



## INSTITUTIONALIZATION PATTERNS IN BREAST CANCER IMMUNOHISTOCHEMISTRY

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### ABSTRACT

**Purpose:** The objective of the present study is to analyze scientometrically some essential patterns of the dynamic science institutionalization on breast cancer immunohistochemistry and to outline the most significant scientists, journals, scientific institutions conference proceedings in this interdisciplinary field.

**Material/Methods:** In December 2019, a retrospective problem-oriented, title-word based search was performed in *Web of Science Core Collection (WoS)*, *MEDLINE* and *BIOSIS Citation Index (BIOSIS)* of *Web of Knowledge* as well as in *Scopus* for 2003-2018. The following parameters were comparatively assessed: annual dynamics of publications, author's names, journal titles, scientific institutions, and scientific forums.

**Results:** There were 1187 publications abstracted in *WoS*, 776 publications abstracted in *BIOSIS*, 711 publications abstracted in *Scopus*, and 616 publications abstracted in *MEDLINE*. There were journal articles in 288 journals abstracted in *WoS*, in 234 journals abstracted in *MEDLINE*, in 156 journals abstracted in *Scopus*, and in 140 journals abstracted in *BIOSIS*. The most productive authors were David G. Hicks, Rohit Bhargava and Ian O. Ellis. The 'core' journals were *Modern Pathology*, *Laboratory Investigation and Cancer Research*. The most influential scientific institutions were the University of Texas System (USA) and the University of Texas MD Anderson Cancer Center (USA). The annual meetings of the US and Canadian Academy of Pathology and the Annual San Antonio Breast Cancer symposia were most attractive to the investigators worldwide.

**Conclusion:** Our comprehensive results could be of interest to breast cancer researchers and clinicians from smaller countries, institutional science managers, and journal editors.

**Keywords:** breast cancer immunohistochemistry, scientometrics, research institutionalization, data-bases

### INTRODUCTION

Breast cancer is a major public health concern worldwide, and its global incidence landscape is critical for primary prevention and disease burden reduction [1]. In recent decades, there has been a permanent interest in the applications of modern immunohistochemical methods in breast cancer patients.

In 720 women with breast cancer, lower leptin receptor immunohistochemical expression within the breast tumor microenvironment might contribute mechanistically to inter-individual variation in aggressive breast cancer clinicopathology, particularly estrogen receptor-negative status and triple-negative subtype [2]. The results from two large, multicentre, non-interventional studies in Germany demonstrate that reliable, high-quality human epidermal growth factor receptor 2-testing methods are essential for the selection of patients with human epidermal growth factor receptor 2-positive breast cancer for human epidermal growth factor receptor 2-targeted treatment [3].

The objective of the present study is to analyze scientometrically some essential patterns of the dynamic science institutionalization on breast cancer immunohistochemistry and to outline the most significant scientific institutions, scientists, conference proceedings, and journals in this interdisciplinary field.

### MATERIALS & METHODS

In December 2019, a retrospective problem-oriented, title-word based search was performed in *Web of Science Core Collection (WoS)*, *MEDLINE* and *BIOSIS Citation Index (BIOSIS)* of *Web of Knowledge* (Clarivate Analytics, Philadelphia, PA, USA) as well as in *Scopus* (Elsevier, Amsterdam, Netherlands) for 2003-2018. The following scientometric parameters of the publication output and citation activity were comparatively assessed: i) annual and total number of abstracted publications; ii) author's names and number of publications; iii) journal titles and number of publications; iv) country belonging and number of publications of scientific institutions, and v) titles of scientific forums and number of publications in their proceedings.

