Global Trends in Orthopedic Implant Research: A Qualitative Mapping of Article Metadata using Natural Language Processing and Machine Learning

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INTRODUCTION: In orthopedic research, keeping up with the latest trends in musculoskeletal injuries and diseases is crucial for improving patient health and mobility. However, bringing together basic, translational, and clinical research to address these issues may not always be feasible. With the advent of digitization, researchers can explore various trends and opportunities in the field and identify connections to extend their research. This paper presents an automated method for investigating comprehensive research trends in orthopedic research, focusing on hip implants as a basic model. Using [+]NLP-driven scientometric and bibliometric analysis, researchers can establish a strong foundation for their work by showcasing historical to state-of-the-art research trends across different countries. The abundance of scientific data available in orthopedic implant studies, is confirmed in the literature. This study aims to collate and organize the information available in the scientific literature from various article repositories, investigating global directions and trends in hip implant research. Furthermore, the automated system has discovered a group of typical metal *by products* linked with orthopedic implants and lead us to effective treatments for hematological malignancies or other biomedical applications.

METHODS: The study consists of four main phases. 1. Metadata extraction: The initial step involved identifying relevant keywords and defining a search query for metadata extraction using TDM API, such as the example ScopusSearch ('hip* AND ("implant" OR "prosthesis" OR "surgery" OR "orthoped*") AND ("tribocorrosion*") AND ("toxicity*") AND ("metal" OR "alloy*")). 2. Scientific web crawler: An automated system based on Python 3.10 was implemented to download scientific articles based on the search query obtained from step (1), which served as a significant source of literature data. 3. Data cleansing and curation: To ensure accurate interpretation of results, cleaning and organizing of metadata was necessary. Various Python 3.10 modules were deployed to organize the dataset and extract relevant information, such as ion releases from prostheses, their causes, and adverse effects. 4. Predictive modeling: The curated datasets are used to categorize and predict trends in the area of interest, such as tribocorrosion, THR, and the effects of metal ions in hematological malignancies.

RESULTS: After acquiring a total of 129,901 records, we were able to filter out and retain a final count of 40,915 unique records that aligned with our specific objective for data curation and information retrieval. To visualize the frequently researched areas in THR studies, we utilized a keyword-based network graph (Fig. 1), while the circular graph (Fig. 2) illustrated the most commonly occurring debris elements found in the human body resulting from events such as corrosion, rub, wear, fracture, and friction in implants. In Figure 3, the disadvantages associated with debris such as metal poisoning, systemic toxicity, and metallosis are presented, along with an examination of potential solutions to address these problems through the application of nanomaterials.

DISCUSSION: Our study highlights the significance of integrating [+]NLP and [+]ML techniques in orthopedic implant research. By utilizing bibliometric and scientometric methods, an end-to-end scientific mapping can be established for each topic, providing insights into the geography, organization, and key researchers in the respective subject area. Unlike traditional search engines that simply provide a list of literature, this approach enables the collection of all relevant articles with a single click, offers scientific insights, and assists in narrowing knowledge gaps. The presence of visual cues that showcase the relationships and interconnections between different nodes can serve as a catalyst for generating novel research ideas and pique interest in previously uncharted areas of study. Moreover, this automated methodology has the potential to aid researchers in efficiently sorting and aggregating copious amount of literary data, recognizing overarching themes and patterns in orthopedic implant research, and identifying areas where the current state of knowledge falls short, thereby unveiling opportunities for future exploration. In this case, the search query yielded a total of 40,915 records, which formed the basis for the visual depiction in Fig.1. A further drill down into the data enabled us to identify the most prevalent types of metal debris and potential underlying factors, as outlined in Fig.2. The analysis also revealed correlation between aforementioned metal debris and toxicity,tumor,nanocarrier usage (Fig. 3).

SIGNIFICANCE: Automating literature reviews can significantly reduce the amount of labor and time invested in conducting them. This adaptable technique can be customized to match the requirements of any research domain by selecting appropriate directions based on underlying hypothesis of the study.

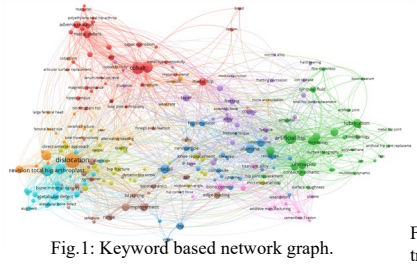

Fig.1: Keyword based network graph.

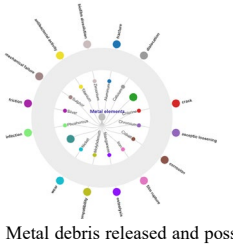

Fig. 2: Metal debris released and possible triggers.

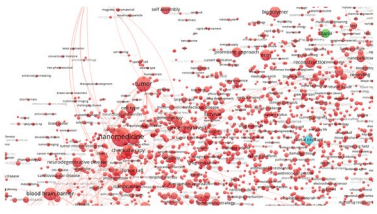

Fig.3: Network graph showing associations between toxicity, nanocarriers, tumor, etc.

REFERENCES:[1] Rose et. al, 2019, [2] Ampadi Ramachandran et al., 2023, [3] Shen et. al 2023.

[+Natural Language Processing, +Machine Learning]