



Mapping Publications and Patents in Breast Cancer Immunotherapy

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Abstract

Objective: To analyse multi-source data including publications and patents, and try to draw the whole landscape of the research and development community in the field of immunotherapy for breast cancer.

Materials and Methods: Publications and patents were collect from the Web of science and databases of the top five patent offices of the world, respectively. Bibliometric methodologies and technology are used to investigate publications/patents, their contents and relationships.

Results: 1691 items published and 1861 patents from 1997 to 2016 including “immunotherapy for breast cancer” were retrieve. The top five countries in global publication and patents share were USA, Germany, Australia, Italy, and China. The universities and enterprises of USA had the highest amount of publication and patents.

Conclusions: The above results show that global research in the field of immunotherapy for breast cancer is increasing and the main participants in this field are USA and Canada in America, China, Japan and South Korea in Asia, and Germany, Italy, and France in Europe, and Australia in Oceania. In addition, this article demonstrates the usefulness of bibliometrics to address key evaluation questions and define future areas of research.

Keywords: Breast Cancer; Immunotherapy; Patents; Publications; Bibliometric

Introduction

Breast cancer remains a major public health problem. Currently, among all cancers, breast cancer is the most common cancer in women in both developed and developing countries [1-5]. According to GLOBOCAN estimates, more than half (52.9%) of 1.67 million new breast cancer cases were diagnosed in developing countries in 2012 [6].

The treatment of breast cancer has improved over recent years and has led to an increased survival rate for patients. Current clinical therapies for breast cancer are offer on an individual patient basis via a multidisciplinary team and comprise surgery, radiotherapy and drug therapies targeting oncogenic processes [7]. However, in recent years, immunotherapy it has been used as a viable treatment option [8].

Immunotherapy is a treatment modality in which antigen or monoclonal antibody is introduced to cause cancer cell death or slow the growth of the tumor. There are different approaches: peptide or protein vaccine, monoclonal antibodies therapy, and adjuvants therapy [9].

Furthermore, extensive research has been conducted to solve the problem of breast cancer, but the remedy remains uncertain. Faced with this dilemma, scientific research evaluation has as purpose monitoring of ongoing research initiatives to assess the efficiency and effectiveness with which they are being implement, and to determine the extent to which they are achieving their targeted objectives, and to recommend adjustments. On this premise, the present study was designed to determine the world share of publications and patents, in the field of immunotherapy for breast cancer from 1997 to 2016.

Materials and Methods

We used a keyword search approach to identity the “immunotherapy for breast cancer”- related publications and patents data from Web of Science and patent’s databases from United State Patent and Trademark Office, European Patent Office, State Intellectual Property Office of the People Republic of China, Japan Patent Office, Korean Intellectual Property Office and World Intellectual Property Office. In this study, Web of Science, which covering nearly all fields of science, was used to produce statistics on the

scientific production of immunotherapy for breast cancer. Immunotherapy articles and reviews, in the field of breast cancer, were downloaded for the 20 publication years, 1997 - 2016. In order to approximate the overall number of published items on breast cancer, the following search strategy was employed; TS = (immunotherap*) AND TS = [(breast invasive ductal carcinoma) OR (infiltrating duct carcinoma\$) OR (mammary ductal carcinoma\$) OR (breast cancer) OR (breast neoplasm\$) OR (breast tumor\$) OR (human mammary neoplasm\$) OR (human mammary carcinoma\$)]; where TS = Topic search, \$ = any character, *= two or more character. The same search strategic was performed in the Title/Abstract/Claims of the patent document. Additionally, the codes classification patents C07K16/00, CO/K16/3015, A61K39/00, and A61K39/395 were used.

Document information included numbers of years of publication, citation, origin countries, source journals, institutes and enterprises. The records were downloaded using Microsoft Excel software, and additional coding was manually performed for the above fields.

