

Information mining in patent filings on injectable antineoplastics as a contribution to Health Policy

Mineração das informações depósitos de patentes sobre antineoplásicos injetáveis como contribuição à Política de Saúde

Minería de información en solicitudes de patentes sobre antineoplásicos inyectables como aporte a la Política de Salud

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Abstract

Introduction: According to data from the United Nations, cancer is the second leading cause of death in the world. Currently, information management has been increasingly difficult due to the large amount of data to be managed. In general, the databases that store patent documents make it possible to read them in full, but do not allow the extraction and treatment of large amounts of data. In this sense, it is necessary to use management software. **Objective:** To identify, extract, process the data, organize, and make available, in the form of graphical interfaces, the technological information on injectable oncology described in the current patents. **Methodology:** Patents deposited between January 2002 and July 2022 were analyzed using the ORBIT Intelligence® platform. In the “Advanced Search” field, the “Title, Abstract” filters were applied and the search terms: “injectable AND cancer” were used. **Results and Discussion:** 115 patent families were identified. The USA stands out in the number of patent documents filed, presenting a total of 56 documents. Inventors Ivan Edward Hofman, Farber Michael, Franco Rodriguez Guillermo and Gutierrez Aduriz Ibon were the most productive, each with 3 documents deposited. The institutions Bespoke Bioscience (USA), Immunocore Holdings (United Kingdom) and Mountain Valley MD Holding (Canada) stood out, each holding 3 documents. In the documents analyzed, the most recurrent technological domain went beyond the “pharmaceutical” technological domain, which obtained 109 documents and others such as chemical, biological, electrical, micro and nanotechnology. **Final Considerations:** The results obtained by mining the data extracted from patent documents proved to be efficient and, can be useful as an effective tool to analyze, compare and monitor research and innovation activities in injectable oncology.

Keywords: Cancer; Antineoplastics; Health information management; Health policy.

Resumo

Introdução: Segundo dados da Organização das Nações Unidas, o câncer é a segunda principal causa de morte no mundo. Atualmente, a gestão da informação tem sido cada vez mais dificultada devido à grande quantidade de dados a serem gerenciados. Em geral, as bases de dados que armazenam os documentos de patentes possibilitam sua leitura

na íntegra, mas não permitem a extração e tratamento das grandes quantidades de dados, sendo necessário, para tanto, o uso de software. *Objetivo:* Identificar, extrair, tratar os dados, organizar e disponibilizar, em formato de interfaces gráficas, as informações tecnológicas sobre oncológicos injetáveis descritas nas patentes vigentes. *Metodologia:* Foram analisadas as patentes depositadas entre janeiro de 2002 e julho de 2022 utilizando a plataforma ORBIT Intelligence®. No campo “Busca Avançada”, foram aplicados os filtros “Título, Resumo” e utilizou-se os termos de busca: “injectable AND cancer”. *Resultados e Discussão:* Foram identificadas 115 famílias de patentes. Os EUA se destacam no número de documentos patentários depositados, apresentando um total de 56 documentos. Os inventores Ivan Edward Hofman, Farber Michael, Franco Rodriguez Guillermo e Gutierrez Aduriz Ibon foram os que mais produtivos, cada um com 3 documentos depositados. Destacaram-se as instituições Bespoke Bioscience (EUA), Immunocore Holdings (Reino Unido) e Mountain Valley MD Holding (Canadá), cada uma titular de 3 documentos. Nos documentos analisados, o domínio tecnológico mais recorrente foi além do domínio tecnológico “farmacêutico”, que obteve 109 documentos e outros como setor químico, biológico, elétrico, micro e nanotecnologia. *Considerações Finais:* Os resultados obtidos pela mineração dos dados extraídos dos documentos patentários mostraram-se eficientes, e podem ser úteis como ferramenta eficaz para analisar, comparar e monitorar atividades de pesquisa e inovação em oncológicos injetáveis.

Palavras-chave: Câncer; Antineoplásicos; Gestão da informação em saúde; Política de saúde.

