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RECENT TRENDS IN NANOMEDICINE RESEARCH: A REVIEW ARTICLE

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Abstract

Nanomedicine, a term coined in the 1990s by the American engineers Eric Drexler (1955) and Robert Freitas Jr. (1952), can be defined as a complex, multidisciplinary branch of medicine in which nano-technologies, molecular biotechnologies, and other nano-sciences are applied at all stages of disease management, from diagnosis (nano-diagnostics) to treatment (nano-therapeutics), prognosis. Nanomedicine is a rapidly and exponentially growing, relatively young discipline marked by evolving ethical problems and implications. In hundreds of various sub-fields, Nanomedicine has branched out. A sample of 6696 papers was extracted and analyzed from PubMed/MEDLINE. In the period from 2003 to 2020, papers were published showing a growing pattern over time. There were four thematic clusters (first cluster: molecular methods; second cluster: molecular biology and nano-characterization; third cluster: nano-diagnostics and nano-theranostics; fourth cluster: clinical applications, nano-oncology, nano-immunology and nano-vaccinology sub-fields).

Keywords: *Applications, medicine, Nanomedicine, Nano, Papers.*

I. INTRODUCTION

Nanomedicine can be defined as a complex, multi-disciplinary branch of medicine in which nano-bio-technologies (including nano-technologies and molecular biotechnologies) and other nano-sciences are applied at all stages of disease management, from diagnosis (so-called nano-diagnostics) to treatment (nano-therapeutics), biological parameters and biomarker prediction and monitoring. "In the nineties, the term "nanomedicine" was coined by the American engineer Eric Drexler (1955) and Robert Freitas Jr. (1952), with the release in October 1999 of the multi-volume textbook entitled "Nanomedicine[1].

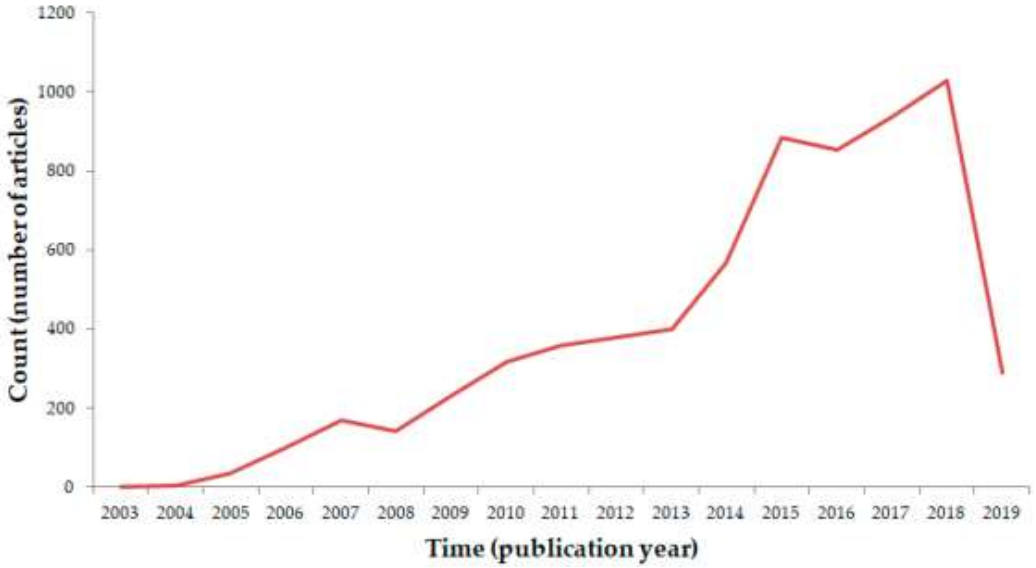

Fig. 1 Illustrates the publishing trend of papers in arena of nanomedicine[1].