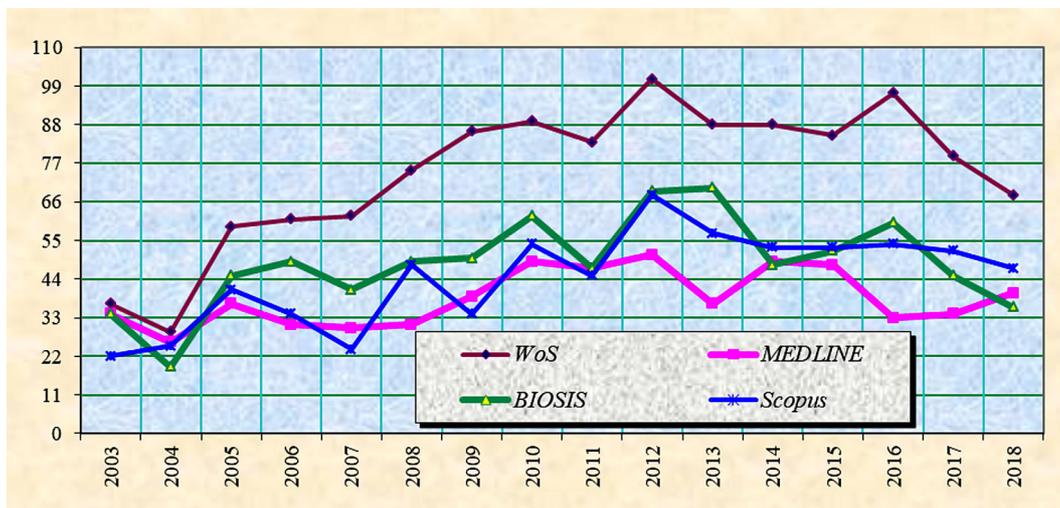
Some scientometric distributions only were demonstrated and briefly interpreted.

## RESULTS

There were 1187 publications abstracted in *WoS*, 776 publications abstracted in *BIOSIS*, 711 publications abstracted in *Scopus*, and 616 publications abstracted in *MEDLINE*. The annual dynamics of publications on the

topic abstracted in these databases is illustrated in Figure 1. A relatively constant publication output was evident as its reduction in 2018 was due to time lag between primary publishing and subsequent abstracting.

**Fig. 1.** Annual dynamics of the number of publications on the topic abstracted in four databases



Original journal articles prevailed in *Scopus* and *MEDLINE* and occupied a second place after meeting abstracts in *WoS* and *BIOSIS*, presenting with 562 articles versus 568 meeting abstracts and with 348 articles versus 421 meeting abstracts, respectively. There were 19 versus 20 congress proceedings (1.60% versus 2.81%) in *WoS* and *Scopus* only, respectively.

There were journal articles in 288 journals abstracted in *WoS*, 234 journals abstracted in *MEDLINE*, 156 journals abstracted in *Scopus*, and 140 journals abstracted in *BIOSIS*.

The names, countries of occupation and numbers of publications of the 12 most productive authors are displayed in Table 1. The USA prevailed among these five countries of researchers on this topic.

**Table 1.** Most productive authors on the topic in four databases

| Rank | Authors            | Country   | WoS | BIOSIS | Scopus | MEDLINE |
|------|--------------------|-----------|-----|--------|--------|---------|
| 1.   | David G. Hicks     | USA       | 22  | 12     | 10     | 8       |
| 2.   | Rohit Bhargava     | USA       | 20  | 17     | 6      | 8       |
| 3.   | Ian O. Ellis       | UK        | 20  | 14     | 12     | 13      |
| 4.   | L. C. Goldstein    | USA       | 18  | 11     | -      | 2       |
| 5.   | Allen M. Gown      | USA       | 17  | 13     | 3      | 4       |
| 6.   | David J. Dabbs     | USA       | 16  | 15     | 7      | 9       |
| 7.   | Andrew R. Green    | UK        | 14  | 10     | 10     | 10      |
| 8.   | Charles M. Perou   | USA       | 14  | 10     | 6      | 4       |
| 9.   | Torsten O. Nielsen | Canada    | 12  | 4      | 7      | 6       |
| 10.  | P. H. Tan          | Singapore | 11  | 7      | 5      | -       |
| 11.  | Jacek Jassem       | Poland    | 10  | 6      | 7      | 7       |
| 12.  | Ja Seung Koo       | Korea     | 10  | 7      | 9      | 5       |

