

Bibliometric analysis of Patent Ductus Arteriosus treatments

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A bibliometric analysis was performed to assess the quantitative trend of Patent Ductus Arteriosus (PDA) treatment research, including intravenous injection of indomethacin and surgery. The documents studied were retrieved from the *Science Citation Index* (SCI) for the period from 1991 to 2002. The publication pattern concerning authorship, collaboration, original countries, citation frequency, document type, language of publication, distribution of journals, page count and the most frequently cited papers were performed. The results indicated that either treatment was not the recent emphasis of PDA research. The publishing countries of both treatments have also denoted that these researches were mostly done in Europe and North America. Both surgery and drug treatments had few international collaboration papers. English was the dominant language, and collaboration of two to six authors was the most popular level of co-authorship.

Introduction

The ductus arteriosus, connecting the main pulmonary arteries and the aortic arch, always closed within 2 days of birth (RUDOLPH et al., 1961). If the ductus remains open, then it is called Patent Ductus Arteriosus (PDA). PDA occurs around 5% to 10% in all congenital heart disease where the male to female ratio is 1 to 3 (MITCHELL et al., 1971). Treatments of PDA can be conducted in two ways: intravenous injection of indomethacin or ibuprofen and surgery of coil embolization or surgical ligation. The most effective treatment for premature PDA infants is intravenous injection of indomethacin. However, the drug treatment does not work for infants older than 1 month. The coil embolization of surgery treatment can only be applied when smaller PDA size occurred (PATEL et al., 1999). The surgical ligation is limited to patients that reach the weight limit, otherwise it would lead to bronchiolitis or pneumothorax. Bibliometric analysis is a quantitative analysis done to aid the evaluation of research performances (VAN DEN BERGHE, 1998). Recent increasing use of bibliometric analysis of institutes (JEEVAN & GUPTA, 2002), journals (SCHUBERT, 1996), grants and many

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others has been indicating its importance. Publication output of a certain discipline or topic can represent its current research trend whether it is present, previous, or future research focus (GARFIELD, 1970).

The purpose of this study, on the basis of bibliometric analysis, was to evaluate the research trend of the treatments of PDA, by drug and surgery. The drug treatment included indomethacin or ibuprofen intravenous injection; the surgery treatment included coil embolization and surgical ligation.

Method

The graphic data on treatments, by surgery and drug, were retrieved from the *Science Citation Index* (SCI) database for the period from 1991 to 2002. SCI was established by the Institute for Scientific Information (ISI) for the purpose of indexing articles and forming the bases for bibliometric analysis. Patent Ductus Arteriosus and indomethacin or ibuprofen was used as the keyword to search as a part of the title, abstract or keyword for drug treatment. The documents under surgery treatment were searched with keyword Patent Ductus Arteriosus and surgical ligation or coil. All document types, including article, editorial material, letter, meeting abstract, note and review, were used.

The bibliometric impact of a publication is assessed in terms of the number of citations received as compared to other outputs in the journal. Let the total number of papers be P and C the number of total citations for first three years since papers were published. The average number of citations per publications (CPP) was defined as the total number of citations over the total number of publications. In some cases, we only discussed the documents published in the period from 1991 to 2000 because there were no data for CPP after 2000.

Results and discussion

Publication output

The results of the publication output are shown in Table 1. A significant correlation was found between the yearly cumulative number of publications and the year (Figure 1). For the period from 1991 to 2002, the cumulative number of publications has increased in both of sub-subjects, drug and surgery treatments. In 1991, 25 papers were published, while in 2002 the cumulative number of publications was 281 for drug treatment. The relationship between yearly cumulative number of publications and the year was linear with a high correlation coefficient (0.997). In the same period,

on the other hand, only 4 papers were published on surgery treatment, and the cumulative number of publications in 2002 was 233. A significant correlation was found between cumulative number of publications and the year. A double logarithmic plot of the data showed that there was a linear relation with high correlation coefficient (0.961) for surgery treatment. The difference of the cumulative trend between the drug and surgery treatment was significant in the period from 1991 to 1996. After 1996, both drug and surgery treatments have linear relationship between cumulative number of publications and the year. Linear fitting suggested that there is a constant publications rate in each year. However, the logistic curve fitting denoted that yearly publications show a constant growth rate.

