Original Article

# Strategies for Prevention and Treatment of Peritoneal Fibrosis: A Scientometric Study


## Abstract

**Background:** Interest in using peritoneal dialysis (PD) shows global and national increase. However, it remains a challenge to prevent the progression of PD-associated fibrosis in clinical practice. Here, we assessed the status of scientific publications in prevention and management of PD-associated fibrosis in a scientometric study. **Methods:** We retrieved the bibliometric data by search terms "encapsulating peritoneal fibrosis," "treatment or prevention," and their synonyms in the Scopus databases until December 2, 2017. Data were analyzed using Scopus analysis tools, SPSS version 15 and Visualizing Scientific Landscapes viewer version 1.6.5. **Results:** Number of publications showed a steady significant increase ($P < 0.001$) reaching to 390 documents. Japan had the highest share (21.3%) followed by United Kingdom. Coauthorship network assessment assigned "Ikeda M." from Japan as the top author. The top source of documents was "Peritoneal Dialysis International." Most of documents were original articles focusing on prevention and management of malignant fibrosis of peritoneum (72.6%). The documents were cited totally 5636 times with average citations per article of 14.45, and relatively high *H*-index of 38. **Conclusions:** Despite the global increasing trend in scientific output in this field, contribution of our country is very small. Perhaps more national and international collaboration is required to encourage our researchers for producing more scientific products.


**Keywords:** *Bibliometric analysis, peritoneal fibrosis, preventive measures, therapeutics*


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## Introduction

Chronic kidney disease (CKD) is a worldwide major public health problem affecting 8–16% of adult population (almost 500 million individuals), from which more than 380 million individuals living in low and middle-income countries.[1]

CKD can progression toward end-stage renal disease (ESRD), in which patients need renal replacement therapy (RRT) in order to survive. Epidemiological studies show a worldwide ESRD increasing rate of ~6%.[2] In our country, the total number of patients with ESRD undergoing RRT is close to 50,000, which shows a huge growth compared to previous years.[3]

Currently, two modalities of transplant and dialysis, either hemodialysis or peritoneal dialysis (PD), are available for ESRD subjects. Because of numerous advantages of PD, this modality has an increasing rate, both nationally and internationally. Annual global growth rate of PD (8%) is even higher than hemodialysis. The number of patients receiving PD has been increased to 24.9 and 21.8 (p/mp) in developing and developed countries, respectively.[4] Accordingly, we observed a continuous increase in PD modality from 2001 to 2010 (to 4.1% from 0.5%) in our country.[5] Despite the advantages and also growing rate of PD, the most important challenge in clinic is to preserve peritoneal membrane filtration capacity. Repeated episodes of peritonitis and using the nonphysiological dialysis fluid are working in harmony and provoking the activation of various inflammatory, fibrogenic, and angiogenic cytokines in the peritoneal tissue with final outcome of peritoneal fibrosis, dialysis efficacy loss, ultrafiltration failure, and drop out. If no preventive strategy applied, patients may develop encapsulating peritoneal sclerosis (EPS) which is a dangerous malignant fibrosis of membrane with high mortality.[6]

At present, clinically available strategy for prevention and treatment of peritoneal fibrosis and membrane dysfunction are



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limited. However, new pharmacological strategies to better control the peritoneal infection and diminish the inflammation are emerging.[7,8] It is noticeable that due to its relatively new concept, the scientific and quantitative description of publications in this matter is lacking. The scientometric analysis is increasingly used for identifying the scientific advancements and directions in a specific field. In addition to help to reliably identify centers of excellence and influential authors, scientometric analysis can give us a prevision of fund assignments and subsequent research design as it will predict how this field will move forward. Therefore, for the first time, we performed an analytical approach in scientific production in field of management and prevention of peritoneal fibrosis in order to identify the research areas and thematic maps of this field. We specifically aimed to explore the way that papers from Scopus web in this field been distributed across documents genres, institutions, countries, and knowledge domains and also to explain the overtime changing distribution pattern of produced papers.

We believe that exploring these issues is important for both researchers, as enabling them to conduct studies with strong evidences based on highly cited articles, and scientists since it allows them to design appropriate prevention programs based on trends studies.