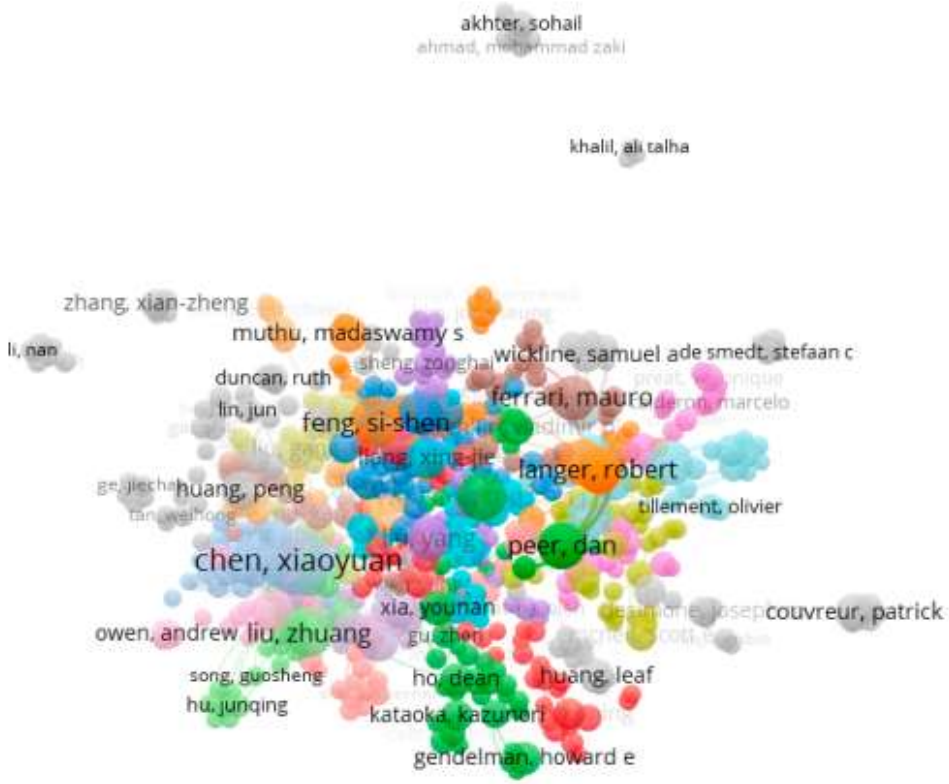

Fig. 2 Depicts the name of the authors doing research in nanomedicine[2].

A number of drug delivery platforms, including protein/polymer-drug conjugates, polymeric micelles, liposomal preparations, dendrimers, and inorganic metal nanoparticles, are used to formulate these drugs. New nano therapeutics are entering clinical trials every year with rapid

progress in this field[3]. As the status of clinical translation is essential to the science of nanomedicine and can guide future research directions, we strive to provide an up-to-date overview of all nano therapeutics in research. An enticing application of nanoparticle drug delivery is dual drug delivery with co-encapsulation of drugs in particles[4]. Optimal drug ratios and drug dose sequences can be established in vitro, but maintaining these spatial and temporal distribution characteristics in vivo at the cellular level is very difficult. Nanoparticles may be formulated to deliver drugs sequentially within the tumour microenvironment at precise molar ratios.

Number of Cluster	Number of Items Per Cluster	Topic
First cluster	279	Molecular methods
Second cluster	235	Molecular biology, nano-characterization
Third cluster	185	Nano-diagnostics and nano-theranostics
Fourth cluster	174	Clinical applications (nano-oncology, nano-immunology and nano-vaccinology)
Fifth cluster	118	Clinical applications (nano-oncology and nano-infectiology)
Sixth cluster	10	Nanodrugs

Table 1 Illustrates the number of clusters and number of items per cluster[5].

II. DISCUSSION

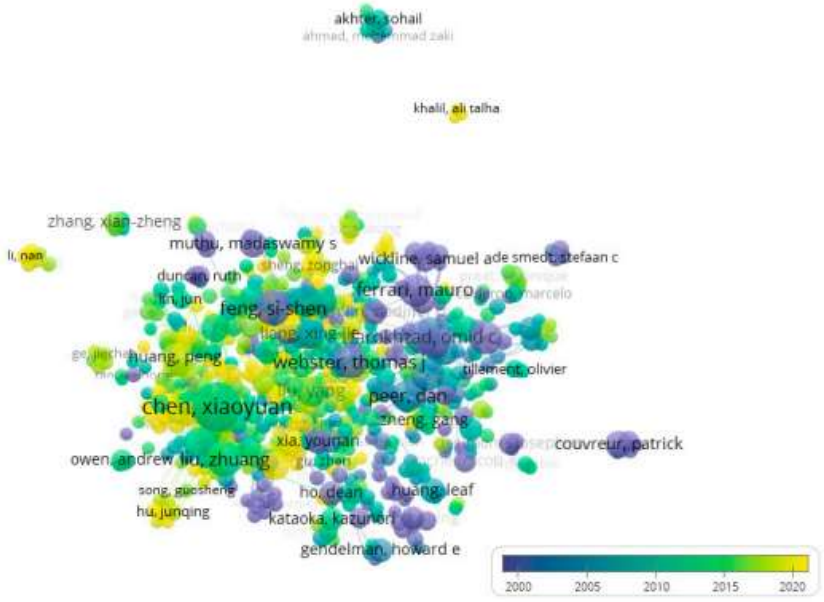

Fig. 3 Illustrates the colors represent the author's clusters based on co-authorship and publication year[6].