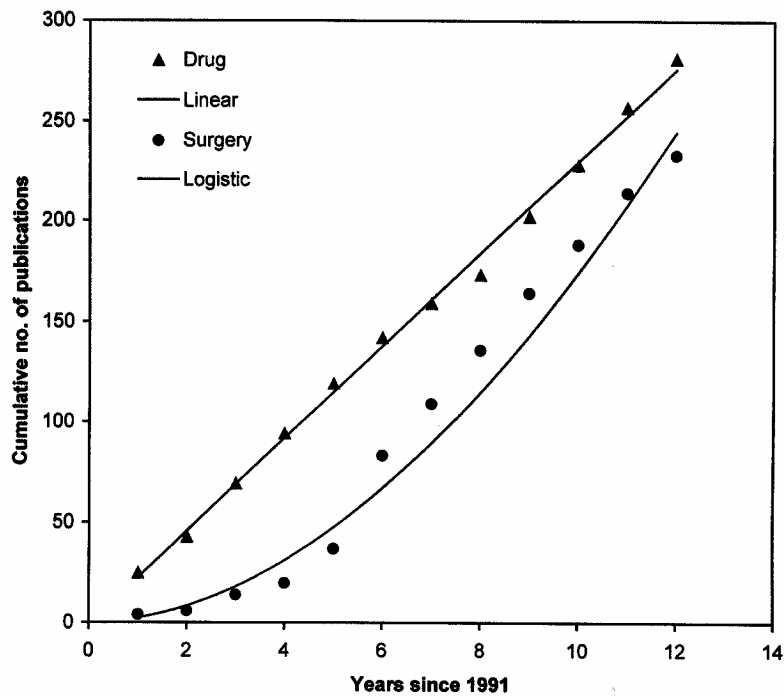


Figure 1. Relationship between cumulative number of publications and year for surgery and drug treatment documents

Table 1. Annual production of surgery and drug treatment

Year	PDA		Drug		Surgery	
	No.P	Cumulative	No. P	Cumulative	No. P	Cumulative
1991	105	105	25	25	4	4
1992	100	205	18	43	2	6
1993	130	335	26	69	8	14
1994	134	469	25	94	6	20
1995	134	603	25	119	17	37
1996	168	771	23	142	46	83
1997	161	932	17	159	26	109
1998	128	1060	14	173	27	136
1999	153	1213	29	202	28	164
2000	148	1361	26	228	24	188
2001	151	1512	29	257	26	214
2002	130	1642	24	281	19	233

No. P: Number of publications

Document type

The drug documents are distributed more scattered than those of surgery in the document type during the period from 1991 to 2000. 73.7% of drug documents and 83.5% of surgery documents were original articles (Table 2). The number of total citations for first three years after publication were further considered for the CPP distribution between drug and surgery treatments. That was significantly different partially due to publication output. The CPP values for articles were 5.48 and 6.00 for drug and surgery treatments, respectively. As for CPP in articles, both drug and surgery ranked second. However, the CPP of drug review ranked first and the CPP of surgery note ranked first leading in distance by article.

Table 2. Document type distribution of surgery and drug treatment

Document type	Drug			Surgery		
	P (%)	C	CPP	P (%)	C	CPP
Article	168 (73.7)	921	5.48	157 (83.5)	942	6.00
Editorial Material	9 (3.95)	21	2.33	5 (2.66)	1	0.200
Letter	10 (4.39)	8	0.800	–	–	–
Meeting Abstract	24 (10.5)	5	0.208	14 (7.45)	3	0.214
Note	5 (2.19)	10	2.00	8 (4.26)	104	13.0
Review	12 (5.26)	67	5.58	4 (2.13)	12	3.00
Total	228 (100)	1032	4.53	188 (100)	1062	5.65

Language of publication

95.4% drug and 91.4% surgery publications in the period from 1991 to 2002 were in English. Surgery documents have contained more articles in German (7.73%) and one in French and Spanish, respectively. Publications in several other languages have been found in drug documents, including German, Italian and Japanese.

Distribution of journals

The average documents published per journal, from 1991 to 2002, was 2.99 and 3.12 for surgery and drug, respectively. Eight journals from surgery and 17 from drug were not found in *Journal Citation Reports* (JCR). The impact factor (IF) of a journal was determined for each document as reported in the year 2002 JCR. Figure 2 shows that the impact factors of the publishing journals were scattered and did not demonstrate a significant trend. The average impact factor of the journals in surgery was 2.45 and 3.25 for drug journals. The journal with the highest impact factor (31.736) for both treatments was the *New England Journal of Medicine*. That the average of surgery journals' impact factor is lower might be due to having only one journal with impact factor higher than 15 where drug treatment had 4.