Providing these information could yield a general road for future research strategic planning in this field.[9] Moreover, quantitatively comparing of research products in our country to other regions could give us an idea of how this research field is performing in our country.

## Materials and Methods

### Data collection

Data provided in this study are based on data obtained from Scopus web database. Following search terms were used: "(TITLE-ABS-KEY ((encapsulating AND (peritoneal OR peritonea) AND (fibrosis OR fibrosing OR fibroses OR sclerosis OR scleroses))) AND TITLE-ABS-KEY (management OR therapy OR treatment OR prevention)." The search was performed on December 2, 2017 and all the available, relevant scientific publications in assessed field were included. There were no restrictions based on type or language of articles. After excluding unrelated papers, remaining 390 documents were analyzed using Scopus-analyzing tool.

### Data analysis

Included articles were analyzed based on total number of publications, publication year, subject area, main sources, author's name and institution, document's type and language, and citation number. The journal impact factor (IF) was evaluated using the Journal Citation Report (Web of Knowledge) 2016 Science Edition by Thomson Reuters (New York, NY, USA). Also, *H*-index, and the *H*-graph, as the measure of research performance quality, was determined. The SPSS version 15 was used to assess correlation between number of published papers and year of publication. Moreover, in order to provide information on scientific collaboration between coauthors in the field, Visualizing Scientific Landscapes (VOS viewer) software version 1.6.5 (available in www.vosviewer.com) was used for displaying large bibliometric maps in label view and density view.

## Results

### Chronological development

We identified 390 documents published between 1986 and 2017, in which more than 95% (374) were issued in year 2000 or after. The average rate of published paper/year was 12.6. The highest number of publication happened on year 2011, and 2010, each one with 38 documents (9.7% of all documents for each year) and then followed by 2013 and 2008 (each one with 33 documents, 8.5%), whereas before 2000, there was only a few publications available [Figure 1]. The *R*-squared = 0.48 indicated a steady increase up to now in number of publication in the field. The overall correlation between the number of published documents and year of publication was 0.722 ($P < 0.001$).

### Type and language

The major types of article retrieved were original ($n$ = 283, 72.6%), review articles ($n$ = 50, 12.8%) and letter ($n$ = 23, 5.9%). The majority of articles were written in English (90%, 351 documents); however, the Japanese, Spanish, Italian, and French were ranked as the second to fifth publication language, respectively.

### Subject area

The top three ranks of subject area were medicine with global publication share of 95.4%, biochemistry/genetics/molecular biology with 5.1%, and agricultural/biological sciences with 1.8%.

### Authors' names, affiliations, and countries

As the five top authors, Kawanishi (23 articles, Japan) and Nakayama (18 articles, Japan) generated the highest number of documents, followed by Betjes MGH (15 papers, Netherlands), Korte MR (15 papers, Netherlands), and Moriishi M (15 articles, Japan). The first five countries generated the highest number of publication were Japan (21.3%), United Kingdom (14.6%), United States (6.7%), Netherland (6.4%), and Turkey (5.9%).

Measuring the institutional degree of involvement in publishing documents showed that "The Erasmus University Medical Center" with 18 documents obtained the first rank in our study followed by "The Jikei University School of Medicine" with 17 documents [Table 1].

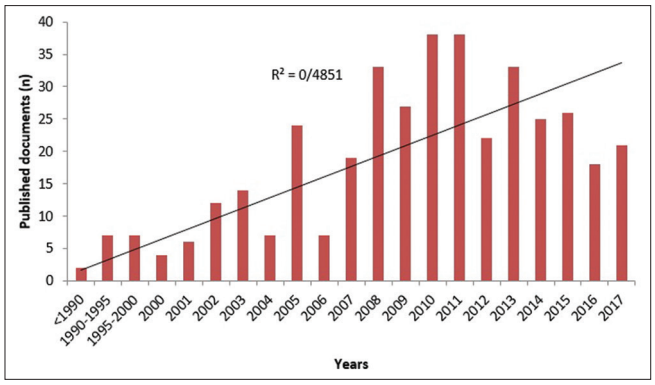


**Figure 1: Time–trend distribution of publications on prevention and management of peritoneal fibrosis**

**Table 1: Characteristics of top five institutes based on number of documents published on prevention and management of peritoneal fibrosis**

| Rank | Institution name | Doc. No. | Country |
|---|---|---|---|
| 1 | The Erasmus University Medical Center | 18 | Netherlands |
| 2 | The Jikei University School of Medicine | 17 | Japan |
| 3 | Tsuchiya General Hospital | 16 | Japan |
| 4 | Manchester Royal Infirmary | 15 | UK |
| 5 | Albert Schweitzer Hospital, Dordrecht | 13 | Netherlands |

