicity of Nickel-implants" are shown in table 4. Table 4 shows the journal activity of this research domain through parameters of publication volume, citations, and co-authorship linkages.

Table 4: Analysis of journal activity

Description	Journal details	Documents	Citations	Average citations per documents
Journal with the highest publications, citations, and links	Biomaterials	4	382	95.5

From the above discussion regarding the bibliometric patterns in the research regarding the toxicity of Nickel-implants, this research had observed a gradual increase in research interest regarding the toxicity of Nickel-implants from the starting of the millennium and the momentum is going on positively. This points out the relevance and potential of this research domain (Refer to Figure 2). The most active author in this research domain Hallab N.J with the highest publication, co-authorship links, and citations (Refer to table 1). The overlay analysis of top countries researching the toxicity of Nickel implantations indicates that the United States of America and United Kingdom was the leading country relating to the highest number of publications and citations; and co-authorship links respectively(Refer to figure 5). The top journals of this research domain were identified as the Biomaterials. From these wide sources of information, researchers can focus on top journals where they can identify the most relevant and highly cited articles regarding toxicity Nickel-implants.

4. Conclusion

The toxicity of Nickel-implant was an interesting research domain and the most active journal related to this research domain was the biomaterial. The most active country was the United States of America and United Kingdom. The leading organization engaged in the research regarding the toxicity of Nickel implants was the Rush University Medical Center, United States of America. The most active author who had made valuable contributions related to the toxicity of Nickel implants was Hallab N.J with the highest publication, co-authorship links, and citations respectively. This research domain offers a new avenue for researchers and future research can be on innovations in the toxicity of Nickel-implants.