Page count

In the period from 1991 to 2000, there were 1249 and 1036 pages in total of 228 and 188 publications with an average of 5.48 and 5.51 pages for drug and surgery, respectively. Three to seven pages were popular which included 64.5% of all drug documents and surgery was 70.2%. Six-page papers (42, 18.4%) dominated most of the documents for drug with CPP value of 6.69, while most documents for surgery were dominated by four-page papers (38, 20.2%) with CPP value of 4.74.

International collaboration

Documents in both categories from 1991 to 2000 showed low percentage share of international collaboration, 5.26% and 5.85% for drug and surgery, respectively. This illustrated that international collaboration was not often conducted whose phenomenon was similar to engineering disciplines (SCHUBERT, 1998). Tables 3 and 4 show that the papers published have been diverse. Drug publications cover 27 countries, while those of surgery cover 26. USA has been dominant by publishing 94 (45.4%) and 101 (53.7%) papers with CPP of 5.98 and 8.03 for drug and surgery, respectively, followed by the second ranking with a four- and six-fold less in these two parts. In addition to its dominant publication, USA also produced most international collaborated papers. For

the surgery part, the international collaboration CPP was 8.82, which was higher than 4.58 for drug. As for the non-international collaboration papers, the CPP of surgery was 5.45 and that of drug was 4.52.

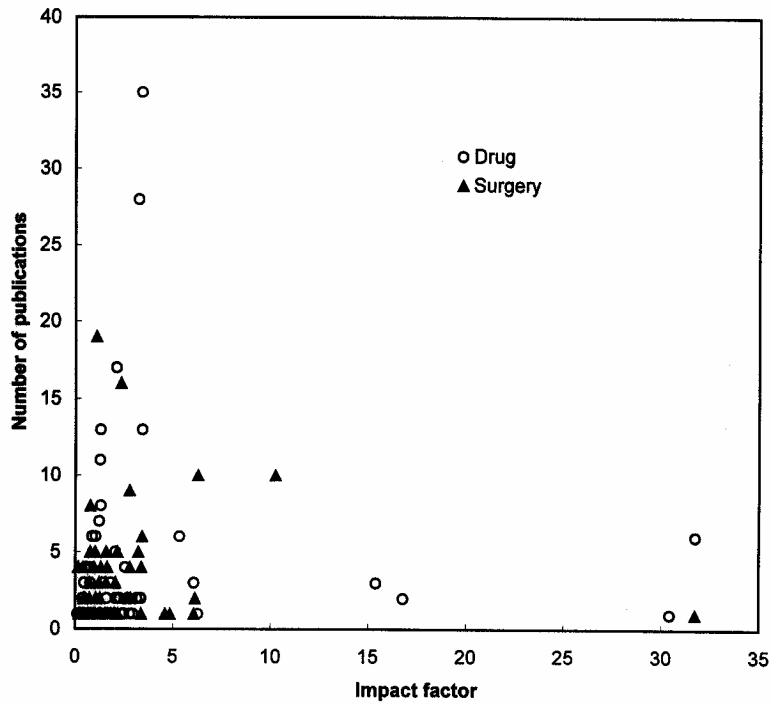


Figure 2. Impact factors' distribution of journals published

Authorship

Figure 3 shows a similar trend of publication and numbers of authors for drug and surgery papers published from 1991 to 2000. With drug treatment papers, four to six authorships were 48.2% and citation was 51.4%. The most frequent authorships for drug was four with 20.2% publications and 14.8% citation with CPP value of 3.33. However, the phenomenon is different for surgery treatment papers. Two to five authorships were 66.0% publication and 66.8% citation. Besides, five authorships were most frequent with 22.9% publication and 21.2% citation having the CPP value of 5.23.