The number of the articles published in the so-called 'core' journals containing most papers on the topic was listed in Table 2. These 12 top journals differed in single databases, and these differences were particularly manifested concerning *Scopus* and *MEDLINE*. The *American Journal of Clinical Pathology* contained 22 and 13 articles ab-

stracted in *MEDLINE* and *Scopus*, *BMC Cancer* - 11 and 19 articles, and *Anticancer Research* - 12 and 16 articles, respectively. In addition, in *MEDLINE*, there were 14 papers abstracted from *Breast Cancer* (Tokyo) and 12 papers from *Histopathology* and *Human Pathology* each, while in *Scopus*, there were 13 papers from *Archives of Pathology*

and *Laboratory Medicine* and 10 papers from the *British Journal of Cancer*, respectively. In *WOS*, 12 ‘core’ journals represented 4.17% of the journals and contained 50.08% of the publications, while in *BIOSIS*, they represented 8.57% of the journals and contained 63.02% of the publi-

cations on the topic. In *Scopus*, 12 ‘core’ journals represented 7.69% of the journals and contained 25.04% of the publications, while in *MEDLINE*, they represented 5.13% of the journals and contained 24.35% of the publications on the topic.

**Table 2.** ‘Core’ journals on the topic in four databases

| Rank | Journal title                           | WoS | BIOSIS | Scopus | MEDLINE |
|------|---|-----|--------|--------|---------|
| 1.   | <i>Mod Pathol</i>                       | 100 | 90     | 11     | 17      |
| 2.   | <i>Lab Invest</i>                       | 93  | 69     | 2      | 0       |
| 3.   | <i>Cancer Res</i>                       | 87  | 82     | 0      | 0       |
| 4.   | <i>Virch Arch</i>                       | 65  | 66     | 2      | 7       |
| 5.   | <i>J Clin Oncol</i>                     | 61  | 0      | 14     | 7       |
| 6.   | <i>Breast Cancer Res Treat</i>          | 55  | 55     | 19     | 15      |
| 7.   | <i>Ann Oncol</i>                        | 39  | 0      | 6      | 5       |
| 8.   | <i>Eur J Cancer (+Suppl)</i>            | 39  | 38     | 5      | 6       |
| 9.   | <i>Breast</i>                           | 25  | 20     | 12     | 10      |
| 10.  | <i>Appl Immunohistochem Mol Morphol</i> | 23  | 22     | 23     | 17      |
| 11.  | <i>BMC Cancer</i>                       | 19  | 0      | 19     | 11      |
| 12.  | <i>Histopathology</i>                   | 18  | 14     | 9      | 12      |

There were 16 specialized journals containing the terms ‘breast’ and ‘histochemistry’ in their titles (Table 3). They were attractive to scientists worldwide.

**Table 3.** Specialized journals with the terms of ‘breast’ and ‘histochemistry’ in their titles in four databases

| Rank | Journal title                           | WoS | BIOSIS | Scopus | MEDLINE |
|------|---|-----|--------|--------|---------|
| 1.   | <i>Breast Cancer Res Treat</i>          | 55  | 55     | 19     | 15      |
| 2.   | <i>Appl Immunohistochem Mol Morphol</i> | 23  | 22     | 23     | 17      |
| 3.   | <i>Breast</i>                           | 25  | 20     | 12     | 10      |
| 4.   | <i>Breast J</i>                         | 9   | -      | 9      | 9       |
| 5.   | <i>J Histochem Cytochem</i>             | 6   | 6      | 6      | 6       |
| 6.   | <i>Breast Cancer Res</i>                | 6   | -      | 6      | 7       |
| 7.   | <i>J Breast Cancer</i>                  | 6   | -      | 7      | -       |
| 8.   | <i>Breast Cancer</i>                    | -   | -      | 9      | -       |
| 9.   | <i>Breast Diseases</i>                  | -   | -      | 7      | -       |
| 10.  | <i>Clinical Breast Cancer</i>           | -   | -      | 6      | -       |
| 11.  | <i>Breast Cancer Tokyo</i>              | -   | -      | 5      | 14      |
| 12.  | <i>Breast Cancer Basic Clin Res</i>     | -   | -      | 3      | -       |
| 13.  | <i>Breast Care</i>                      | -   | -      | 2      | -       |
| 14.  | <i>Folia Histochem Cytobiol</i>         | -   | -      | 2      | -       |
| 15.  | <i>Acta Histochem Cytochem</i>          | -   | -      | 1      | -       |
| 16.  | <i>Breast Cancer Targets Ther</i>       | -   | -      | 1      | -       |

The ten most influential scientific institutions from four main countries as detected in *WOS* and *Scopus* were comparatively listed in Table 4. The researchers from the

USA dominated. There was intensive national and international collaboration between the scientists from these and other institutions worldwide.

