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WORLD TREND OF PERITONEAL DIALYSIS PUBLICATIONS

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♦♦ ***Objectives:*** **To analyze the trend of global peritoneal dialysis (PD) publications, especially of publications in *Peritoneal Dialysis International* (*PDI*), from 1991 to 2005 according to the Institute for Scientific Information databases of the Thomson Corporation.**

♦♦ ***Methods:*** **Data were downloaded from the Web of Science, which includes the databases of Science Citation Index Expanded and Social Sciences Citation Index. The searching strategies were key-in of "peritoneal dialysis" in general search and of "SO=Peritoneal Dialysis International" in advanced search. Only articles and reviews were included in the analysis. The analysis was stratified by publication year, journal, author, country of each author's affiliation, and citation count of each paper.**

♦♦ ***Results:*** **There were 7618 PD papers (6991 articles and 627 reviews) in 887 journals; 15.8% of them (n = 1204) were published in *PDI*. The annual outputs of global PD publications has been more than 500 papers since 1996, with a peak of 665 articles in 2003. In total, 18531 authors from 102 countries and areas contributed to PD publications. Authors from the USA were present in 30.6% of all papers although their global share decreased with time. A PD paper received an average of 12.7 citations. A review received more citations than an article (17.0 vs 12.3 on average), yet statistical significance was not reached (p = 0.216, Mann–Whitney U test).**

♦♦ ***Conclusions:*** **The number of PD research societies in the world has been growing during the past 15 years. More and more research is from countries other than the USA and the United Kingdom. Papers on PD have thus been published in many journals other than *PDI*, the leading journal in PD. However, the growth rate of PD publications in the world is diminishing. We present here the most likely reasons for the decrease in PD publications and propose suggestions for *PDI* to keep its leading role in the development of PD.**

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Peritoneal dialysis (PD) is a major subfield of nephrology. It has evolved rapidly along with technological progress in recent decades. Although there have been several reports on the quantitative aspect of nephrology publications (1–3), an analysis specific to PD publications would provide valuable information for related researchers. Here we performed a bibliometric analysis on PD publications using the Institute for Scientific Information (ISI) databases of the Thomson Corporation, one of the most authoritative bibliographic databases in science. We also paid extra attention to records of the journal *Peritoneal Dialysis International* (*PDI*), the official publication of the International Society for Peritoneal Dialysis (ISPD) and the most important forum for PD researchers in the world.

MATERIALS AND METHODS

We downloaded records from the Web of Science over the Internet: http://portal.isiknowledge.com/portal.cgi?DestApp=WOS&Func=Frame (accessed 5 April 2006). This site includes databases of the Science Citation Index Expanded and the Social Sciences Citation Index. The searching strategies were key-in of "peritoneal dialysis" in the general search and "SO=Peritoneal Dialysis International" in the advanced search.

After downloading, we extracted papers published between 1991 and 2005. The analysis was then limited to those in the type of either "article" or "review," that is, excluding letter, editorial material, note, meeting abstract, *etc*. A Short Report, if not printed in the section of Letters to the Editor, is categorized as an "Article." Commentaries usually categorized as Editorial Materials are thus excluded. Papers in all languages were included. To study the bibliometrics of *PDI* in the most recent 10 years, we also looked up related data in annual

printed and electronic versions of *Journal Citation Reports* from 1995 to 2004.

The analysis of PD publications was stratified by publication year, journal, author, country of the author's affiliation, and citation count of each paper. We identified authors' affiliations and countries from addresses in their affiliations and correspondences. To maintain consistency within the study period, records of Hong Kong were separated from those of the People's Republic of China. Data from England, Scotland, Wales, and Northern Ireland were integrated under United Kingdom.

For *PDI* specifically, we studied fluctuations of its annual impact factor along with its determinants, which were paper count, total citation count, recent citation count, percentage of recent citations (citations to papers published in the preceding 2 years) in total citations, and cited half-life.

Extraction and computation of data were processed with programs written in Perl language (version 5.8.8, freely available at http://www.perl.com/). The descriptive statistics, for example, the frequency in count and percentage, are presented. We further compared the citation numbers received by articles and by reviews. Because numbers of citations varied widely among papers, we chose the Mann–Whitney U test for this analysis. We also probed the correlation between each of *PDI*'s yearly impact factors, paper counts, total citation counts, recent citation counts, share of recent citations, and cited half-lives. The correlation coefficient Spearman's rho was calculated. A p value less than 0.05 was regarded as statistically significant (two tailed). The statistical analyses were performed with SPSS release 13.0 (2004; SPSS Inc., Chicago, Illinois, USA) for Windows operating system (Microsoft Corp., Redmond, Washington, USA).

