

■ SPECIAL ARTICLE ■

Scientific Publication Productivity of Korean Medical Colleges: An Analysis of 1988-1999 MEDLINE Papers

To identify where the quality research activity has been and is carried out in Korea, and to examine to what extents Korean medical colleges play leading roles in the production of international research papers, we investigated the publication productivity of Korean medical colleges and their medical departments as measured by the number of papers published in foreign journals indexed in MEDLINE. The 12-year period from 1988 to 1999 is covered. A total of 4,881 papers is published in MEDLINE foreign journals by the researchers in Korean medical colleges during the period. The production of MEDLINE papers are concentrated in a few universities. More than 60% of MEDLINE foreign journal papers is published by top five universities—25% by Seoul National University, and 15% by Yonsei University. The newly established medical colleges at the University of Ulsan and Sungkyunkwan University produced outstanding numbers of papers in less than ten years. Radiology has led the internationalization of Korean medical papers. It was the most productive specialty identified in this study. The productivity of Internal medicine is on the rise from the mid-1990s, and the field began to produce the most number of papers since then.

Key Words: *Bibliometrics; Korea; Medicine; Periodicals/Statistics & Numerical Data; Research/Statistics & Numerical Data*

Man Chung Han, Choon Shil Lee*

Department of Radiology, Seoul National University
College of Medicine, Seoul, Korea
Department of Library and Information Science,*
Sookmyung Women's University, Seoul, Korea

Received: 2 February 2000

Accepted: 2 February 2000

Address for correspondence

Choon Shil Lee, Ph.D.
Department of Library and Information Science,
Sookmyung Women's University, Seoul 140-742,
Korea
Tel: +82.2-710-9372, Fax: +82.2-710-9276
E-mail: cslee@sookmyung.ac.kr

*Tables and figures published in this paper are available at URL: <http://sookmyung.ac.kr/~cslee/english/index.html#publications>. Other tables with more detailed data are also available at the same URL.

INTRODUCTION

A paper published in a journal indexed in MEDLINE or SCISearch is regarded in Korea as the paper of quality approved internationally. Korean medical institutions give more weights to MEDLINE papers along with SCISearch papers in the promotion of researchers or in rewarding grants to researchers.

The purpose of the present study is to identify where the quality research activity has been and is carried out in Korea, and to examine to what extents these institutions play leading roles in the production of international research papers. We investigated the publication productivity of Korean medical colleges and their medical departments as measured by the number of papers published in foreign (non-Korean) journals indexed in MEDLINE. We also investigated the productivity of each medical specialty measured by the union of all the corresponding medical departments of any Korean medical colleges. We measured the annual outputs to examine the growths over the years. The 12-year period from 1988 to 1999 was covered in this study. Subsequently,

five most productive Korean medical colleges and their five most prolific medical departments were identified. Twenty most productive medical departments of Korean medical colleges are also identified. The investigation was focused on the Korean medical papers published in the foreign journals indexed in MEDLINE because they would precisely represent the Korean medical papers in the international arena.

It is true that several studies have been conducted to investigate the publication activity by Korean medical researchers at the international level (1-3). However, the studies concentrated their analysis on Korean medical papers published in the journals indexed in the SCISearch. No studies have been reported yet to measure the productivity of Korean research using the MEDLINE data.

SCISearch is solely used throughout the world in the measurement of mainstream (international) research performance of nations, institutions, or authors, and of any disciplines individually or as a whole (4-7). Nevertheless, the use of the database in the measurement of the scientific publication activity of Korean medical colleges in particular is a subject of debate. The SCISearch's classi-

fication of subject categories (SC codes) for the papers indexed in the database is not appropriate in measuring the publication productivity of medical specialties of medical colleges. The SCISearch system classifies a paper by the subject of the journal where the paper is published. It is not by the institution (department) of the contributors of a paper. For instance, a dermatology paper published in *Lancet* by faculty members of a dermatology department is not counted as a dermatology paper. The journal is classified into a "Medicine, general & internal" category by SCISearch. Thus, the use of MEDLINE databases by the affiliations of authors is more effective in the measurement of publication productivity of Korean medical colleges

MATERIALS AND METHODS

Study period: 1988-1999

The analysis of publication output by medical college utilizing MEDLINE database is only possible from 1988—the year our investigation begins. The major search field used in this study to identify papers contributed to MEDLINE from Korean medical colleges and from individual departments of those colleges is the corporate source (CS) field. It is the field called "affiliation" in PubMed. The MEDLINE records entered before 1988 is not searchable by the field as a key, because the field is used in MEDLINE "beginning in 1988" (8).