Table 3. International collaboration country distribution of drug documents

Country	P_I	C_I	CPP_I	P_C	C_C	CPP_C
USA	89	523	5.88	5	39	7.80
Canada	21	66	3.14	3	14	4.67
UK	15	70	4.67	0	0	0
Italy	13	52	4.00	0	0	0
Japan	12	36	3.00	0	0	0
Australia	10	33	3.30	0	0	0
Gennany	7	9	1.29	1	7	7.00
France	6	14	2.33	0	0	0
Israel	5	18	3.60	0	0	0
Netherlands	5	22	4.40	3	3	1.00
Taiwan	5	10	2.00	0	0	0
Finland	4	16	4.00	3	28	9.33
Belgium	3	46	15.3	2	2	1.00
Switzerland	3	35	11.7	1	1	1.00
Hong Kong	3	1	0.333	0	0	0
New Zealand	2	17	8.50	0	0	0
Greece	1	4	4.00	0	0	0
Norway	1	0	0	2	9	4.50
Sweden	1	3	3.00	2	3	1.50
Austria	1	1	1.00	1	1	1.00
South Korea	1	1	1.00	0	0	0
Croatia	1	0	0	0	0	0
Malaysia	1	0	0	0	0	0
Portugal	1	0	0	0	0	0
Saudi Arabia	1	0	0	1	0	0
Singapore	1	0	0	0	0	0
Spain	0	0	0	1	5	5.00
Anonymous	3	0	0	0	0	0
Total	216	977	4.52	25	112	–

P_I : Single country publication output

C_I : Times cited of single country publication

CPP_I : Citation per publication of single country publication

P_C : International collaboration publication output

C_C : Times cited of international collaborated publication

CPP_C : Citation per publication of international collaborated publication

The most frequently cited papers

The time dependence for a single article is called its history and may be viewed as the ‘sales figure’ of the article (MARX & CARDONA, 2003). Among PDA related papers, the most frequently cited was ‘Very-Low-Birth-Weight Outcomes of the National-Institute-of-Child-Health-and-Human-Development Neonatal Network’.

Table 4. International collaboration country distribution of surgery documents

Country	P_I	C_I	CPP_I	P_C	C_C	CPP_C
USA	96	773	8.05	5	38	7.60
Japan	15	31	2.07	0	0	0
Germany	13	21	1.62	4	15	3.75
Canada	12	15	1.25	2	8	4.00
Austria	5	9	1.80	0	0	0
India	4	16	4.00	1	10	10.0
Taiwan	4	16	4.00	1	5	5.00
Italy	4	15	3.75	0	0	0
UK	3	7	2.33	1	27	27.0
Saudi Arabia	2	6	3.00	0	0	0
Slovakia	2	17	8.50	0	0	0
Brazil	2	3	1.50	1	5	5.00
Switzerland	2	8	4.00	0	0	0
Israel	2	4	2.00	0	0	0
Netherlands	1	14	14.0	0	0	0
Belgium	1	5	5.00	0	0	0
Turkey	1	2	2.00	0	0	0
Qatar	1	1	1.00	0	0	0
Spain	1	1	1.00	0	0	0
Sweden	1	1	1.00	0	0	0
Finland	1	0	0	0	0	0
Jamaica	1	0	0	0	0	0
South Africa	1	0	0	0	0	0
Australia	0	0	0	1	10	10.0
Slovenia	0	0	0	0	0	0
Russia	0	0	0	0	0	0
Anonymous	2	0	0	0	0	0
Total	177	965	5.45	16	118	–

P_I : Single country publication output

C_I : Times cited of single country publication

CPP_I : Citation per publication of single country publication

P_C : International collaboration publication output

C_C : Times cited of international collaborated publication

CPP_C : Citation per publication of international collaborated publication

This paper, in 1991 by HACK et al. from USA, was published in *Pediatrics* and was cited 293 times since its publishing to 2003. This paper was also related to surgery treatment. Regarding the drug treatment related papers, 'Neonatal complications after the administration of indomethacin for preterm labor', in 1993 by NORTON et al. from USA, was the most frequently cited. It was published in the *New England Journal of Medicine* and was cited 157 times to 2003. The citation history of the most frequently cited papers for drug and surgery was shown in Figure 4. The citations reached to a maximum after 4 years' publication for surgery and 2 years' for drug. The peak position depended on the research discipline and was shifted to about 4 years in the case of

technical sciences (MARX & CARDONA, 2003). In addition, different fields show dissimilar citation frequency where the present impact factor accounted citation only for two years after publication (ZETTERSTROM, 2002). The citation pattern of the most cited PDA article may suggest that the impact factor be accounted for longer period after publication to maintain a better citation overview.