RESULTS

We retrieved 13276 PD literature records dating back to 1965 from ISI's Web of Science. There were 7618 papers (6991 articles and 627 reviews) published by 887 journals between 1991 and 2005. Only 12 journals published more than 100 PD papers in the past 15 years. With 1204 (15.8%) papers, *PDI* outnumbered the following: *American Journal of Kidney Diseases* (627 papers; 8.2%), *Nephrology Dialysis Transplantation* (595 papers; 7.8%), and *Kidney International* (579 papers; 7.6%). The top 12 journals accounted for 57.7% of all publications on PD.

The annual output of global PD publications has been more than 500 papers since 1996, reaching a peak of 665 articles in 2003 (Figure 1). However, the annual growth rate was close to zero after the year of 2000. The PD publications in *PDI* reached a peak of 182 papers in 1999 though, and then decreased. Correspondingly, the global share of PD articles in *PDI* attained the highest point of 24.3% in 1999 and then decreased to 11.9% in 2004 and 15.5% in 2005.

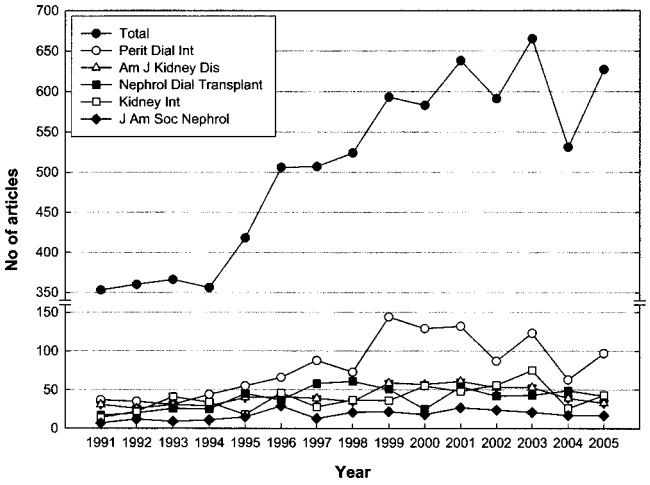

Figure 1 — Trend of peritoneal dialysis publications indexed in the Institute for Scientific Information databases (Thomson Corporation).

Authors from 102 countries and areas contributed to PD publications. Contributors from the USA authored 30.6% of all papers, but their global share decreased over time (Table 1). A decreasing tendency of contribution was also noted for the United Kingdom and Germany.

A PD paper received an average of 12.7 citations (median 5, interquartile range 13). Only 100 papers (1.3%) received 100 or more citations; 19 of them were reviews in document type. Table 2 shows the 10 most frequently cited PD papers. In short, 285 papers (3.7%) received 50 – 99 citations, 2219 papers (29.1%) had 10 – 49 citations, and 1347 papers (17.7%) had no citations at all. That is, 17.6% (n = 1230) of articles and 18.7% (n = 117) of reviews did not receive any citation. A tendency was present for a review to receive more citations than an article (mean 17.0, standard deviation 35.1, mode 5, interquartile range 16 vs mean 12.3, standard deviation 24.2, mode 5, interquartile range 13), but statistical significance was not reached (p = 0.216 by Mann–Whitney U test).

When ranked by total citations of their PD papers, only 7 journals received more than 2000 citations: *Kidney International* (15396 citations), *American Journal of Kidney Diseases* (14951), *PDI* (10519), *Journal of the American Society of Nephrology* (8956), *Nephrology Dialysis Transplantation* (8537), *Nephron* (2783), and *Clinical Nephrology* (2152).