The final searching of MEDLINE database was conducted in January 31st of 2000 through DIALOG. The DIALOG file 155, covering the 1966-2000/Mar W4 (March Week 4) period is used. Since the input of records for 1999 is still in progress at the time of searching, the data for 1999 does not reflect the number of records in full. It takes about 2-6 months before records are entered into MEDLINE once a journal issue is published.

Primary institutions only

MEDLINE automatically excludes the possibility of repetitive counting of research outputs among coauthoring institutions. Only the first author's affiliation is entered in MEDLINE. Assuming the first author of a paper is the primary author, the medical college listed in a MEDLINE record is the primary authoring institution. Similarly, only the medical departments of the first authors are counted.

Affiliations of every authors listed in a published paper are retrievable in SCISearch. This significantly differentiates the search results of MEDLINE from that of SCISearch. For instance, an internationally collaborated

work is not considered as a Korean paper unless the first author is affiliated with Korean medical colleges in the present study. On the other hand, in the studies done with SCISearch, any international collaboration is counted as the output of Korea as well as of all other participating countries. Thus, it may be said that our data reported here is a conservative measure of Korean research performance at the international level.

Foreign journal research papers only

Six Korean journals are indexed currently in MEDLINE. Five journals were already being indexed in MEDLINE in 1988, the beginning year of our investigation. They are the *Journal of Korean Medical Science*, *Korean Journal of Internal Medicine*, *Korean Journal of Ophthalmology*, *Korean Journal of Parasitology*, and *Yonsei Medical Journal*. Recently in 1998, *Experimental and Molecular Medicine* is picked up by MEDLINE. We excluded these Korean journals in the main analysis, although the number of papers published in these journals were measured and subtracted from the total number of MEDLINE papers in order to obtain the number of foreign journal papers.

Only journal articles, letters, and reviews indexed in MEDLINE are included in this study. Although other types of documents are also covered in MEDLINE (9), none of these other types of documents is found for Korean papers in MEDLINE.

Korean medical college and medical department names

MEDLINE covers the fields of medicine, nursing, dentistry, veterinary medicine, the health care system, and the preclinical sciences (10). Because the scope of the study is limited precisely to the measurement of research output produced by medical colleges, the search statements specify the words such as dentistry, veterinary, nursing or nurse to be excluded using Boolean operator "NOT". In addition, the search statements specify either "medicine" or "medical" to appear in the CS field. Thus, those records without "college of medicine", "school of medicine", "medical college", or "medical school" in the field are not retrieved. These limits are introduced in an attempt to avoid the retrieval of records contributed by the researchers who are in the related medical areas but are not affiliated with medical colleges.

English names of Korean medical colleges are taken from the Present Status of Korean Medical College Education (11). Other variant spellings of the college names are also used in searching to retrieve as many relevant records as possible. For instance, "Chungang", "Jung-Ang" and "Jungang" are also searched for "Chung-Ang"

University. However, even with such efforts, some records with obvious typos and awkward spacings between syllables of a name could not be retrieved.

Although free MEDLINE is available on the PubMed web site, the MEDLINE is searched through DIALOG because it allows the more sophisticated proximity searching by which names of Korean medical colleges and medical departments can be defined precisely in a search statement. The search of "Korea" and "university" would retrieve records published by any "university" in "Korea", whereas "Korea(w)university" in the DIALOG command retrieves only the records with the unique university name.

