



Global patent landscape in breast cancer metastasis

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Abstract

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

Materials and Methods: Patents were collect from databases of the top five patent offices of the world. Patentometric methodologies are used to investigate patents, their contents and relationships.

Results: 6574 patents from 1998 to 2017 including “breast cancer metastasis” were retrieve. The top five countries in global publication and patents share were USA, Australia, China, Germany, and South Korea. The universities and enterprises of USA had the highest amount of patents.

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

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Introduction

Breast cancer is the most commonly diagnosed cancer in women, with 1.7 million new cases annually and 520,000 deaths globally [1], and metastasis to distant organs is responsible for ~90% of this death. Metastasis is the process by which breast cancer cells spread from the primary tumor to establish colonization at distant organs, such as the bone, lung, liver, and brain. It has been estimated that 85% of patients develop metastasis of bone [2], while 60-70%, 50% and 15-35% develop metastasis to lung [3], liver [4] and brain [5], respectively.

Extensive research has been conducted to solve the problem of breast cancer, but the metastasis solution still remains un-

certain. 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 implemented, and to determine the extent to which they are achieving their targeted objectives, and to recommend adjustments. Recently, publications trend on breast cancer-originated metastasis was determined; it is notable that the publications trend concerning bone metastasis was above the trend of lung metastasis, whereas the trends of liver and brain metastasis were very similar [6]. It is also important to emphasize that in the last years the production of research publications tries to fulfill the magnitude of the problem.



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However, trends regarding patents on metastasis in breast cancer have not been addressed. Therefore, the objective of this study is to identify recent patents of breast cancer metastasis that may have application in improving cancer treatment. In addition, a list of the most cited patents in this area is provided.

Materials and methods

We used a keyword search approach to identify the “breast cancer metastasis”- related patents data from 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 order to approximate the overall number of patent on breast cancer metastasis, the following search strategy was employed in the Title/Abstract/Claims of the patent document: (metast*) AND [(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 \$ = any character* = two or more character. Document information included numbers of years of publication, citation, jurisdictions countries, inventors, institutes and enterprises. The records were downloaded using Microsoft Excel software, and additional coding was manually performed for the above fields.

Results

6574 patent family documents from 1998 to 2017 including “breast cancer metastasis” were counted (Figure 1). A development trend was found for items published, which increased from 38 in 1998 to 663 patents in 2017. The global patent share of top 10 most productive countries in breast cancer metastasis is shown in Table 1, with USA occupying the first rank and contributing the largest patent share (2597), followed by Australia (1031), China (196), Germany (111), and South Korea (91). It should be noted that all countries, with the exception of Germany and Canada, grew every five years.

Additionally, Figure 2 shows the top ten of patent applicants. With the exception of Nerviano Medical Sciences (Italy) and Novartis (Switzerland), all the assignees are from the United States. Four are universities (University of Texas, University of California, University Johns Hopkins and Dana Farber Cancer Intitute) and one is a government entity (US Health). Likewise, top ten inventors are shown in Figure 3; with the exception of Sui Yi Kwok and Bing Lou Wong (both from Taiwan) all the inventors are from the United States. Flynn Daniel and Michael Kaufman work in Deciphera Pharmaceuticals, and Carl Illig, Jinsheng Cheng, Shelley Ballentine, Sanath Meegalla, Renee Desjarlais and Mark Wall work in Janssen Pharmaceutica.

On the other hand, main International Patent Clasification codes on breast cancer metastasis are shown in Table 2. Two IPC codes (A61P35/00 and A61P35/04) were relevant for drugs based on chemical compounds; one IPC code (A61K39/395) was relevant for oncology immunotherapy; and one IPC code (C12Q1/68) was relevant for testing processes involving nucleic acids.

The Table 3 shown the twenty top patents with the highest number of citations on breast cancer metastasis. Interestingly, of the twenty most cited patents twelve are chemical compounds, two of micro-RNA therapy, and one of immunotherapy. It also highlights that eight patents present protein kinases as

targets for drugs.