TABLE 1
Share of Articles on Peritoneal Dialysis for the Twenty Top-Ranking Countries

Country	1991–1995 (*n*=1853) [*n* (%)]	1996–2000 (*n*=2713) [*n* (%)]	2001–2005 (*n*=3052) [*n* (%)]	1991–2005 (*n*=7618) [*n* (%)]
USA	641 (34.6)	865 (31.9)	826 (27.1)	2332 (30.6)
United Kingdom	244 (13.2)	270 (10.0)	289 (9.5)	803 (10.5)
Germany	133 (7.2)	199 (7.3)	176 (5.8)	508 (6.7)
Canada	109 (5.9)	194 (7.2)	175 (5.7)	478 (6.3)
Italy	97 (5.2)	143 (5.3)	176 (5.8)	416 (5.5)
The Netherlands	90 (4.9)	129 (4.8)	172 (5.6)	391 (5.1)
Japan	68 (3.7)	143 (5.3)	163 (5.3)	374 (4.9)
Sweden	72 (3.9)	126 (4.6)	152 (5.0)	350 (4.6)
France	93 (5.0)	112 (4.1)	113 (3.7)	318 (4.2)
Spain	61 (3.3)	125 (4.6)	132 (4.3)	318 (4.2)
Belgium	40 (2.2)	70 (2.6)	116 (3.8)	226 (3.0)
Hong Kong	32 (1.7)	51 (1.9)	131 (4.3)	214 (2.8)
Poland	26 (1.4)	46 (1.7)	95 (3.1)	167 (2.2)
Australia	39 (2.1)	50 (1.8)	74 (2.4)	163 (2.1)
Turkey	3 (0.2)	14 (0.5)	140 (4.6)	157 (2.1)
Austria	14 (0.8)	63 (2.3)	70 (2.3)	147 (1.9)
Taiwan	14 (0.8)	52 (1.9)	75 (2.5)	141 (1.9)
Israel	42 (2.3)	48 (1.8)	43 (1.4)	133 (1.7)
South Korea	7 (0.4)	50 (1.8)	57 (1.9)	114 (1.5)
Greece	15 (0.8)	36 (1.3)	41 (1.3)	92 (1.2)

Disregarding the possibility of authors having the same name, a PD paper had an average of 4.7 authors (maximum 61, median 4, and interquartile range 3); 18 531 authors contributed to PD publications. Most authors (n = 13305) were present only in 1 paper, and 398 authors were present in 10 or more papers. The 10 most prolific authors are listed in Table 3 and the 10 top authors with most citations are listed in Table 4.

We obtained 2637 records of *PDI*, dating back to 1988, from the ISI's Web of Science. Among those records, 1421 papers (1390 articles and 31 reviews) were published between 1991 and 2005 and 15.3% (n = 217) of them could not be retrieved with the key word "peritoneal dialysis" in the ISI databases.

Table 5 shows some important bibliometric data for *PDI* from the past 10 years. The full bloom of *PDI* in terms of annual impact factor was around 1998. The impact factor of *PDI* was associated only with the percentage of recent 2-year citations in the annual total citations (correlation coefficient Spearman rho = 0.66, p = 0.039). However, the impact factor is derived from the number of 2-year citations, thus a statistical significance about the correlation between these two variables might not be stated. We also found the total citation count correlated with yearly publication count (correlation coefficient Spearman rho = 0.63, p = 0.039).

DISCUSSION

Peritoneal dialysis is only a small subfield of nephrology and urology in scientific research. There were 627 PD papers listed in 2005 in the ISI databases, while the subject category of "urology & nephrology" contained 8377 papers in 51 journals. That is, only 7.5% of papers were PD papers (http://portal.isiknowledge.com/portal.cgi?DestApp=JCR&Func=Frame; accessed 10 October 2006). Although the annual number of PD papers grew during the study period, from 353 papers in 1991 to 627 in 2005, a similar trend could also be observed in global hemodialysis publications but with higher growth: from 1019 papers in 1991 to 2135 in 2005 (according to our separate calculations).

Papers on PD were scattered in varied biomedical journals because PD research societies have burgeoned in the past 15 years. More and more PD research and papers were from countries other than the most medically advanced countries, such as the USA and the UK. Proof could be found in decreasing PD paper contributions from the USA (from 34.6% to 27.1%), the UK (from 13.2% to 9.5%), and Germany (from 7.2% to 5.8%) between the years 1991 and 2005, as shown in Table 1.