References

1. Averbeck, M. et al. (2009) 'Resolution of both persistent eczema and implant failure following removal of nickel-containing implant', Journal of the European Academy of Dermatology and Venereology, 23(10), pp. 1215–1216. doi: 10.1111/j.1468-3083.2009.03120.x.
2. Baumann, C. A., and Crist, B. D. (2020) 'Nickel allergy to orthopedic implants: A review and case series', Journal of Clinical Orthopaedics and Trauma. Elsevier B.V., 11, pp. S596–S603. doi: 10.1016/j.jcot.2020.02.008.
3. Bibas, N. et al. (2013) 'Nickel-induced systemic contact dermatitis and intratubal implants: The baboon syndrome revisited', Dermatitis. Lippincott Williams and Wilkins, 24(1), pp. 35–36. doi: 10.1097/DER.0b013e31827cd32e.
4. Bjurholm, A. et al. (1990) 'the lymphocyte response to nickel salt in patients with orthopedic implants', Acta Orthopaedica. Informa Healthcare, 61(3), pp. 248–250. doi: 10.3109/17453679008993510.
5. Cahoon, J. R., and Hill, L. D. (1978) 'Evaluation of a precipitation-hardened wrought cobalt-nickel-chromium-titanium alloy for surgical implants', Journal of Biomedical Materials Research, 12(6), pp. 805–821. doi: 10.1002/jbm.820120604.
6. Er, Y. and Unsaldi, E. (2013) 'The production of nickel-chromium-molybdenum alloy with open-pore structure as an implant and the investigation of its biocompatibility in vivo', Advances in Materials Science and Engineering, 2013. doi: 10.1155/2013/568479.
7. Farhat, T. et al. (2013) 'Research in congenital heart disease: A comparative bibliometric analysis between developing and developed countries', Pediatric Cardiology, 34(2), pp. 375–382. doi: 10.1007/s00246-012-0466-6.
8. Grimalt, F. and Romaguera, C. (1980) 'Acute nickel dermatitis from a metal implant', Contact Dermatitis, 6(6), pp. 441–447. doi: 10.1111/j.1600-0536.1980.tb04992.x.
9. Kanerva, L. and Förström, L. (2001) 'Allergic nickel and chromate hand dermatitis induced by orthopedic metal implant', Contact Dermatitis. Blackwell Publishing Ltd, 44(2), pp. 103–104. doi: 10.1034/j.1600-0536.2001.4402096.x.
10. Kolkailah, A. A. et al. (2019) 'Bibliometric Analysis of the Top 100 Most Cited Articles in the First 50 Years of Heart Transplantation', American Journal of Cardiology. Elsevier Inc., 123(1), pp. 175–186. doi: 10.1016/j.amjcard.2018.09.010.
11. Li, J. et al. (2014) 'Low elastic modulus titanium-nickel scaffolds for bone implants', Materials Science and Engineering C, 34(1), pp. 110–114. doi: 10.1016/j.msec.2013.08.043.
12. Liao, J. et al. (2016) 'The most cited articles in coronary heart disease: A bibliometric analysis between 1970 and 2015', International Journal of Cardiology. Elsevier Ireland Ltd, 222, pp. 1049–1052. doi: 10.1016/j.ijcard.2016.08.002.
13. Marek, M. and Treharne, R. W. (1982) 'An in vitro study of the release of nickel from two surgical implant alloys', Clinical Orthopaedics and Related Research, No. 167, pp. 291–295. doi: 10.1097/00003086-198207000-00045.
14. Mikhailov, O. V (2002) 'Complexation of nickel(II) with dioxides in Ni2[Fe(CN) 6] gelatin-immobilized matrix implants', Russian Journal of Coordination Chemistry/Koordinatsionnaya Khimiya, 28(5), pp. 352–357. doi: 10.1023/A:1015573301672.
15. Nagaraja, S. et al. (2017) 'Current practices in corrosion, surface characterization, and nickel leach testing of cardiovascular metallic implants', Journal of Biomedical Materials Research - Part B Applied Biomaterials. John Wiley and Sons Inc., 105(6), pp. 1330–1341. doi: 10.1002/jbm.b.33630.
16. Nwashindi, A. and Dim, E. M. (2014) 'Adverse effects of nickel in transosseous wires and surgical implants: a literature review', Nigerian journal of medicine : journal of the National Association of Resident Doctors of Nigeria, 23(4), pp. 335–343. Available at: https://www.scopus.com/inward/record.uri?eid=2-s2.0-84922281652&partnerID=40&md5=86e299b4a50a9b4306ba60db91e593b4.
17. Ozkomur, A., Erbil, M. and Akova, T. (2013) 'Diamondlike carbon coating as a galvanic corrosion barrier between dental implant abutments and nickel-chromium superstructures', International Journal of Oral and Maxillofacial Implants, 28(4), pp. 1037–1047. doi: 10.11607/jomi.3091.
18. Rodríguez-Padial, L. et al. (2019) 'Trends and Bibliometric Impact of Research Grants of the Spanish Society of Cardiology/Spanish Heart Foundation (2007-2012) [Evolución e impacto bibliométrico de las becas de la Sociedad Española de Cardiología/Fundación Española del Corazón en el periodo 2007-2012]', Revista Espanola de Cardiologia. Ediciones Doyma, S.L., 72(12), pp. 1012–1019. doi: 10.1016/j.recesp.2018.08.013.

19. Rostoker, G. et al. (1986) ‘Dermatitis due to orthopedic implants [DERMATOSES D’INTOLERANCE AUX METAUX DES MATERIAUX D’OSTEOSYNTHESE ET DES PROTHESES (NICKEL-CHROME-COBALT)]’, Annales de Dermatologie et de Venereologie, 113(11), pp. 1097–1108. Available at: https://www.scopus.com/inward/record.uri?eid=2-s2.0-0022844691&partnerID=40&md5=87ed793d5522a1086f2cbbc9705409a4.
20. Shahid, I. et al. (2020) ‘Characteristics of highly cited articles in heart failure: A bibliometric analysis’, Future Cardiology. Future Medicine Ltd., 16(3), pp. 189–197. doi: 10.2217/fca-2019-0016.
21. Tran, B. X. et al. (2019) ‘The current research landscape of the application of artificial intelligence in managing cerebrovascular and heart diseases: A bibliometric and content analysis’, International Journal of Environmental Research and Public Health. MDPI AG, 16(15). doi: 10.3390/ijerph16152699.
22. Ullah, S. et al. (2019) ‘Publication trends of Pakistan Heart Journal: A bibliometric study’, Library Philosophy and Practice. University of Idaho Library, 2019. Available at: https://www.scopus.com/inward/record.uri?eid=2-s2.0-85072911351&partnerID=40&md5=c7b4ec3c78fbd1fed8e2e7890fdef688.