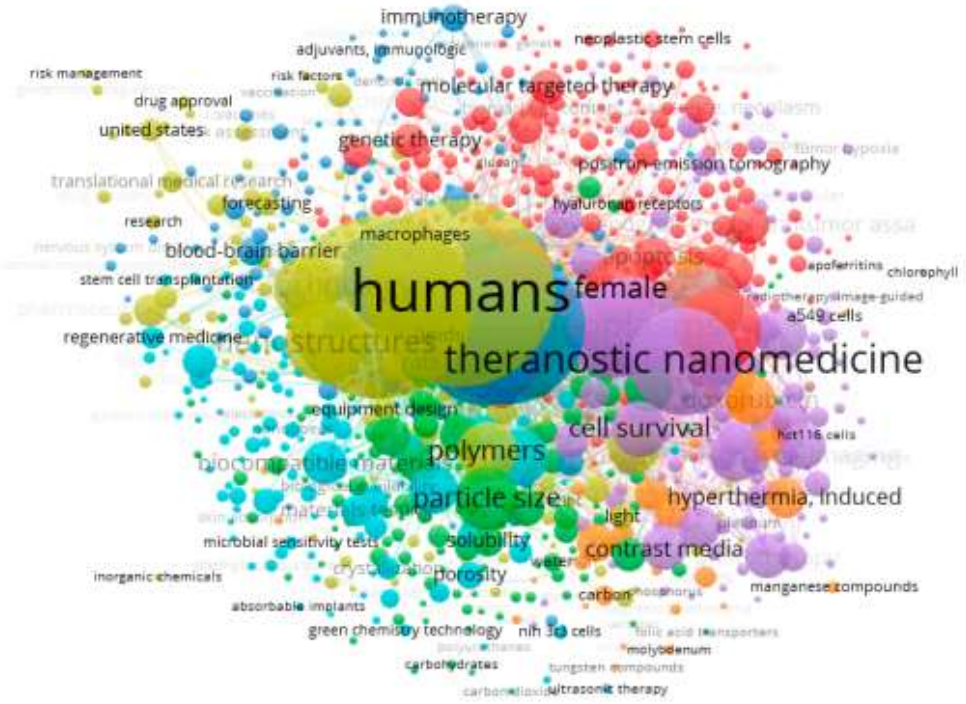

Fig. 4 Illustrates the topics addressed by inquiries in nanomedicine domain[7].

The current study has shown that publishing and conducting research in the super-specialty of nanomedicine is rapidly trending. The USA and European countries, with China as an emerging region, were the most active countries. Nano-diagnostics and nano-theranostics, and clinical applications in the sub-fields of nano-oncology and nano-infectiology, have become hot topics in recent years[3]. There are few scholarly articles on publishing developments related to nanotechnology and nano-science medical applications. Teles and collaborators focused on nanomedicine future promises for triple negative breast cancer (TNBC) management and treatment, mining the literature (Scopus database) from 2012 to 2017. Authors found that antineoplastic agents studied using in-vitro models, cell cultures, or animal models were the topic of most posts[8]. The "Michigan Cancer Foundation-7" (MCF-7) cell line was a hot research topic. Figure 1 illustrates the publishing trend of papers in arena of nanomedicine. Figure 2 depicts the name of the authors doing research in nanomedicine. Table 1 illustrates the number of clusters and number of items per cluster. Figure 3 illustrates the colors represent the author's clusters based on co-authorship and publication year. Figure 4 illustrates the topics addressed by inquiries in nanomedicine domain.

III. CONCLUSION

The current investigation has shown a rising trend in publishing and research in the nanomedicine super-specialty, with the United States and European countries as the most active settings, and

China as an emerging field. Nano-diagnostics and nano-theranostics as well as clinical applications in the sub-fields of nano-oncology and nano-infectiology have been topics that have drawn recent attention from the academic community. In view of the above limitations, however, further study in the field is warranted. Despite its strengths (robust methodology, high reproducibility), however, our study is not without any constraints. The search restricted to just one database (although PubMed/MEDLINE is the largest biomedical archive, with over 30 million papers, and the most frequently used database by researchers in the field) provides the main weakness. As such, further studies should be undertaken, including other similar repositories.

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