Some of the university hospitals with distinctive names such as Samsung Medical Center of Sungkyunkwan University are specified in the search statements, and the retrieved papers are counted as the papers of parent medical colleges. Papers published by the medical center prior to the establishment of a medical college at the University in 1997 are included in our data. Similarly, the papers of Asan Medical Center at the University of Ulsan (established in 1990), Gil Medical Center at Gachon University (established in 1997), etc are also included.

Different medical department names are used in different medical colleges. For example, either Otorhinolaryngology or Otolaryngology is used in most medical colleges. Yet, Head and neck surgery are added to one of these two words in some medical colleges such as Seoul National University. The most complicated example is the case of Internal medicine. Some universities such as Sungkyunkwan University call it simply the Department of Medicine. The genuine problem in defining Internal medicine as a specialty is to include more than a dozen subspecialties. The departments integrated into this category are Allergy, Bone marrow transplantation, Cardiology, Chest medicine, Clinical nutrition, Endocrinology, Gastroenterology, Genetics, Hematology, Immunology, Infectious disease, Medicine, Medical oncology, Nephrology, Pulmonary and critical care medicine, and Respiratory medicine.

In order to minimize the proportion of "non-classifiable" records, every single record which did not belong to 35 medical specialties used in this study was eye-checked, and reclassified into the appropriate specialties. Yet, it was inevitable to put some records into the "non-classifiable" category. In some cases, the authors did not indicate a department as a part of the institution they are affiliated. In some cases, a paper is produced by a multidisciplinary institute or center of a university. Examples are the Medical Research Institute of Sungkyunkwan University, or the Brain Research Center of Yonsei University.

In general, issues of the *Journal of Korean Medical Science* published between 1989 and 1999 are scrutinized to verify all possible name variations of Korean medical colleges, their affiliations and medical departments.

RESULTS

Total publication output

The total number of MEDLINE Korean papers identified in this study for the period of 1988-1999 is 6,726 as shown in Table 1. This is the number of papers contributed from 41 medical colleges which existed in Korea as of March 1999 (11). Of those 6,726 papers, 1,845 papers were published in six Korean medical journals, consisting 27.4% of the total contribution to MEDLINE from Korea. Consequently, the number of MEDLINE records for papers published in foreign journals by the medical researchers affiliated in medical colleges in Korea is 4,881, and this is the set of records used in various analysis in the present study.

Most productive Korean medical colleges

Table 2 lists the twenty most productive Korean medical colleges among 41 medical colleges examined. The productivity was ranked by the number of papers pub-

Table 1. No. of MEDLINE papers contributed from Korean medical colleges by publication year: 1988-1999

Publication year	Total* [T]	Korean journals [K]	Foreign journals [F] [†]
1988	90	23	67
1989	117	28	89
1990	249	100	149
1991	291	113	178
1992	368	137	231
1993	425	169	256
1994	515	171	344
1995	601	207	394
1996	719	196	523
1997	918	221	697
1998	1,203	285	918
1999 [‡]	1,230	195	1,035
Total	6,726	1,845	4,881

*CS (Corporate source, i.e., affiliation) field is used as a search field for this column. CS field is a MEDLINE field "beginning in 1988", DIALOG Bluesheet (<http://library.dialog.com/bluesheets/html/bl0154.html>) [Accessed October 1, 1999].

[†][F]=[T]-[K]

[‡]The nos. for this year are to be increased. The final searching of MEDLINE was done in January 31 of 2000, and the input of records for 1999 was not completed yet at the time.

Table 2. The twenty most productive Korean medical colleges by the no. of MEDLINE papers published in foreign journals: 1988-1999