Table 4. Most productive institutions on the topic in *WoS* and in *Scopus*

| Rank | Institution  | Country | <i>WoS</i> | <i>Scopus</i> |
|------|--|---------|------------|---------------|
| 1.   | University of Texas System                           | USA     | 35         | -             |
| 2.   | University of Texas MD Anderson Cancer Center        | USA     | 31         | 14            |
| 3.   | Unicancer  | France  | 31         | 6             |
| 4.   | University of British Columbia                       | Canada  | 29         | 11            |
| 5.   | University of Pittsburgh                             | USA     | 26         | 7             |
| 6.   | Pennsylvania Commonwealth System of Higher Education | USA     | 28         | -             |
| 7.   | University of Nottingham                             | UK      | 20         | 10            |
| 8.   | University of Toronto                                | Canada  | 19         | 9             |
| 9.   | University of North Carolina Chapel Hill             | USA     | 19         | 6             |
| 10.  | University of California System                      | USA     | 21         | -             |

The bibliometric characteristics of the scientific forums with abstracted publications on the topic in *WoS* and *BIOSIS* were demonstrated in Table 5. The scientific forums which had attracted the attention of most participants dur-

ing this period are indicated in Table 6. In *WoS*, 55 different forum titles presented with 132 unique events and contained 587 publications. In *BIOSIS*, these figures were the following: 42, 112 and 421.

Table 5. Bibliometric characteristics of scientific forums on the topic in *WoS* and *BIOSIS*

| Parameter  | <i>WoS</i> | <i>BIOSIS</i> |
|--|------------|---------------|
| number of forum titles                           | 55         | 42            |
| number of unique forums                          | 132        | 112           |
| number of publications                           | 587        | 421           |
| number of forums with a single event only        | 31         | 30            |
| percentage of these forums                       | 23.48      | 26.79         |
| maximal number of events of a unique forum       | 16         | 15            |
| maximal number of publications in a unique forum | 18         | 18            |

Table 6. Scientific forums with most events and papers in them on the topic in *WoS* and *BIOSIS*

| Scientific forum title   | <i>WoS</i> |        | <i>BIOSIS</i> |        |
|--|------------|--------|---------------|--------|
|  | events     | papers | events        | papers |
| Annual Meeting of the US and Canadian Academy of Pathology     | 16         | 167    | 15            | 147    |
| Annual San Antonio Breast Cancer Symposium                     | 10         | 79     | 13            | 101    |
| European Congress of Pathology                                 | -          | -      | 11            | 53     |
| Annual Meeting of the American Association for Cancer Research | 3          | 8      | 13            | 29     |
| Annual Meeting of the American Society of Clinical Oncology    | 10         | 20     | -             | -      |
| European Breast Cancer Conference                              | 6          | 16     | 7             | 18     |
| Congress of the European Society for Medical Oncology          | 5          | 16     | 1             | 6      |

## DISCUSSION

Our results convincingly proved the dynamic science stratification in this interdisciplinary field. It indicated the necessity of sharing the rich experience, gained by the eminent researchers, with their colleagues from the smaller countries worldwide.

According to an original scientometric concept, there is a unity of the institutionalization, interdisciplinarity and internationalization of contemporary science and university education [4, 5]. Along with the acknowledged problem-ori-

ented denominations of single institutions of different organizational type, the following essential components belong to science institutionalization defined as a historically established disciplinary organization of scientific and higher educational structures [5-7]: i) the organization of national and international scientific forums on a concrete interdisciplinary (or narrow-monodisciplinary) topic; ii) the regular publication of problem-oriented and narrow- or broad-profile inter- or monodisciplinary journals and monographs and their subsequent inclusion in secondary information sources

and databases; iii) foundation of national and international scientific societies and associations; iv) establishing of corresponding university departments and/or their subdivisions performing a regular students' education; v) introduction of postgraduate studies and preparation of doctoral dissertations; vi) introduction of the topic into university students' curricula, initially, in the form of extracurricular activity such as invited lectures delivered by experts from the same country and abroad, publication of textbooks and manuals, summer schools, etc.; vii) creation and subsequent dynamic development of corresponding paradigms or paradigm circles, etc.