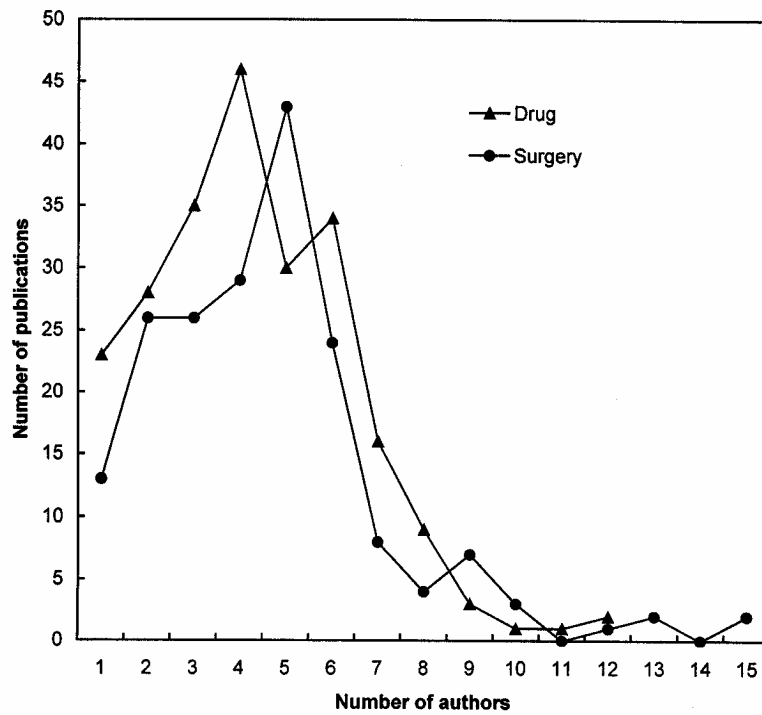


Figure 3. Comparison of number of publications and number of authors for surgery and drug treatment documents

Conclusion

PDA is a kind of heart diseases for infants. Compared with other kinds of heart diseases, it is not the most serious. However, it is sometimes fatal to a newborn baby. In this study, we have evaluated and analysed PDA treatments on surgery and drug by using the bibliometric tools. Though the study showed that both the treatments

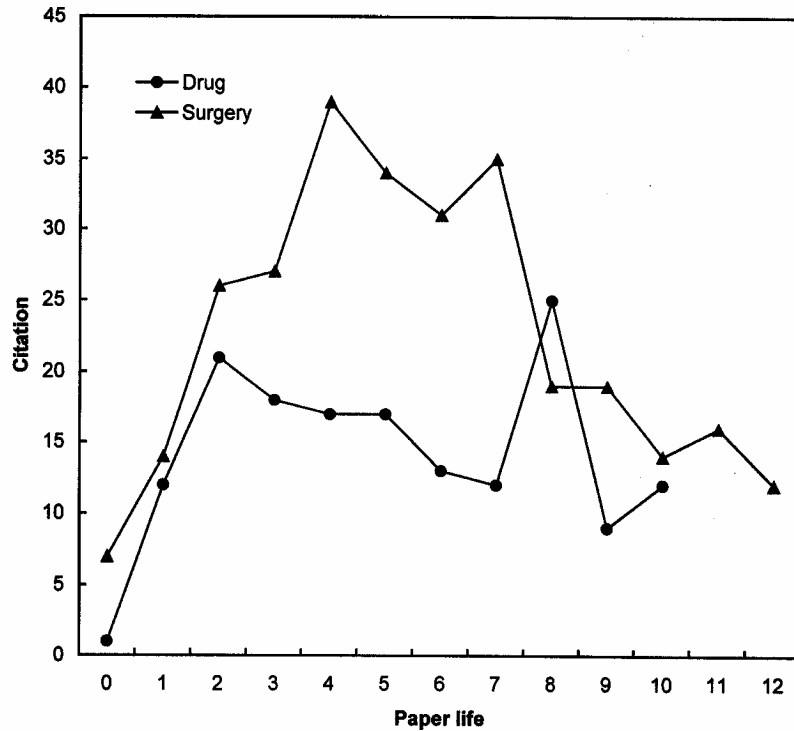


Figure 4. Citation pattern of the most frequently cited articles for surgery and drug treatment

were not the focus of PDA research, we still obtained some significant points that could contribute further studies to decrease the mortality of the disease. The paper denoted that yearly publications sustain constantly in each year for drug and in the later period of 90's for surgery treatment. However, the surgery treatment was a constant growth rate on publications in the early 90's. The average impact factor of the drug journals was higher than that of surgery's. The countries in which the documents of surgery and drug treatments were published have denoted that most of these researches were done by Europe and North America. Both of surgery and drug treatments had low international collaboration papers. The dominant language was English. Besides, two to six author group collaboration was a popular method as co-authorship.

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