Results and Discussion

1691 items published and 1861 patent documents from 1997 to 2016 including “immunotherapy for breast cancer” were counted (Figure 1). A development trend was found for items published, which increased from 23 in 1997 to 185 publications in 2016. In addition, the development trend of patents had publication’s similar behaviour as a growth trend was observed from 15 in 1997 to 163 patents in 2016.

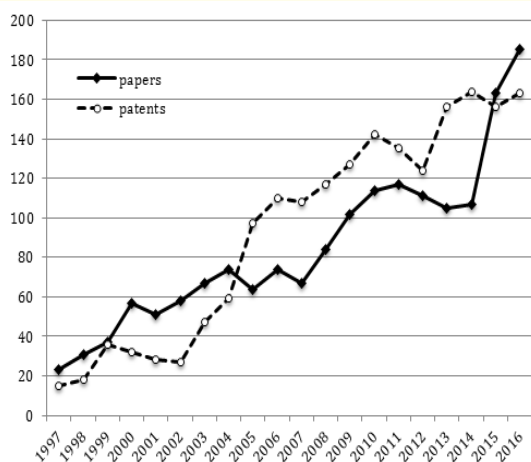


Figure 1: Publication and Patent Trend Distribution Analysis Based in “Immunotherapy for Breast Cancer”.

The global publication and patent share of top 10 most productive countries in immunotherapy for breast cancer is shown in (Figure 2), with USA occupying the first rank and contributing the largest publication share (47.96%), followed by Germany (9.87%), Italy (7.33%), China (7.04%), and France (5.62%). 1861 patent documents, the global patent share of top ten most productive countries is shown in Figure 2, with USA occupying the first rank and

contributing the largest publication share (37.24%), followed by Australia (3.06%), Japan (2.2%), England (6.88%), and Germany (1.72%).

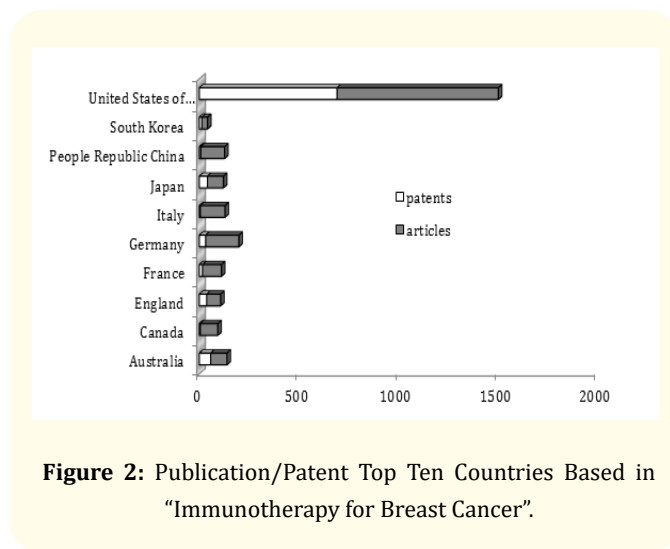


Figure 2: Publication/Patent Top Ten Countries Based in “Immunotherapy for Breast Cancer”.

The global publication share and global citation share of top 10 most productive countries in immunotherapy for breast cancer is shown in Table 1, with USA occupying the first rank with global citation share of 55.8%, followed by Germany (10.6%), Canada (6.3%), Australia (6%), England e Italy (5.3%), France, Netherlands, Japan, and China (from 5.2% to 3.4%). In terms of average citation per paper (ACPP), the first rank with ACPP of 45.56 was registered by Netherlands (40.62), followed by Australia (30.17), England (31.34), Canada (29.55), USA (28.27), Germany (26.08), France (22.46), Japan (19.1), Italy (17.58), (17.32) and China (11.58). Additionally, in terms of high-cited papers (HCP) (receiving 100 or more citations since the appearance of publication until the end of 2013), the largest (73) number comes from USA, followed by Germany (33), Canada (28), Australia (28), France (26), and England (26).