Discussion

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 analyzed patents in the field of breast cancer metastasis and some important points about the trend of research in this field were obtained. Our findings suggest a growing interest in the field of breast cancer metastasis as shown by the increased number of patent each year. USA, Australia, China, Germany and South Korea were the jurisdictions of most important countries in the subject. Likewise, US companies and their inventors were the most relevant. It should also be noted that, with few exceptions, US patents are among the most cited.

Since there are few studies that involve the subject of patents and breast cancer, a comparative analysis between countries and companies can not be carried out. However, since patents are generally linked to scientific publications, we can say that the behavior between countries in terms of patents is very similar to that of scientific publications. For example, there is one 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 [27]. Additionally, a study of reconstructive breast surgery research shows a match between the same countries groups obtained in our study [28]. Similarly, Ha., et al. shows that USA is the leader in articles published in the field of breast cancer imaging research [29]. The only study, to the knowledge of the author, that involves the behavior of different countries in terms of patents and breast cancer is that described by Anaya-Ruiz & Perez-Santos, which shows the behavior in patents about gene therapy in breast cancer [30]. This work represents the first patentometric assessment of breast cancer metastasis. The findings of this study should provide useful information for those who will be performing research and studying breast cancer metastasis and for prospective models in the study of breast cancer [31].

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Conflict of Interest

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

Figures

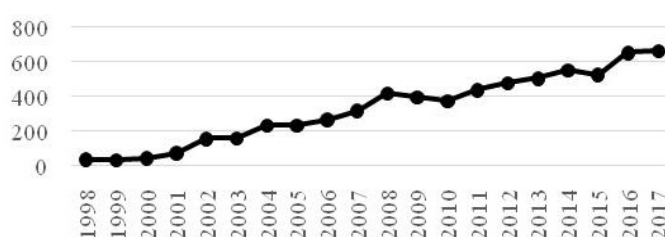


Figure 1: Patent trend distribution analysis based in breast cancer metastasis, 1998-2017.

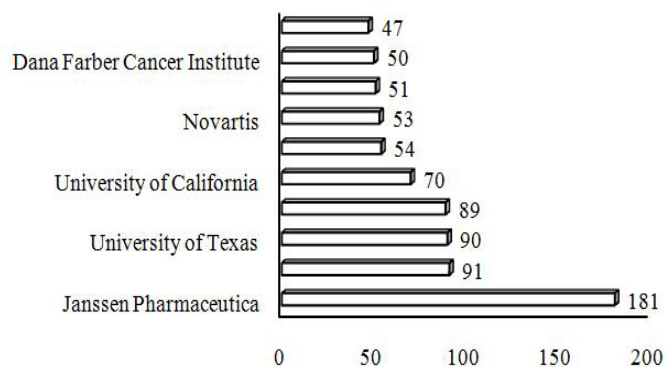


Figure 2: Top ten of applicants with patents on breast cancer metastasis, 1998-2017.

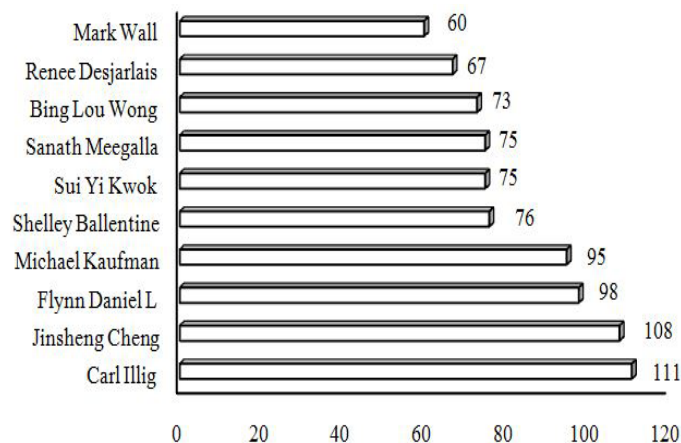


Figure 3: Top ten of inventors with patents on breast cancer metastasis, 1998-2017.