Medical College	Total [T]	Korean journals [K]	Foreign journals [F]*
1. Seoul National University College of Medicine	1,461	292	1,169
2. Yonsei University College of Medicine	1,283	542	741
3. Catholic University of Korea College of Medicine	508	89	419
4. University of Ulsan College of Medicine	492	94	398
5. Sung Kyun Kwan University College of Medicine	266	40	226
6. Hanyang University College of Medicine	236	93	143
7. Hallym University College of Medicine	184	50	134
8. Korea University College of Medicine	191	62	129
9. Chonbuk National University College of Medicine	147	23	124
10. Ajou University School of Medicine	159	43	116
11. Kyung Hee University College of Medicine	160	61	99
12. Chonnam University Medical School	147	48	99
13. Chung-Ang University College of Medicine	136	41	95
14. Soonchunhyang University College of Medicine	127	40	87
15. Yonsei University Wonju College of Medicine	113	30	83
16. Pusan National University College of Medicine	82	4	78
17. Keimyung University School of Medicine	106	31	75
18. Gyeongsang National University College of Medicine	94	19	75
19. Wonkwang University College of Medicine	79	8	71
20. Kyung Pook University College of Medicine	104	34	70
The Other 21 medical colleges	651	201	450
Total	6,726	1,845	4,881

English names of Korean medical colleges are taken from the Present Status of Korean Medical College Education [Euikwa Taihak Kyoyouk Hyunwhang]: 1998-1999. (Seoul: Council of Korean Medical College Deans, 1998.) Other variant spellings of the college names are also used in searching.

*[F]=[T]-[K]

lished between 1988 and 1999 in foreign journals indexed in MEDLINE.

The research output of these 20 medical colleges consists more than 90% of the total output from Korea. Of the 4,881 MEDLINE foreign journal papers contributed by 41 Korean medical colleges, 450 papers are contributed by 21 other medical colleges not listed in Table 2. The proportion of foreign journal papers is little bit higher in the more productive medical colleges than in the less productive medical colleges. It is 72.9% for the 20 medical colleges listed in Table 2 and 69.1% for the other 21 medical colleges not listed in the table.

The 12-year output of the most productive medical college, Seoul National University, is 1,169 papers—one fourth of the total outputs of Korean medical colleges. The annual average of 97 papers is almost the same as the 12-year total produced by the university at rank 11 in Table 2. The outstanding performances of newly established medical colleges such as the University of Ulsan (established in 1990), Sungkyunkwan University (established in 1997) and even Ajou University (estab-

lished in 1988) are of noteworthy. They ranked the fourth, fifth and tenth.

Publication output by medical specialty

Table 3 lists the number of MEDLINE papers of each medical department. The production of MEDLINE papers is also concentrated in a few specialties. Radiology is the specialty which produced the most number of papers. It published 714 papers, 15% of all MEDLINE Korean papers during the 12-year period. It is followed by the Internal medicine by a slight difference of 10 papers. The sizes of the contribution to MEDLINE of Surgery and Dermatology which ranked the third and the fourth drop to one half of the two most productive specialties. The number of pathology papers, next in the rank drops to two thirds.

Most productive medical departments

The number of MEDLINE papers published in each

Table 3. No. of MEDLINE papers contributed by medical specialty: 1988-1999

Medical specialty	Total [T]	Korean journals [K]	Foreign journals [F] [†]
Anatomy	125	16	109
Physiology & biophysics	233	43	190
Biochem & molec biol	221	53	168
Pharmacology	230	18	212
Microbiology	170	44	126
Prevent med & pub health	75	31	44
Parasitology & trop med	331	198	133
Hist med & med ethics	0	0	0
Forensic med	3	1	2
Health policy & mgt	1	0	1
Occupat & environ med	21	3	18
Internal med*	1,181	476	705
Surgery	467	91	376
Obstetrics & gynecology	146	26	120
Pediatrics	258	94	164
Psychiat & neuropsychiat	73	10	63
Neurology	199	72	127
Dermatology	420	45	375
Orthopedics	213	36	177
Thoracic & cardiovasc surg	80	23	57
Neurosurgery	170	43	127
Plastic & reconstruct surg	120	1	119
Urology	172	47	125
Otorhinolaryngology	150	14	136
Ophthalmology	277	149	128
Radiology	749	35	714
Therapeut radiol&radiat oncol	30	6	24
Nuclear med	59	5	54
Anesthesiology	62	25	37
Pathology	494	261	233
Clinical pathology	119	53	66
Rehabilitation med	46	23	23
Biomedical engineering	46	6	40
Family med	25	10	15
Emergency med	1	0	1
Non-Classifiable	240	25	215

Column totals are greater than the true total nos. of Korean papers because some overlaps exist among medical specialties.