Resumen

Introducción: Según datos de Naciones Unidas, el cáncer es la segunda causa de muerte en el mundo. En la actualidad, la gestión de la información se ha vuelto cada vez más difícil debido a la gran cantidad de datos a gestionar. En general, las bases de datos que almacenan documentos de patentes permiten leerlos en su totalidad, pero no permiten la extracción y el tratamiento de grandes cantidades de datos, lo que requiere el uso de software. *Objetivo:* Identificar, extraer, procesar los datos, organizar y poner a disposición, en forma de interfaces gráficas, la información tecnológica sobre oncología inyectable descrita en las patentes vigentes. *Metodología:* Se analizaron las patentes depositadas entre enero de 2002 y julio de 2022 mediante la plataforma ORBIT Intelligence®. En el campo “Búsqueda avanzada” se aplicaron los filtros “Título, Resumen” y se utilizaron los términos de búsqueda: “inyectable Y cáncer”. *Resultados y Discusión:* Se identificaron 115 familias de patentes. EE.UU. destaca en el número de documentos de patente presentados, presentando un total de 56 documentos. Los inventores Ivan Edward Hofman, Farber Michael, Franco Rodriguez Guillermo y Gutierrez Aduriz Ibon fueron los más productivos, cada uno con 3 documentos depositados. Destacaron las instituciones Bespoke Bioscience (EE.UU.), Immunocore Holdings (Reino Unido) y Mountain Valley MD Holding (Canadá), con 3 documentos cada una. En los documentos analizados, el dominio tecnológico más recurrente fue más allá del dominio tecnológico “farmacéutico”, que obtuvo 109 documentos y otros como el sector químico, biológico, eléctrico, micro y nanotecnológico. *Consideraciones finales:* Los resultados obtenidos al extraer los datos extraídos de los documentos de patente demostraron ser eficientes y pueden ser útiles como una herramienta eficaz para analizar, comparar y monitorear las actividades de investigación e innovación en oncología inyectable.

Palabras clave: Câncer; Antineoplásicos; Gestión de información de salud; Política de salud.

1. Introduction

In the last decades, knowledge has been considered one of the most important resources of an organization, as it allows managers to take actions, at the organizational and individual levels, in a faster and more assertive way. The technological evolution that encompasses people, organizations and the world reach practically all activities and services, providing the rapid dissemination of a large volume of information in the most diverse media, mainly through the Internet (Rossetti & Morales, 2007). Due to the ease of access to the internet, most of the population now has access to technology and, therefore, to information. Currently, it is possible to carry out a range of activities and transactions from any device connected to the network, at any time and place (Rocha et al., 2012). Due to the various transformations dictated by the digital revolution, the economy is now oriented towards the digital world, which is a path of no return (Santos, 2022).

Technologies for handling Big Data make information spread faster, in real time. As a result, the reflexes of this accelerated process in the various work sectors, including health, are notorious, thus requiring scientometric and bibliometric studies that allow managers to have a panoramic view of essential information to support decision-making processes in a more assertive way (Magalhães et al., 2018).

Operating in a scenario of extreme complexity and constant changes, managers and professionals from different areas of knowledge are forced to quickly understand the phenomena that occur in the economic, political and social fields. In order to maintain the competitiveness of organizations, the management of state-of-the-art knowledge becomes increasingly important for decision-making.

Due to the large amount of data constantly available on the Web, the development of tools for their management is urgent. Technological prospecting, as an innovation strategy, allows government agencies or private companies to visualize new business possibilities, as well as map markets and competitors. Regarding the technological area, which is essential in any country development project, the need for prospective studies is undeniable (Amparo et al., 2012). Technological prospecting, through qualitative and quantitative methods, allows managers to assess the current scenario of a given sector, identifying the possibilities of using competing technologies, new opportunities for improvement, as well as the gaps to be filled, significantly influencing the industry, the economy or society (Teixeira, 2013). The proper use of technological prospecting can result in potentially disruptive products, services or technologies, which is why it is necessary to systematically monitor and evaluate innovations. In this context, we can mention patentometry as a tool for technological prospecting.

The patent is an official document and legally protects new inventions. Therefore, it can be considered a great incentive to technological development in a country. It is one of the richest sources of existing technological information, easily accessed in the various patent offices in the world and with unpublished data that are not available in any type of technical-scientific publication (Longa, 2007; Soares et al., 2010). Thus, it can be inferred that the number of patent filings reflects a country's level of investment in Research, Development and Innovation (R,D&I), both in public and private agencies. Both in academia and in sectors of the economy that work with R&D, patentometric analyzes and other technological prospecting tools are still underused, constituting an absolute novelty among researchers (Speziali & Nascimento, 2020). The state-of-the-art analyzes presented in these documents allow specialists from different areas of knowledge to have a panoramic view of the degree of technological maturity in their area, as well as to evaluate emerging technologies that could inspire or contribute to their research.