## Sources

Journal of "Peritoneal Dialysis International" with publishing 82 documents (21%) had the highest rate of publication (IF = 1.557), followed by "Advances in Peritoneal dialysis" with 28 documents (7.2%) and no IF, "Nephrology, Dialysis and Transplantation" with 20 documents (IF = 4.08), "International Urology and Nephrology" with 14 published paper (IF = 1.56), and "American Journal of Kidney" with 10 published papers (IF = 7.623) were ranked as second to fifth journal publishing documents in studied field, respectively.

## Cited numbers

The total citation for documents in our study was 5636 with an average citation of 14.45 for each published document at the time of data analysis. In addition, 89 documents (22.8%) received no citation at all. The citation rate had several up and down, although the general view was an increase in rate of citation from year 2005 (285) compared to 2004 (68 citations), having a slight attenuation in years 2006 and 2007 (162 and 203 citations) and again reaching up from year 2011 (589 citations) and peaking at year 2013 with 616 citations. First citation for published documents was on year 1989 (one citation) for a paper published in *American Journal of Kidney Diseases*.

We also gathered the characteristics of top 10 documents that had the highest rate of citation [Table 2]. For these documents, the citations ranged between 256 and 84 times

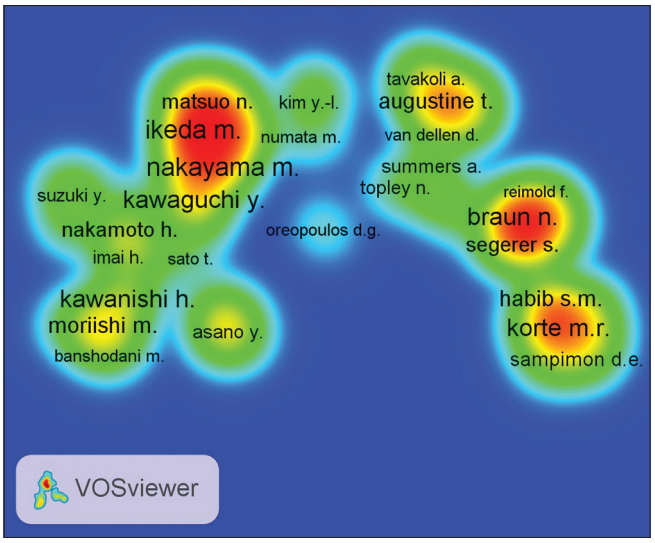


**Figure 2: Density map of coauthorship network for published scientific documents on prevention and management of peritoneal fibrosis. Choice of color is optional, but commonly, red shows the high score, green the medium and blue the lowest score for link strength. In our study, the order of color based on total link strength is from red (showing the highest strength) to dark brown (showing the lowest strength) with green, dark blue, yellow, violet, sky blue, blue, light blue, dark green, and pink are between**

with half of these documents being published in journal of "Peritoneal Dialysis International." Interestingly, 60% of these top 10 documents were original articles written by either Japanese or United Kingdom authors. Only one document from countries except Japan and United Kingdom fall in these top 10 documents (from Australia) [Table 2]. The *H*-index, which is an author-level metric based on assumption of higher importance of citation than number of publication, was high in our study reaching 38. It means that 38 documents out of 390 retrieved documents were cited at least 38 times.

