

# Review paper on Chromium and Cobalt based Implants in Biomedical Engineering

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## Abstract

Chromium and Cobalt are one of the most used metals for implants. The review analysis had been conducted to understand the active authors, organizations, journals, and countries involved in the research domain of “Chromium-cobalt-implants”. All published articles related to “Chromium-cobalt-implants” from “Scopus”, were analyzed using the Meta Analysis to develop analysis tables and visualization maps. This article had set the objective to consolidate the scientific literature regarding “Chromium-cobalt-implants” and also to find out the trends related to the same. The most active journals in this research domain were the Journal of Bone and Joint Surgery-Series A and Journal of Biomedical Materials Research. The most active country was the United States of America. The leading organization was the University of Pennsylvania of United States of America. The most active authors were Savarino and Maloney W.J

**Keywords:** Chromium-cobalt-implants, Material engineering, Review analysis, Meta Analysis,

## 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 Titanium (Priyanka *et al.*, 2014). 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. Rough surfaced implants have better bone anchoring and biomechanical stability (Le Guehennec *et al.*, 2007).

Cobalt-Chromium is a commonly used material, and used for diversified bio-implants including dental implants (Andreasen, 1968). The surface characteristics of Cobalt-Chromium alloys are unique and have the characteristics of more resistant to surface modifications and surface roughening. In short, Cobalt-Chromium is smoother with less plaque accumulation than Titanium implants (Herbst *et al.*, 2013). A study on hemo-compatibility evaluation of electrical discharge treated cobalt-chromium implants had come up with results that corrosion resistance and biological response can be significantly improved. Dihydrotestosterone improves the osseointegration of cobalt-chromium implants (Maus *et al.*, 2013). Selective laser melting additive manufacturing (AM) technologies can be used to fabricate complete-arch cobalt-chromium (Co-Cr) implant-supported prostheses.

However the implants made of cobalt-chromium are not free from short comings. The issues of toxicity are also associated with various types of cobalt-chromium implants, especially hip implants. Corrosion is another issue related to the cobalt-chromium implants (Cohen and Wulff, 1972) (Weightman, Zarek and Bingold, 1969). Surface modification can be a remedy against corrosion of cobalt-chromium implants.

This review 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 review analysis systematically.

## 1.1 Research Objectives

- To consolidate the literature regarding Chromium-cobalt-implants
- To find out the trends related to research in Chromium-cobalt-implants

## 1.2 Research Questions

- Who are the active researchers working on Chromium-cobalt-implants?
- Which are the main organizations and countries working on Chromium-cobalt-implants?
- Which are the main journals related to Chromium-cobalt-implants?

## 2. Research Methodology

Scopus files had been used for this article. For the article selection, the Boolean used was TITLE-ABS (Chromium-cobalt-implants). All the tables in this paper were created by using Microsoft Excel and Meta Analysis. Grammarly was used for spelling and grammar checks. Mendeley was used for article review and citation. This paper had been inspired by review analysis in its presentation style, analysis, and methodology from the works.

## 3. Results and discussion

### 3.1 Results

This first round of search produced an outcome of 111 documents, in eight languages, out of which 88 documents were in English. The classification of document categories is shown in Table 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 76 English articles (both open access and others) and had been used to conduct review analysis and visualization using Meta Analysis. The English research articles in this domain since 1974 had been shown in Table1. Co-authorship analysis of top authors had been shown in Table1. For a better presentation of the analysis, the parameters used were the minimum number of documents of an author as 3 and the minimum number of citations of authors as one. This combination plotted the map of 32 authors, in 11 clusters. The overlay visualization map of co-authorship analysis plotted in Table1, points out the major researchers with their strong co-authorship linkages and clusters involved. 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 one.

Table 1: Highlights of most active authors

| Description  | Authors     | Documents | Citations | Average citations per documents | Link strength |
|--|-------------|-----------|-----------|---------------------------------|---------------|
| Authors with the highest publication and co-authorship links | Savarino I  | 4         | 125       | 31                              | 26            |
| Authors with the highest citations                           | Maloney W.J | 2         | 425       | 212.5                           | 8             |

In Co-occurrence analysis, we had used all keyword analyses, by keeping the minimum number of occurrences of a keyword as 10. This combination plotted the map of 26 thresholds, in three clusters. The overlay visualization of co-occurrence analysis of keywords has been shown in Table2. The leading organizations engaged in research on “Chromium-Cobalt-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 “Chromium-Cobalt-implants”, with the highest number of publications and citations, was the University of Pennsylvania of United States of America(Refer to table 2).

Table 2: Highlights of the most active organization

| Organizations              | Country                  | Documents | Citations | Average Citations per document |
|----------------------------|--------------------------|-----------|-----------|--------------------------------|
| University of Pennsylvania | United States of America | 4         | 185       | 46.25                          |

Co-authorship analysis of the countries engaged in the research on “Chromium-Cobalt implants” had been shown in Table3. The overlay visualization map of co-authorship analysis plotted in Table3, points out the main countries with their strong co-authorship linkages and clusters involved. 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, citations, and co-authorship links | United States of America | 21        | 1316      | 5             |

The most active country in this research domain was the United States of America, with the highest number of publications, and citations.

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 “Chromium- Cobalt implants” are shown in table 4. Table 4shows 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 and citations | Journal of Bone and Joint Surgery-Series A | 6         | 834       | 2                               |
| Journal with the highest co-authorship links        | Journal of Biomedical Materials Research   | 5         | 89        | 5                               |

From the above discussion regarding the review patterns in the research regarding Chromium-Cobalt-implants,this research had observed a gradual increase in research interest regarding Chromium-Cobalt -implantsfrom 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 Table 2).The most active authors in this research domain were Savarino and Maloney W.J with the

highest publication and co-authorship links; and citations respectively(Refer to table 1).The overlay analysis of top countries researching Chromium Cobalt indicates that the United States of America was the leading country relating to the highest number of publications, citations, and co-authorship links(Refer to Table 5). The top journals of this research domain were identified as the Journal of Bone and Joint Surgery-Series A and Journal of Biomedical Materials Research From these wide sources of information, researchers can focus on top journals where they can identify the most relevant and highly cited articles regarding Chromium-Cobalt-implants.

#### 4. Conclusion

Chromium- Cobalt- implant was an interesting research domain and the most active journals related to this research domain were the Journal of Bone and Joint Surgery-Series A and Journal of Biomedical Materials Research. The most active country was the United States of America. The leading organization engaged in the research regarding Chromium-Cobalt-implants was the University of Pennsylvania of United States of America. The most active authors who had made valuable contributions related to Chromium-Cobalt were Savarino and Maloney W.J with the highest publication and co-authorship links; and citations respectively. This research domain offers a new avenue for researchers and future research can be on innovations in Chromium-Cobalt- implant.

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