Regarding the pharmaceutical industry, the process that precedes the availability of the drug to society is long, including: i) *in vitro* tests in laboratory models, ii) pre-clinical and clinical studies and iii) submission of the registration request for analysis and approval by the regulatory health authority (Hanney et al., 2015). In this context, the patent protection of the drug or medicine becomes extremely necessary, to guarantee the return of the high investment in R&D and guarantee exclusive rights over them.

To facilitate the identification, extraction and processing of data in patent documents found in various patent offices around the world, software such as Orbit Intelligence®, Cortellis Competitive®, Patent Inspiration® etc. overview of a given technology. In the present work, the Orbit Intelligence® tool from Questel® was used, as it is one of the tools provided by Fiocruz for this type of study.

According to data from the World Health Organization (WHO), in the last two decades, the total number of people diagnosed with cancer practically doubled, from about 10 million in 2000 to 19.3 million in 2020. Studies also suggest that the number of people diagnosed with cancer in the coming years. An increase in the number of cancer deaths was also observed, from 6.2 million in 2000 to 10 million in 2020 (WHO, 2021).

Considering all the steps in the development of a new drug, the total time can exceed 10 years. In this context, the field of Oncology stands out in medicine, where the incorporation of new knowledge into clinical practice occurs dynamically (INCA, 2018). The process of innovation in oncology needs to be constant, due to the need for new drugs to circumvent the

resistance process acquired by tumor cells, as well as the constant discovery of new metabolic routes that lead to the emergence and maintenance of tumor cell activity (Al- Lazikani et al., 2012; Holohan et al., 2013).

The number of research, clinical studies and techniques to combat the disease is increasing. In Brazil, as an example of a developing country, the reference centers for cancer treatment are increasingly sought out and invited to participate in clinical research protocols (Equipe Oncoguia, 2015). Anticancer therapies currently available include chemotherapeutic agents, biologicals, molecular targeted therapy, radiation therapy, surgery and interventional oncology (Ramos et al., 2021; Sag et al., 2016). In addition to therapy with drugs that act directly against various types of cancer, other drugs are used to minimize toxicities caused by anticancer drugs: urinary protectors, antiemetics, corticosteroids and venous hydration, including, when indicated, red blood cell and platelet transfusions. , antibiotics and growth factors. (Matz & Hsieh, 2017; Oun et al., 2018).

In the pharmaceutical sector, the handling of injectable drugs is a complex activity. Injectable drugs have long been discussed for their success and importance in administration. However, the difficulty is based on the fact that they can impair and also improve the acquisition and retention of learned responses in the organism in which it was administered (McGaugh 1973). These drugs are not commercially available, with the possibility of personalizing the preparation to meet the specific needs of the patient: individualization of the dose, adaptation of the formulation to the route of administration, adding components to the formulation and choosing the type of diluent volume suitable for the patient's clinical condition (“ASHP Guidelines on Compounding Sterile Preparations”, 2014; Mohiuddin, 2020; Pergolizzi Jr et al., 2013). Regarding the handling of antineoplastic drugs, their correct handling is essential to ensure success in the treatment of cancer patients, as any error in dosage can lead to irreversible damage (ABRALE, 2020).

Based on the above, the present study presents an overview of how patentometry can help in the management of technological innovation in the area of injectable antineoplastics, through Big Data in cancer. In addition, it is intended to contribute to the management of public health policies, as well as to identify the world scenario in research and development of technology in injectable oncology for application in cancer therapy, considering the time span of 20 years.

2. Methodology

Patent analyzes were performed using the ORBIT Intelligence® platform (QUESTEL SAS – France). This database allows document searches in more than 100 patent offices, such as European Patent Office (EPO), World Intellectual Property Organization (WIPO), African Regional Intellectual Property Organization (ARIPO) and Eurasian Patent Organization (EAPO) (Santos et al. 2019). This tool has superior performance compared to other free databases, allowing the export and manipulation of data in various file extensions, in addition to having a greater number of connectors and truncation operators on its platform (Guerreiro et al. 2018).