*Includes Allergy, Bone marrow transplantation, Cardiology, Chest medicine, Clinical nutrition, Endocrinology, Gastroenterology, Genetics, Hematology, Immunology, Infectious disease, "Medicine", Medical oncology, Nephrology, Pulmonary and critical care medicine, Respiratory medicine.

[†][F]=[T]-[K]

year by 5 most productive medical departments of 5 leading Korean medical colleges are shown in Table 4. Naturally, the five most productive specialties of Korean medical colleges displayed in Table 3 are usually the most prolific departments of these 5 medical colleges. Radiology and Internal medicine obviously appear in every medical colleges listed in Table 4. Radiology ranked the first in three colleges, and Internal medicine ranked the first in two college. Dermatology and Surgery appear in 4 medical colleges.

Table 5 shows the best 20 medical departments of Korean medical colleges simply based on the number of papers indexed in MEDLINE. Department of Radiology of Seoul National University is the most productive department of all Korean medical colleges. The publication output of this single unit is more than the total publication output of the medical college ranked the fifth in Table 2. Internal medicine is a strong specialty at the University of Ulsan, Yonsei university, and Seoul National University.

Table 4. No. of MEDLINE papers of 5 most productive medical departments of 5 leading Korean medical colleges by publication year

Department	88	89	90	91	92	93	94	95	96	97	98	99	Total
Seoul National University													
Radiology	8	15	16	14	29	29	25	28	29	22	30	32	277
Internal medicine	2	6	4	5	6	7	1	7	7	16	22	24	107
Pathology	7	6	6	7	3	8	2	9	5	8	19	15	95
Dermatology	0	2	1	5	1	3	6	6	13	15	12	6	70
Pediatrics	1	0	5	1	2	2	3	9	7	13	8	7	58
Total*	20	35	58	53	71	87	89	110	116	158	190	182	1,169
Yonsei University													
Internal medicine	0	2	0	1	6	0	8	11	12	18	15	35	108
Surgery	1	1	1	1	8	3	12	7	15	14	24	17	104
Dermatology	4	5	7	6	4	9	9	13	12	8	7	9	93
Radiology	0	1	1	3	1	2	6	4	8	13	15	16	70
Orthopedics	2	0	1	3	0	2	7	7	9	6	12	8	57
Total*	15	19	25	31	41	29	49	69	85	109	128	141	741
Catholic University of Korea													
Radiology	1	0	0	3	4	10	10	8	4	4	10	11	65
Internal medicine	0	0	0	1	3	5	5	6	15	7	12	7	61
Ophthalmology	0	0	0	0	5	7	3	2	4	4	2	9	36
Dermatology	0	0	0	0	1	0	3	4	5	5	7	6	31
Surgery	2	0	2	0	3	2	3	2	6	3	3	4	30
Total*	7	6	9	9	20	32	38	39	51	47	65	96	419
University of Ulsan													
Internal medicine		0	0	1	1	5	8	7	13	18	26	31	110
Radiology		0	0	4	3	4	4	6	6	11	14	20	72
Neurology		0	0	1	2	3	7	8	8	6	8	12	55
Surgery		0	0	0	1	2	4	2	11	3	14	6	43
Biochemistry & molecular biology		0	0	2	0	3	2	5	4	5	3	5	29
Total*		0	0	8	9	21	28	28	53	55	92	104	398
Sungkyunkwan University													
Radiology							0	2	9	11	11	32	65
Surgery							0	1	4	3	7	6	21
Internal medicine							0	0	0	3	8	10	21
Pediatrics							0	0	1	1	7	6	15
Dermatology							0	1	1	2	4	5	13
Total*							0	5	22	32	64	103	226

*Total no. of records of all medical departments of the university

DISCUSSION

Growth of publication outputs

The annual publication outputs of Korean medical colleges have increased drastically doubling every two to three years during the 12-year study period. The output in 1999 is approximately 15 times of the output in 1988. Fig. 1 displays the growth of the annual publication outputs from Korean medical colleges as indexed in MEDLINE. The growth in the total number of MEDLINE papers contributed from Korea is entirely due to the growth in the number of foreign journal papers.