COUNTRY	TP	TC	SC	ACPP	HCP
United States of America	811	22929	55.8	28.27	76
Germany	167	4356	10.6	26.08	33
Italy	124	2180	5.3	17.58	25
People Republic China	119	1378	3.4	11.58	18
France	95	2134	5.2	22.46	26
Canada	88	2600	6.3	29.55	28
Australia	82	2474	6	30.17	28
Japan	80	1528	3.9	19.1	22
England	70	2194	5.3	31.34	26
Netherlands	53	2153	5.2	40.62	24

Table 1: Total Papers, Citations, Average Citation Impact per Paper and High-Cited Papers of 15 Most Productive Countries in “Gene Therapy for Breast Cancer”, 1997-2016. TP: Total Papers, TC: Total Citations, SC: Share Citations, ACPP: Average Citation Per Paper, HCP: High Cited Papers.

In total, 1691 articles were published in more 500 journals. Cancer Immunology Immunotherapy published the most articles with 98 articles comprising 5.79% of all the articles, followed by Cancer Research (4.49%), Journal of Immunology (3.13%), Breast Cancer Research and Treatment (2.9%), and Journal of Immunotherapy (2.72%).

The contributions of different institutes were estimated by the affiliation of at least one author. The top 10 organizations involved in “immunotherapy against breast cancer” are shown in Figure 3,

with University of California System occupying the first rank and contributing the largest publication share (3.37%), followed by National Institutes of Health NIH USA (3.25%), UTMD Anderson Cancer Center (2.95), National Cancer Institute (2.6%), and Institute National de la Sante et de la Recherche Medicale Inserm (2.54%). The Figure 3 also shows the top ten of assignees with patents. Genentech Incorporation is the leading assignee reporting 49 patents contributing 2.63%, followed by Arius Research Corporation (1.93%), Hoffman La Roche (1.55%), Abbott Laboratories (1.4%), and University of California (1.02%).