Peritoneal dialysis publication numbers after 2000 were in a plateau, as shown in Figure 1. Not only *PDI*, but

TABLE 2
The Top Ten Peritoneal Dialysis Articles by Highest Number of Citations Indexed in the Institute for Scientific Information Databases (Thomson Corporation), 1991–2005 (Status: 5 April 2006)

Article	Citations (*n*)
Churchill DN, Taylor DW, Keshaviah PR, Thorpe KE, Beecroft ML, Jindal KK, *et al*. Adequacy of dialysis and nutrition in continuous peritoneal dialysis: association with clinical outcomes. Canada–USA (CANUSA) Peritoneal Dialysis Study Group. *J Am Soc Nephrol* 1996; 7:198–207.	573
Sherrard DJ, Hercz G, Pei Y, Maloney NA, Greenwood C, Manuel A, *et al.* The spectrum of bone disease in end-stage renal failure—an evolving disorder. *Kidney Int* 1993; 43:436–42.	382
Foley RN, Parfrey PS, Sarnak MJ. Clinical epidemiology of cardiovascular disease in chronic renal disease. *Am J Kidney Dis* 1998; 32(5 Suppl 3):S112–19.	373
Foley RN, Parfrey PS, Harnett JD, Kent GM, Murray DC, Barre PE. The impact of anemia on cardiomyopathy, morbidity, and mortality in end-stage renal disease. *Am J Kidney Dis* 1996; 28:53–61.	309
Handwerger S, Raucher B, Altarac D, Monka J, Marchione S, Singh KV, *et al.* Nosocomial outbreak due to *Enterococcus faecium* highly resistant to vancomycin, penicillin, and gentamicin. *Clin Infect Dis* 1993; 16:750–5.	297
Young GA, Kopple JD, Lindholm B, Vonesh EF, De Vecchi A, Scalamogna A, *et al.* Nutritional assessment of continuous ambulatory peritoneal dialysis patients: an international study. *Am J Kidney Dis* 1991; 17:462–71.	267
Fenton SS, Schaubel DE, Desmeules M, Morrison HI, Mao Y, Copleston P, *et al.* Hemodialysis versus peritoneal dialysis: a comparison of adjusted mortality rates. *Am J Kidney Dis* 1997; 30:334–42.	233
Pereira BJ, Shapiro L, King AJ, Falagas ME, Strom JA, Dinarello CA. Plasma levels of IL-1 beta, TNF alpha and their specific inhibitors in undialyzed chronic renal failure, CAPD and hemodialysis patients. *Kidney Int* 1994; 45:890–6.	216
Foley RN, Parfrey PS, Harnett JD, Kent GM, Murray DC, Barre PE. Impact of hypertension on cardiomyopathy, morbidity and mortality in end-stage renal disease. *Kidney Int* 1996; 49:1379–85.	216
Churchill DN, Thorpe KE, Nolph KD, Keshaviah PR, Oreopoulos DG, Page D. Increased peritoneal membrane transport is associated with decreased patient and technique survival for continuous peritoneal dialysis patients. The Canada–USA (CANUSA) Peritoneal Dialysis Study Group. *J Am Soc Nephrol* 1998; 9:1285–92.	210

TABLE 3
The Most Prolific Authors in Peritoneal Dialysis Publications Indexed in the Institute for Scientific Information Databases (Thomson Corporation): 1991–2005

Author	Papers (*n*)
Krediet RT	128
Lindholm B	121
Oreopoulos DG	94
Heimbürger O	86
Li PKT	82
Gokal R	75
Struijk DG	75
Selgas R	74
Piraino B	67
Bergström J	64

TABLE 4
Authors with the Most Citations in Peritoneal Dialysis Publications Indexed in the Institute for Scientific Information Databases (Thomson Corporation): 1991–2005 (Status: 5 April 2006)

Author	Citations (*n*)
Lindholm B	2827
Krediet RT	2539
Oreopoulos DG	2340
Bergström J	2136
Nolph KD	1977
Heimbürger O	1910
Gokal R	1820
Struijk DG	1586
Foley RN	1436
Parfrey PS	1391

Kidney International, *American Journal of Kidney Diseases*, and *Nephrology Dialysis Transplantation* all published fewer PD papers. The most likely reasons for this decrease in PD publications are that journals other than *PDI* had limited interest and capacity for PD articles; nephrologists had lost their interest in PD research; professionals had not yet found new dimensions for PD studies; less molecular biology-related research, the mainstream in current scientific study, had been devel-

TABLE 5
Trend of Bibliometric Data for *Peritoneal Dialysis International*

Year	Impact factor[a]	Paper count (source items[b])	Total citation count[a]	Citations to papers in preceding 2 years (% of total citations)[c]	Cited half-life (years)
1995	1.520	61	1116	126 (11.3)	3.9
1996	1.673	88	1340	184 (13.7)	5.1
1997	2.129	114	1351	317 (23.5)	4.8
1998	2.856	83	1818	577 (31.7)	4.8
1999	2.406	182	2030	474 (23.3)	4.6
2000	1.842	145	2571	488 (19.0)	4.8
2001	1.657	161	2277	542 (23.8)	5.3
2002	1.915	99	2410	586 (24.3)	5.2
2003	1.950	135	2528	507 (20.1)	5.1
2004	1.056	73	1726	247 (14.3)	5.9