In the literature, several techniques are found to carry out searches in databases. Among them, the most way approach is the search for keywords, which are chosen based on the knowledge of the researcher or specialist in a certain area of knowledge. Some measures can be used to search for keywords, such as using synonyms, using truncation operators, proximity or Boolean keys, matching saved search queries correctly, among others (Alberts et al. 2011). This way, in the “Advanced Search” field of the ORBIT Intelligence® platform, the “Title, Abstract” filters were applied and the search terms: “injectable AND cancer” were used. After extracting the documents, they were individually analyzed by reading the titles and abstracts to verify if the patent documents found fit the scope of the research. Patent documents deposited between January 2002 and July 2022 were identified and extracted.

3. Results and Discussion

A total of 233 patent documents were found. Of these, 118 documents had expired and 115 were still in force (82 had been granted and 33 were pending review). It was decided to analyze in this study only the patent documents that were still in force. Although the expired patent documents have not been analyzed, it should be noted that they are in the public domain and can be exploited for the development of new drugs, medicines or therapies, even by other countries that do not have the financial resources to work with R,D&I. Due to the period of secrecy of the patent application (an 18-month interval that exists between the filing of the application and its publication), it should be noted that the data presented in this work present a moment, due to the gap that exists between the updated information and the number of patents filed.

Figure 1 shows the distribution of patent documents deposits in the countries in the analyzed period. It was observed that the United States leads in the number of patent documents filed, with a total of 56 documents (48.70%). In second place was China with a total of 27 documents (27.48%). The Republic of Korea stands out next with 10 documents (8.70%), Australia with 9 (7.83%), France and the United Kingdom with 7 (6.09%), Japan with 6 (5.22%), India with 4 (3.48%), Canada, Spain and New Zealand with 3 (2.61%) and Brazil and Hong Kong with 2 (1.74%).

Figure 1. Worldwide distribution of patent document deposits comprising injectable antineoplastics between 2002 and 2022.



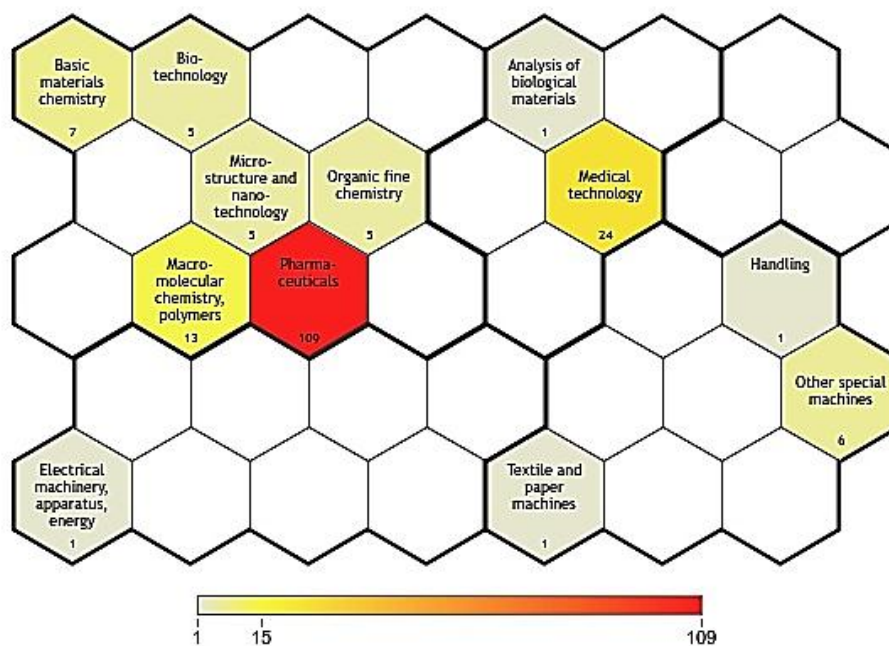
Source: Extracted by the authors, Questel Orbit (2022).