Table 1: Top ten countries with patents on breast cancer metastasis, 1998-2017.

Country	1998-2002	2003-2007	2008-2012	2013-2017	Total
USA	101	482	821	1193	2597
Australia	93	206	301	431	1031
China	0	8	69	119	196
Germany	1	11	51	48	111
South Korea	2	14	23	52	91
England	7	14	22	45	88
Canada	7	14	27	24	72
Japan	4	9	13	33	59
France	2	9	15	32	58
Switzerland	4	9	14	16	43

Table 2: Main International Patent Classification codes on breast cancer metastasis, 1998-2017.

IPC	Definition	1998-2002	2003-2007	2008-2012	2013-2017	Total
A61P35/00	Specific therapeutic activity of chemical compounds or medicinal preparations; antineoplastic agents	170	343	926	721	2150
C12Q1/68	Measuring or testing processes involving enzymes, nucleic acids or microorganisms; involving nucleic acids	91	238	378	382	1089
A61K39/395	Medicinal preparations containing antibodies	47	165	392	357	961
G01N33/574	Investigating or analysing materials by specific methods for cancer	85	200	234	334	853
A61P35/04	Specific therapeutic activity of chemical compounds or medicinal preparations; specific for metastasis	74	151	279	174	678

Table 3: Twenty main patents with the highest number of citations on breast cancer metastasis, 1998-2017.

<i>Patent</i>	<i>Title</i>	<i>Applicant</i>	<i>Inventors</i>	<i>Cites</i>
US6057105 [7]	Detection of melanoma or breast metastasis with a multiple marker assay	NGI Cancer Tech	Hoon et al	184
US20030198970 [8]	Genostics	Genostic Pharma	Roberts et al	176
US5985270 [9]	Adoptive immunotherapy using macrophages sensitized with heat shock protein-epitope complexes	University of Fordham	Srivastava et al	142
US6653301 [10]	Pyrazole compounds useful as protein kinase inhibitors	Vertex Pharma	Bebbigton et al	136
US20040077601 [11]	Methods and compositions relating to isoleucine boroproline compounds	Point Therapeutics	Adams et al	122
WO2010129053 [12]	EGFR inhibitors and methods of treating disorders	Dana Farber Cancer Institute	Gray et al	119
US20090203690 [13]	5-substituted indazoles as kinase inhibitors	Abbott Lab	Akritopoulou-Zanze et al	110
US6037129 [14]	Multi-marker RT-PCR panel for detecting metastatic breast cancer	University of Soutj Carolina	Cole et al	108
US20100029610 [15]	Heteroaryl compounds and uses thereof	Avila Therapeutics	Singh et al	106
US6291504 [16]	Acylsemicarbazides and their uses	Du Pont Pharmaceutical	Nugiel et al	98
US6100248 [17]	Method of inhibiting cancer growth	Golub et al	Golub et al	94
US20050148603 [18]	Compositions useful as inhibitors of protein kinases	Jimenez et al	Jimenez et al	89
WO2007016548 [19]	Micro-RNA-based methods and compositions for the diagnosis, prognosis and treatment of breast cancer	University of Ohio	Croce & Calin	86
WO2004016597 [20]	Protein kinase inhibitors and uses thereof	Vertex Pharma	Cochran et al	85
US20080076674 [21]	Novel oligonucleotide compositions and probe sequences useful for detection and analysis of non coding RNAs associated with cancer	Litman et al	Litman et al	81
WO2009140128 [22]	Compounds and compositions as kinase inhibitors	IRM	Albaugh et al	77
US20050137201 [23]	Compositions useful as inhibitors of protein kinases	Aronov et al	Aronov et al	75
US20050112630 [24]	Diagnosis, prognosis and identification of potential therapeutic targets of multiple myeloma based on gene expression profiling	Shaughnessy et al	Shaughnessy et al	75
US20100215743 [25]	Composition and drug delivery of bisphosphonates	Leonard TW	Leonard TW	72
US20100249092 [26]	Heteroaryl compounds and uses thereof	Avila Therapeutics	Singh et al	64

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