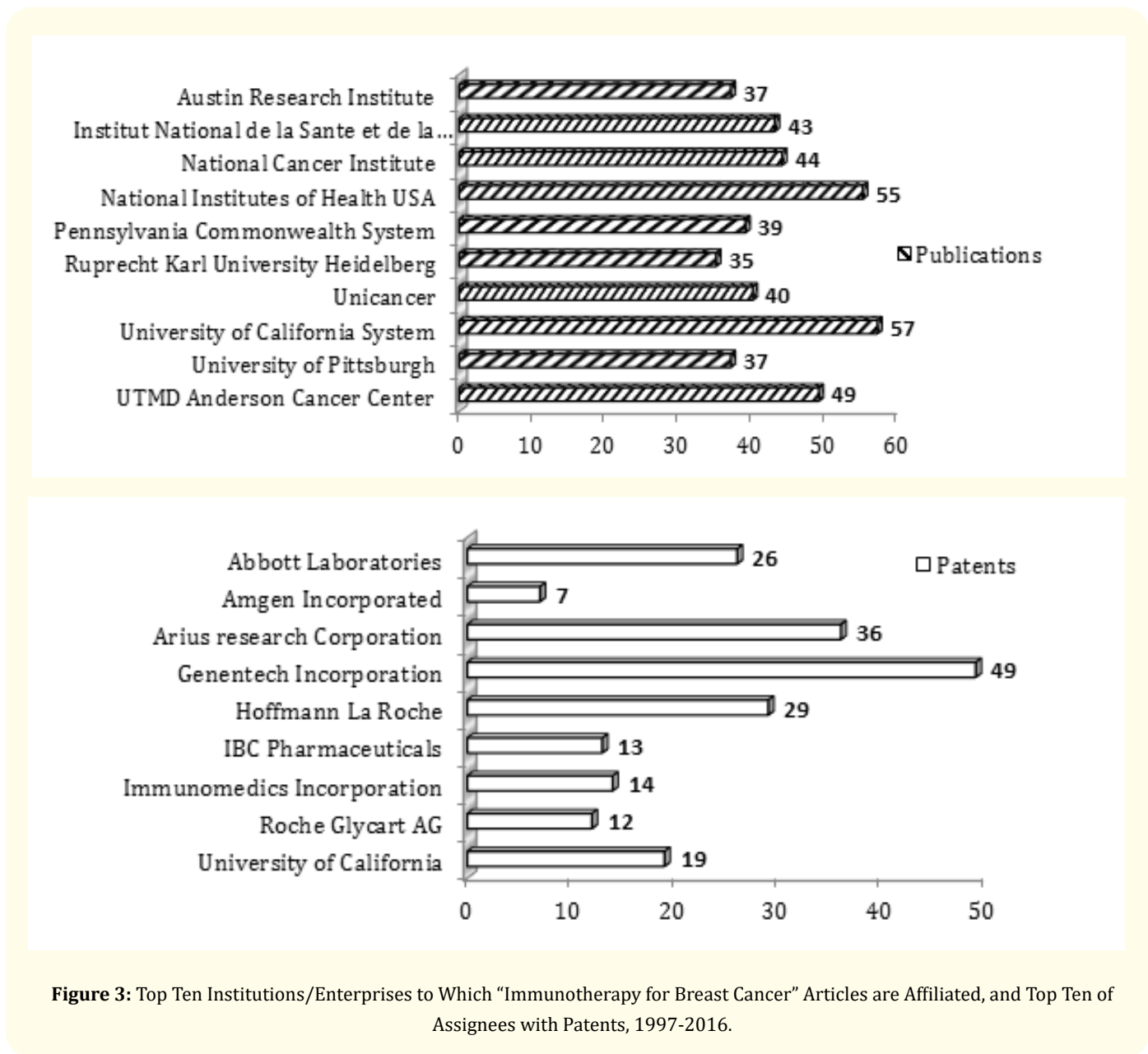


Figure 3: Top Ten Institutions/Enterprises to Which “Immunotherapy for Breast Cancer” Articles are Affiliated, and Top Ten of Assignees with Patents, 1997-2016.

Breast cancer research evaluation allows answering questions related to the performance of research to determine the extent to which they are achieving their targeted objectives, and to recommend adjustments.

This study analysed publications and patents in the field of immunotherapy for breast cancer and some important points about the trend of research in this field were obtained. Our findings suggest a growing interest in the field of immunotherapy for breast cancer as shown by the increased number of items each year.

Other different studies have examined several fields in breast cancer research. For example, the trends for breast cancer research have been addressed in several countries such as France [10], China [11], Mexico [12], Iran [13], India [14] and Portugal [15]. On the other hand, there is another study in the field of breast cancer diet, which shows that the main participating countries, including the US, are consistent with ten of the present study [16]. Additionally, a study of reconstructive breast surgery research shows a match between the same countries groups obtained in our study [17]. Similarly, Ha, *et al.* shows that USA is the leader in articles published in the field of breast cancer imaging research [18]. Finally, the results of another study on gene therapy for breast cancer show that the main producing countries of publications and patents are similar to those obtained in this study [19].

There are few studies based on data integration of research publications and patents, or any two of them. This work represents the first bibliometric assessment of immunotherapy for breast cancer research that includes publications and patents. The findings of this study should provide useful information for those who will be performing research and studying immunotherapy for breast cancer and for prospective models in the study of breast cancer [20].

Conclusion

This analysis has also demonstrated the leading role which the United States plays in immunotherapy for breast cancer research, due to the following: a) it is the largest producer of scientific papers, b) is the leading producer of patents, c) has eight of the ten major institutions/companies producing scientific articles, and d) has six of the top ten institutions/production companies of patents in the field of immunotherapy for breast cancer. The present study shows predominance in research and patents for the following countries: USA and Canada in America; China, Japan and South Korea in Asia; Australia in Oceania, and Germany, France, England and Italy in Europe.

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Conflict of Interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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