Regarding the continents, it is also observed that the American continent is the one that holds the largest number of patent documents deposited, with a total of 62 deposits (53.9%). Then comes the Asian continent with a total of 39 deposits (33.9%), Europe with 22 (19.1%), Oceania with 12 (10.4%) and, finally, Africa with 2 (1, 7%). These results indicate that patent documents involving injectable antineoplastics are concentrated in developed countries, possibly due to greater investments in the areas of research and development.

Figure 2 is a heat map of the technological domains found in the 115 patent documents. This map is based on the IPC (International Patent Classification) classification and shows the technological areas of greatest influence for the search terms, as well as the number of patent documents present in each technological domain. The closer the hexagon is to the red color, the greater the number of patents deposited in that technological domain. The IPC classification facilitates the search and

organization of patent documents, in addition to facilitating access to technological information (BRASIL, 2015). It should be noted that, since the technological domains are based on groupings of IPC codes, these patent documents may appear in more than one category.

Figure 2. Heat map of the technological domains present in the 115 patent documents comprising injectable antineoplastics between 2002 and 2022.

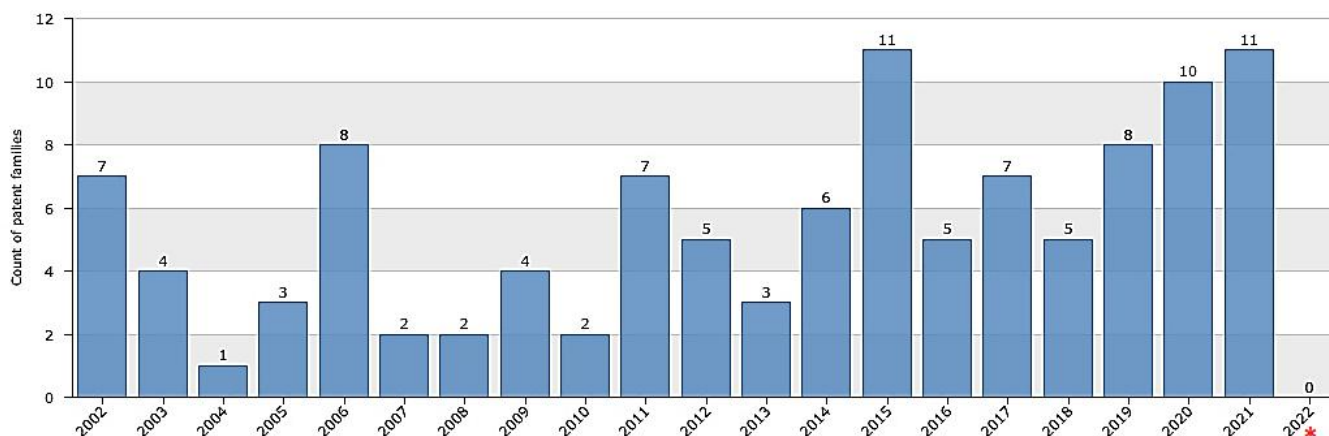


Source: Extracted by the authors, Questel Orbit (2022).

The technological domain that is most present in the analyzed patent documents is the “pharmaceutical” domain, appearing in 109 of them. Next, the technological domains stand out: “medical technologies” (24), “macromolecular chemistry, polymers” (13), “basic materials chemistry” (7), “other special machines” (6), “biotechnology” (5), “fine organic chemistry” (5), “microstructure and nanotechnology” (5), “electrical machinery, apparatus and energy” (1), “analysis of biological materials” (1), “textile and paper machines” (1), “manipulation” (1). Although some of the technological domains presented in the graph seem to be outside the area of the present study, their analysis revealed that they are technological innovations referring to the development of new techniques, materials or devices related to oncology. For example, in the field of “textile and paper machinery”, the patent document describes a methodology for the preparation and application of injectable nano-short fibers loaded with anticancer drug.

In the time period in which the patent documents were analyzed, a constant deposit of these was observed, with increases and retractions over the years, with emphasis on the years 2015 and 2011, in which 11 documents were deposited in both cases (Figure 3). Based on this graph, it can be inferred that the market for injectable oncology remains heated in relation to the development of new technologies in the area.