The two graph lines go parallel. On the contrary, the number of Korean journal papers has not increased much during the study period. It is because five Korean journals were already being indexed in MEDLINE in 1988, and only one more journal is added to the database since then. The last journal *Experimental and Molecular Medicine* is added in 1998.

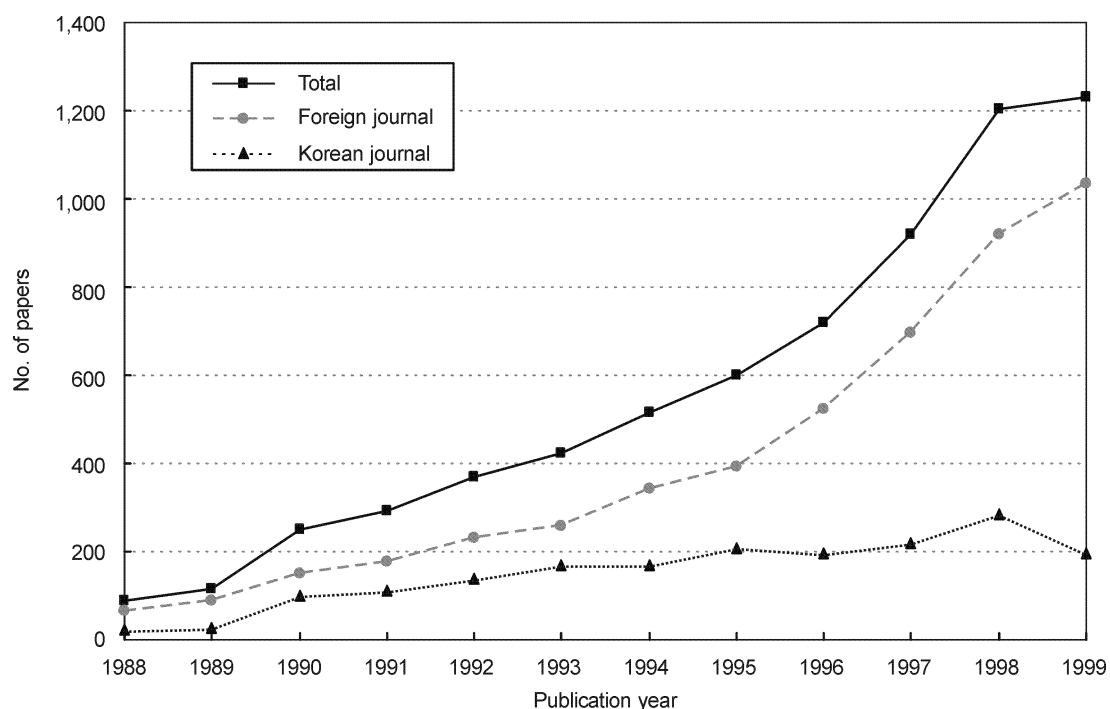
The number of foreign journal papers has increased dramatically beginning around 1993. This is when Korean medical institutions began enforcing publication in international journal to the medical faculty.

The growth pattern of Korean medical college papers found in MEDLINE is very similar to the growth pattern

Table 5. No. of MEDLINE papers of 20 most productive medical departments of Korean medical colleges