[a] Data sources: the annual *Journal Citation Reports*, *Science Edition*.
[b] Source items were derived from the downloaded datasets of the Institute for Scientific Information databases (Thomson Corporation). The data in 1995 and 2001 differed from those printed in the *Journal Citation Reports*.
[c] Recent citation count and share of recent citations.

oped; experimental studies dealing with the peritoneal membrane, transport, or defense issues did not mention PD in their titles or abstracts; and PD papers were published in journals not indexed in the ISI databases, which could be verified by tracing the fate of manuscripts rejected by *PDI* (4).

Peritoneal Dialysis International has played a pivotal role in the development of PD since the initiation of its society (the ISPD). The annual PD paper count in *PDI* correlates with global PD publications. The reduction in PD articles in *PDI* in recent years has not been countervailed by an increase in PD articles in other journals since the annual PD paper count in non-*PDI* journals also shows similar fluctuation. For example, the dip in 2004 (Figure 1) was observed in *PDI* and other journals as well (63 papers and 468 papers respectively).

Our citation counts were not stratified by publication year when making comparisons between document types among journals or among authors. Due to the absence of a full authors' names index, we could not discern the authors who shared the same surname and forename initials (5).

The citation count per paper in *PDI* was obviously lower than that of other top-ranking journals. The impact factor of a journal is arbitrarily defined as the citation number that all its publication items in the preceding 2 years received in the reference year, divided by the journal's total number of articles and reviews ("source items") in the preceding 2 years. Accordingly, the impact factor of *PDI* was lower. This algorithm for impact factor is controversial (6,7) and especially unfavorable to *PDI*, which has a longer cited half-life.

The cited half-life of *PDI* is much longer than other journals. Apparently, there have been few classical and breakthrough papers for citation in recent years. Loss of interest in PD among nephrologists was again manifested. However, we believe that lack of free access to an electronic version of *PDI* was another influential factor of *PDI*'s longer cited half-life. During the past decade, scientific publications have increasingly become available on the Internet, where they can be used by far more readers than print journals have ever reached (8). Without having free access to an electronic version of *PDI*, authors of newly submitted manuscripts would probably use secondary citations or forsake citing *PDI*. That would result in fewer recent citations and further increase the length of "cited half-life" and decrease the impact factor at the same time. Since promotion of PD instead of commercial purpose is the main goal of the ISPD, a free electronic version of *PDI* would be very appropriate.

An impact factor can be boosted by either decreasing its denominator or increasing its numerator. To increase the rejection rate of a journal for higher quality papers, that is, to decrease the denominator, would raise its impact factor. A higher rejection rate would rule out self-cited papers, which could increase the denominator and the numerator of the impact factor at the same time. However, it is commonly believed that such papers are usually not so valuable and their contributions to an impact factor would be minimal or even negative.

Therefore, increasing the rejection rate would definitely increase the impact factor in the short term.

Nevertheless, a high rejection rate might conversely hamper young nephrologists' interest in PD research. The total number of PD papers after 2000 has been growing slowly (Figure 1). That is, the manuscripts rejected by *PDI* were not accepted by other SCI journals. As above in Results, the total citation count significantly correlated with yearly paper count (correlation coefficient Spearman rho = 0.63, $p = 0.039$). With a higher rejection rate, *PDI* might get even fewer PD publications, especially at such time of output shrinkage. We are afraid that, before long, citations would decrease as well. For instance, as shown in Table 5, *PDI*'s impact factor plunged in 2004, to 1.056 [247/(99 + 135)], because "citations to papers in the preceding 2 years" dropped precipitously, from 507 (2003) to 247 (2004). The most likely reason for this drop was that the reduction of source items in 2002 and 2003 left fewer papers for citation. Therefore, raising the rejection rate alone would not likely sustain a higher impact factor in the long run.

In conclusion, developing new directions for PD research would be the fundamental solution for a higher *PDI* impact factor. Before that, retaining the original rejection rate along with providing free access or at least open access (9) to an electronic version of *PDI* would help increase the impact factor of *PDI* and encourage nephrologists to consistently put their efforts into PD publications.

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