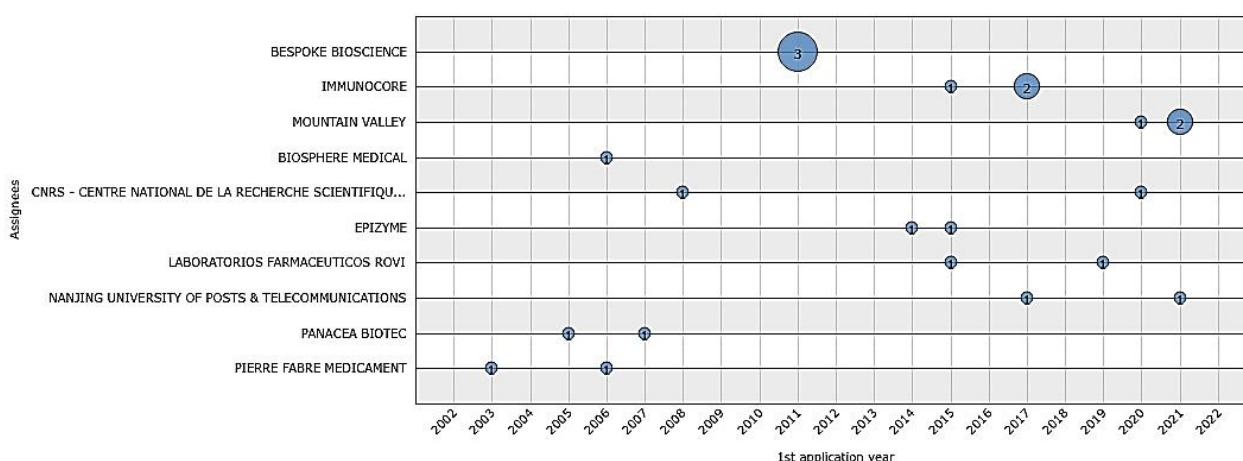
Figure 3. Evolution of patent families comprising injectable antineoplastics filed between 2002 and 2022.



Source: Extracted by the authors, Questel Orbit (July, 2022); *Patent applications filed in the last 18 months are confidential, therefore not listed in the search.

Of the 115 patent documents analyzed, the inventors Ivan Edward Hofman, Farber Michael, Franco Rodriguez Guillermo and Gutierro Aduriz Ibon stand out, each with 3 documents. Inventor Ivan Edward Hofman appears in 3 documents in 2011, with Bespoke Bioscience (USA) as depositor. Farber Michael appears in 1 document in the year 2020 and in 2 documents in 2022, with Mountain Valley MD Holding (Canada) as depositor. Inventors Franco Rodriguez Guillermo and Gutierro Aduriz Ibon appear in the same patent documents (2012, 2015 and 2019), being deposited by Laboratorios Farmaceuticos Rovi (Spain). Regarding the depositing entities, it is observed that Bespoke Bioscience, Immunocore Holdings (United Kingdom) and Mountain Valley MD Holding (Canada) were the institutions that most deposited these documents over the years, each with 3 documents (Figure 4).

Figure 4. Distribution of the amount of patent documents filed by depositor comprising injectable antineoplastics between 2002 and 2022.