## Coauthorship network mapping

Coauthorship network is a social network in which authors or organizations are linked to each other through participation in one or more publication. The "nodes" of a network are the people and the "links" are the relationships between people.[10] To draw the map of coauthorship, we considered at least two papers as cut off for published documents by each author. Applying this criterion, 241/1488 authors were considered eligible. Within these 241 authors, coauthorship link was just shown among 146 authors. The density views and coauthorship network of the authors are presented in Figures 2 and 3, respectively. It should be noted that in density network, each point is colored according to density of that item. By default, this color is set to be somewhere between red and blue. The color of a point is closer to red when number and weight of items in neighborhood of that point are larger and higher, respectively.[11] The font and bubble size of an author name reflect the coauthorship frequency of that author. In label view coauthorship, in case of

**Table 2: Characteristics of top 10 documents based on citation number**

| Title | Total citation (*n*) | Published year | Type of document | Country | Journal name (IF) | Highest citation number (years) |
|---|---|---|---|---|---|---|
| Encapsulating peritoneal sclerosis: Definition, etiology, diagnosis, and treatment. International Society for Peritoneal Dialysis Ad-Hoc Committee on Ultrafiltration Management in Peritoneal Dialysis | 256 | 2000 | Rev. | Japan | *Perit Dial Int* (1.55) | 30 (2005) |
| Sclerosing peritonitis: The experience in Australia | 239 | 1998 | OA | Australia | *Nephrol Dial Transplant* (4.08) | 26 (2005) |
| Encapsulating peritoneal sclerosis in Japan: A prospective, controlled, multicenter study | 216 | 2004 | OA | Japan | *AJKD* (7.62) | 28 (2009) |
| Single-center experience of encapsulating peritoneal sclerosis in patients on peritoneal dialysis for end-stage renal failure | 115 | 2005 | OA | UK | *KI* (8.56) | 17 (2009) |
| Encapsulating peritoneal sclerosis in the new millennium: A national cohort study | 107 | 2009 | OA | UK | *Clin J Am Soc Nephrol* (4.61) | 19 (2011, 2013, 2014) |
| Pathology of encapsulating peritoneal sclerosis | 100 | 2005 | Rev. | Japan | *Perit Dial Int* (1.55) | 18 (2013) |
| Recommendations on the management of encapsulating peritoneal sclerosis in Japan, 2005: Diagnosis, predictive markers, treatment, and preventive measures | 96 | 2005 | Rev. | Japan | *Perit Dial Int* (1.55) | 12 (2010) |
| The Pan-Thames EPS study: Treatment and outcomes of encapsulating peritoneal sclerosis | 88 | 2009 | OA | UK | *Nephrol Dial Transplant* (4.08) | 20 (2013) |
| Encapsulating peritoneal sclerosis - a clinician's approach to diagnosis and medical treatment | 86 | 2005 | Rev. | Japan | *Perit Dial Int* (1.55) | 12 (2013, 2015) |
| Successful surgical management of encapsulating peritoneal sclerosis | 84 | 2005 | OA | Japan | *Perit Dial Int* (1.55) | 13 (2010) |

Perit Dial Int=Peritoneal Dialysis International, Nephrol Dial Transplant=Nephrology Dialysis Transplantation, AJKD=American Journal of Kidney Diseases, Clin J Am Soc Nephrol=Journal of the American Society of Nephrology, KI=Kidney International, OA=Original article, Rev=Review article

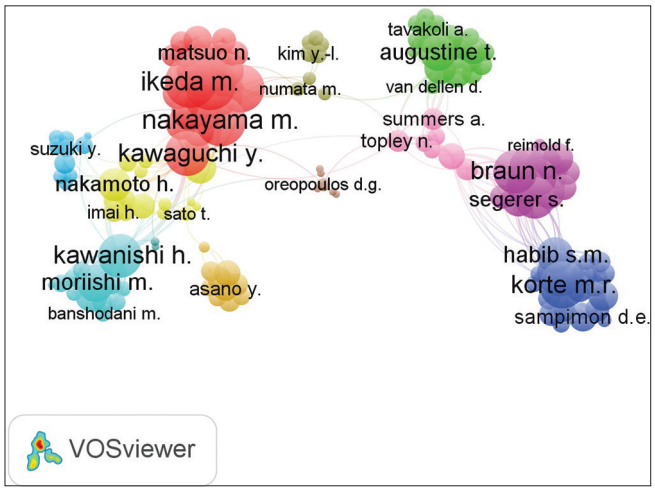


**Figure 3: Map (label view) of coauthorship network for published scientific documents on prevention and management of peritoneal fibrosis. Choice of color is optional, but commonly, red shows the high score, green the medium, and blue the lowest score for link strength. In our study, the order of color based on total link strength is from red (showing the highest strength) to dark brown (showing the lowest strength) with green, dark blue, yellow, violet, sky blue, blue, light blue, dark green, and pink that are in between**

availability of a network, two weights, one for number of links, and the other for total strength of link are provided automatically.