Some newly-published investigations testify to the uninterrupted interest in science institutionalization worldwide.

The styles and spreads of global institutional research are quantified and visualized, as well as the shares of these efforts are measured [8].

Home to many of the oldest research universities and other organizational forms, such as academies and research institutes, Europe is at the heart of scientific productivity between North America and East Asia [9]. The neo-institutional analysis of a comprehensive historical database from 1900 to 2010 uncovers both, stable and dynamic, patterns of production and productivity in the fields of science, technology, engineering, mathematics, and health in Germany, France, Belgium, and Luxembourg and shows the varying contributions of different organizational forms, especially research universities and research institutes. Comparing the institutionalization pathways that create the conditions necessary for continuous and strong growth in scientific productivity identifies the research university as the key organizational form across countries.

Institutionalization framework elements such as nominal, leadership, administrative support, multi-year funding, research targets, formal researcher-to-researcher exchange, visibility, evaluation, and supporting characteristics, are examined in five cases studies of institutionalization framework, in order to explain the development of international university research ventures between US universities, on the one hand, and China and Singapore, on the other hand [10].

The institutionalization of the of Women's Studies Research Centre, Gauhati University in India [11], the institutionalization and professionalization of science policy in Portugal [12] and the stimulation of the institutionalized involvement of society, when accomplishing the policy in the fields of science, technology and innovations in Japan [13], are assessed. The development of the institutionalization of the university education systems in seven countries such as China, Japan, Germany, Qatar, South Korea, Taiwan, and the

USA) during the period between 1945 and 2015 is analyzed, and the expansion of the university education along with growing science dimensions is established [14].

A bibliometric analysis of the top 100 cited manuscripts in robotic surgery shows that 28 papers feature urological surgery, 15 deal with multiple surgical subspecialties, and 13 do with colorectal surgery [15-18]. The USA present the greatest number of publications (68 papers). Johns Hopkins University has published 18 papers.

Another analysis of the top 100 most cited articles among 4651 articles on recurrent glioma in WOS shows that the number of citations varies between 149 and 1471 [19]. Sixty-six articles are published in oncology-specific journals, and 67 are authored by institutions in the USA. Eighty-two papers deal with treatment, six - with genetic mechanisms, seven - with diagnosis, and five - with prognosis [20].

Between 2008 and 2017, a total of 835 hepatocellular carcinoma magnetic resonance imaging publications were identified in *WoS Core Collection* [21]. The *Journal of Magnetic Resonance Imaging* has published most articles (79 or 9.46%). South Korea has the most publications (199 or 23.83%), followed by the USA (190 or 22.75%), Japan (162 or 19.40%), and China (148 or 17.72%).

The institutionalization of neuroethics in Korea is an integral component of the Korea Brain Initiative within neuroscience research [22]. A historical case study of the institutionalization of laboratory work in Japan from the 1880s to the 1930s is performed [23]. A scientometric ranking of top Spanish public universities for 2019 is carried out [24]. The dynamic institutionalization patterns in the field of pediatric Crohn's disease are investigated [25]. The contributions made by Howard Wilcox Haggard for the institutionalization and consolidation of modern alcohol studies in twentieth-century post-Prohibition America are described [26, 27].

## CONCLUSION

Our study demonstrates the capacities of the constellation of scientometric indicators purposefully used for integrated assessment of science institutionalization under the conditions of internationalization in this advancing field. This complex scientometric methodology should become more popular in university curricula, especially within the research methodology courses for postgraduate students and young researchers [6]. It promotes comprehensive problem-oriented analyses and faces the challenges of the timely identification of the essential patterns of scientific advances in hot topics. Our results could be of interest to breast cancer researchers and clinicians from smaller countries, institutional and national science managers and journal editors as well.

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