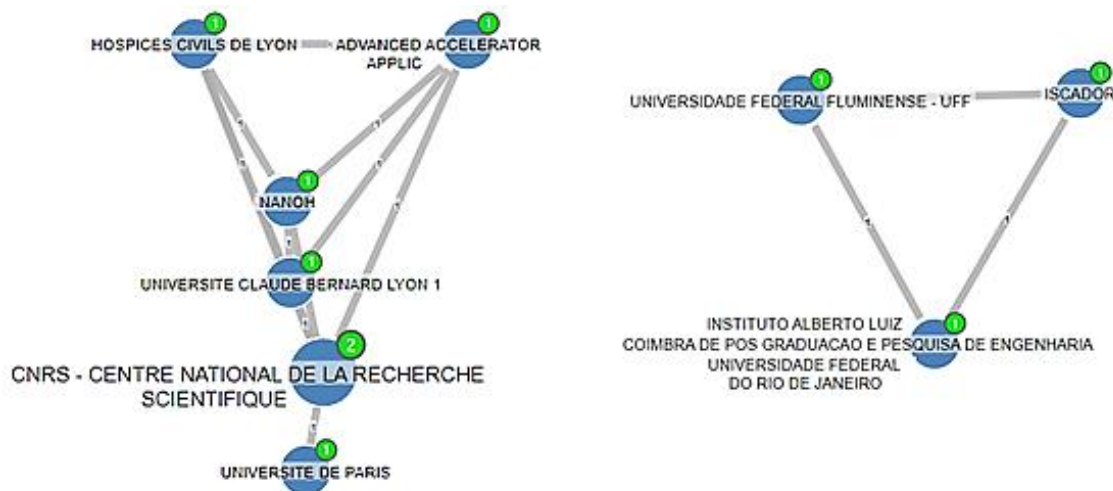


Source: Extracted by the authors, Questel Orbit (2022).

Figure 5 shows the main collaboration networks between the institutions holding the analyzed patent documents. Since hubs with few connections between depositing institutions were found, we chose to present in this work only those with at least two connections. This type of graph makes it possible to analyze research or commercial interactions and, therefore, map the technological competence of the subject studied, the so-called core business (Guerreiro et al. 2018). In this way, the

formation of collaborative networks becomes a competitive differentiator for institutions, as it enables the exchange of information and knowledge in research, which can generate new patentable technologies (Mahnken & Moehrle 2018).

Figure 5. Main collaboration networks for patenting containing injectable antineoplastics between 2002 and 2022.



Source: Extracted by the authors, Questel Orbit (2022).

Among the hubs represented, the one formed by French institutes (hub on the left) deserves mention, in which the Center National de la Recherche Scientifique (CNRS) was the institution that presented the most connections and deposited, in partnership, the largest number of patents (2). The hub on the right is made up of Brazilian institutes, with a maximum of two connections and 1 patent document deposited in partnership. In all cases, the hubs were formed between agencies in the same country, including hospitals, universities, technological institutes and companies.

4. Conclusion

From the analysis of the deposits of patent documents on injectable oncology between the years 2002 and 2022, a greater amount of these deposits was noted in the years 2011 and 2015, with a total of 11 documents in both cases. The number of deposits over the last twenty years indicates that the pharmaceutical area, such as injectable antineoplastics, is constantly evolving, being researched and developed by universities, hospitals, companies and technological institutes. In the current competitive scenario, universities end up becoming important partners for companies and constitute themselves as one of the main sources of knowledge for them. The university-company partnership is beneficial for both parties, as it contributes to the formation of good professionals and allows the company to have access to new research or technology, leveraging its innovation process. In this way, this partnership enables the development of new solutions and innovative products, capable of impacting the market.

Among the countries analyzed, the USA proved to be a leader in injecting oncology innovation, having deposited a total of 56 patent documents. Thus, it can be inferred that the US is the dominant country in this area, enabling it to achieve a competitive advantage over its competitors. Regarding the inventors who filed the most patent applications in the study area, the inventors Ivan Edward Hofman, Farber Michael, Franco Rodriguez Guillermo and Gutierro Aduriz Ibon stand out, having each filed 3 patent documents. Bespoke Bioscience (USA), Immunocore Holdings (UK) and Mountain Valley MD Holding (Canada) were the institutions that most deposited these documents over the years, both with a total of 3 documents. Regarding

the technological domains present in the analyzed patent documents, the “pharmaceutical” domain stands out, appearing in 109 of these.

Despite patent documents being one of the least mediatic indicators, it can be inferred that they are important sources of technological information and innovation, accurately and objectively reflecting the creation and dissemination of knowledge in a country's productive activity. The availability, constant updating and ease of access to information in these documents at patent offices, allow managers to monitor technological innovation in countries, as well as identify technological trends, investment opportunities and markets that should be prioritized. With regard to public health, the information made available in patent documents contributes to innovation in the sense of directing research to make the process more productive and assertive.

The information obtained in the present study highlights the importance of stimulating the culture of intellectual property in the most diverse sectors, whether public or private, encouraging the search for solutions in technologies that are already protected or through their improvement. Therefore, the systematic analysis of this information can support the discovery of new treatments or drugs for different types of cancers in a faster and more assertive way, thus avoiding wasted investment in the various funding bodies.

The results obtained by mining the data extracted from patent documents proved to be efficient at various institutional levels, as a contribution to health policies, and can be replicated in studies with other types of anticancer drugs, as well as in other areas of knowledge.

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