In our research, we found that within 1511 total link between the authors, the top 5 authors were "Ikeda M." (88 coauthorships) followed by "Yamamoto H.," "Nakayama M.," "Yokoyama K.," and "Hosoya T." with 88, 82, 79, and 75 coauthorships, respectively [Figure 2].

Based on these rules, the highest density in the network belonged to "Ikeda M." [Figure 3].

## Discussions

We found a progressive significant increase in scientific publication, manifested mostly from the beginning of the 2002s. Choosing the Scopus database as the "largest abstract and citation database of peer-reviewed literature" gives us a reliable scientific visualization and attenuates the chance of methodical bias because as it is "more international in coverage" and includes European and Asia Pacific literature in both English and non-English languages.[10]

Publication of first paper in 1986 emphasizes on relatively new concept of this field. PD has started to become wide spread after Baxter Healthcare introduced the "Automated Peritoneal Dialysis" home system (in 1994s) and Extraneal (in 2000) as a new class of PD solution.[12] Increase in quantity of publications several years after

popularity of this scientific invention may highlight the impact of major scientific advances on the research output.

Although more than 40 countries had publication in this issue, which indicates its worldwide growing interest, only a small numbers of countries were responsible for the majority of research products (35.9%) with Japan and United Kingdom being ranked as the top two countries, perhaps because of high expenditure for research and development, efficient management of PD patients, awareness within the medical community about the advances of therapeutic and preventive measures, and having a well-established ESRD registry.[13]

Of note, in our country, only three scientific papers were documented with the first one being published in 2011.[14] This number is really low, compared to our neighbored country "Turkey" that produced 23 documents with first of them being published in 2004. This may highlight that Iranian scientists just recently start to pay more interest into this field. Given the importance of ESRD subjects and growing rate of PD in Iran, paying more attention to this subject might result in considerable scientific growth publication.

The majority of subject area was medicine. This highlights the importance of prevention and management of peritoneal fibrosis as an important factor in lowering the burden and direct and indirect medical expense.[15,16]

The high-cited scientific publications were published in highly related, scholarly valuable international journals. The 50% of these high-cited publications were published only in one journal (PDI). This might emphasis that authors willing the world see their research should publish their documents in relative rather than high impacted journal.

Top author in the coauthorship network assessment was "Ikeda M" from Japan. Analysis of the label and density views of coauthorship network of authors showed that all of the top five authors were Japanese, which might emphasize that Japanese researchers' value the collaborative work and see it as a tool for advancing the science.

Looking at the authors with high number of publications, institutes involved in scientific productions and origin of articles with high citation rate together show that three countries of Japan, Netherlands, and United Kingdome are the core nodes performing the most research. The last two countries are member of European Union and have greater chance and facility to collaborate, access, and reuse the results among themselves.

We noted that objective of all the top 10 highly cited articles were EPS as the most important and devastating complication of long-term PD.[6] It is noticeable that although this complication is not frequent, but strategies to prevent this complication may in fact improve the continuity and quality of dialysis and lower the cost, burden, and patient drop-out rate.

## Conclusions

In conclusion, our study performed for the first time in this field showed an increasing trend in publication, which was in line with the development of novel therapeutic tools. We also showed that EPS, as the most important complication of PD, is the focus of most of these publications. Despite the worldwide increasing rate of PD, the most important back draw is still development of peritoneal fibrosis with final subsequence of dialysis dropout. Implementing the new preventive or treatment for this complication requires accurate information and scientific evidences provided through scientific papers and report.

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### Conflicts of interest

There are no conflicts of interest.

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