Department	88	89	90	91	92	93	94	95	96	97	98	99	Total
1. Radiology (SNU)	8	15	16	14	29	29	25	28	29	22	30	32	277
2. Internal med (Ulsan)		0	0	1	1	5	8	7	13	18	26	31	110
3. Internal med (Yonsei)	0	2	0	1	6	0	8	11	12	18	15	35	108
4. Internal med (SNU)	2	6	4	5	6	7	1	7	7	16	22	24	107
5. Surgery (Yonsei)	1	1	1	1	8	3	12	7	15	14	24	17	104
6. Pathology (SNU)	7	6	6	7	3	8	2	9	5	8	19	15	95
7. Dermatology (Yonsei)	4	5	7	6	4	9	9	13	12	8	7	9	93
8. Radiology (Ulsan)		0	0	4	3	4	4	6	6	11	14	20	72
9. Dermatology (SNU)	0	2	1	5	1	3	6	6	13	15	12	6	70
9. Radiology (Yonsei)	0	1	1	3	1	2	6	4	8	13	15	16	70
11. Radiology (Catholic)	1	0	0	3	4	10	10	8	4	4	10	11	65
11. Radiology (SKKU)							0	2	9	11	11	32	65
13. Internal med (Catholic)	0	0	0	1	3	5	5	6	15	7	12	7	61
14. Pediatrics (SNU)	1	0	5	1	2	2	3	9	7	13	8	7	58
15. Orthopedics (Yonsei)	2	0	1	3	0	2	7	7	9	6	12	8	57
15. Otorhinolaryngol (SNU)	0	0	1	1	3	2	6	12	9	8	7	8	57
17. Neurology (Ulsan)		0	0	1	2	3	7	8	8	6	8	12	55
18. Surgery (SNU)	1	0	0	0	7	4	5	2	2	6	5	11	43
18. Surgery (Ulsan)		0	0	0	1	2	4	2	11	3	14	6	43
20. Physiol & biophys (SNU)	0	0	1	2	1	2	3	7	3	10	9	2	40
20. Neurosurgery (SNU)	1	0	1	0	2	3	1	4	5	7	10	6	40

SKKU, Sungkyunkwan University; SNU, Seoul National University

**Fig. 1.** Growth of MEDLINE papers contributed from Korean medical colleges: foreign vs Korean journal papers.

observed in SCISearch as reported in the previously mentioned studies (1-3), although direct comparisons between the two groups should be made with caution because the SCISearch data includes all Korean medical

papers contributed from any sector, not just medical colleges.

Medical colleges seem to be the driving forces of internationally acknowledged medical research done in

Korea. The total of 6,726 papers contributed from Korean medical colleges consist about 60% of all MEDLINE Korean papers (11,784) indexed in the same period. The rest is contributed by institutes and by colleges in other disciplines including natural sciences and pharmacy. More than 4.4 million records are indexed in MEDLINE during the study period from 1988 to 1999. Thus, the contribution rate from Korean medical colleges to MEDLINE for this period is about 0.15%. The entire contribution rate from Korea to MEDLINE is 0.25%. The contribution rate from Korean medical colleges to MEDLINE is still very low.

Major producers of international papers: medical colleges

The production of MEDLINE papers are concentrated in a few universities. The research output of the top 10 medical colleges is more than 70% of the total output from Korea, and that of the top five medical colleges is more than 60%. Almost 40% of MEDLINE foreign journal papers is published by two universities—25% by Seoul National University, and 15% by Yonsei University. They are certainly the major producers of international papers in Korea.

Fig. 2 depicts the annual outputs and growth patterns of MEDLINE papers contributed from each of the five most productive Korean medical colleges. The annual publication outputs by these prestigious universities have grown steadily. The most striking feature of Fig. 2 is the

outstanding performances of the two relatively new medical colleges, the University of Ulsan and Sungkyunkwan University. The two colleges outperformed the average Korean medical colleges. They obviously demonstrated the rapid growth rate over a short time period enough to catch up with the number of papers produced by the other colleges in 12 years. The University of Ulsan has produced more papers every year than the Catholic University of Korea from 1996. Sungkyunkwan University is approaching to the level of the University of Ulsan in 1999.

Major producers of international papers: medical specialties

Fig 3. illustrates the growth of MEDLINE Korean papers of five most productive medical specialties. The graphs generally go upward with a very modest fluctuation over the years. In 1988, the number of MEDLINE Korean papers in each of these five specialties was less than 10, and not much differences in international outputs among them were noticeable. Radiology showed a sharp increase, and it was definitely the most productive medical specialty in Korea until 1995 when it was surpassed by Internal medicine. Dermatology and Surgery competed each other for the last ten years. However, the number of Surgery papers almost doubled in 1998 in one year (from 48 papers to 89 papers), and the gap between the two specialties has gotten suddenly wider.

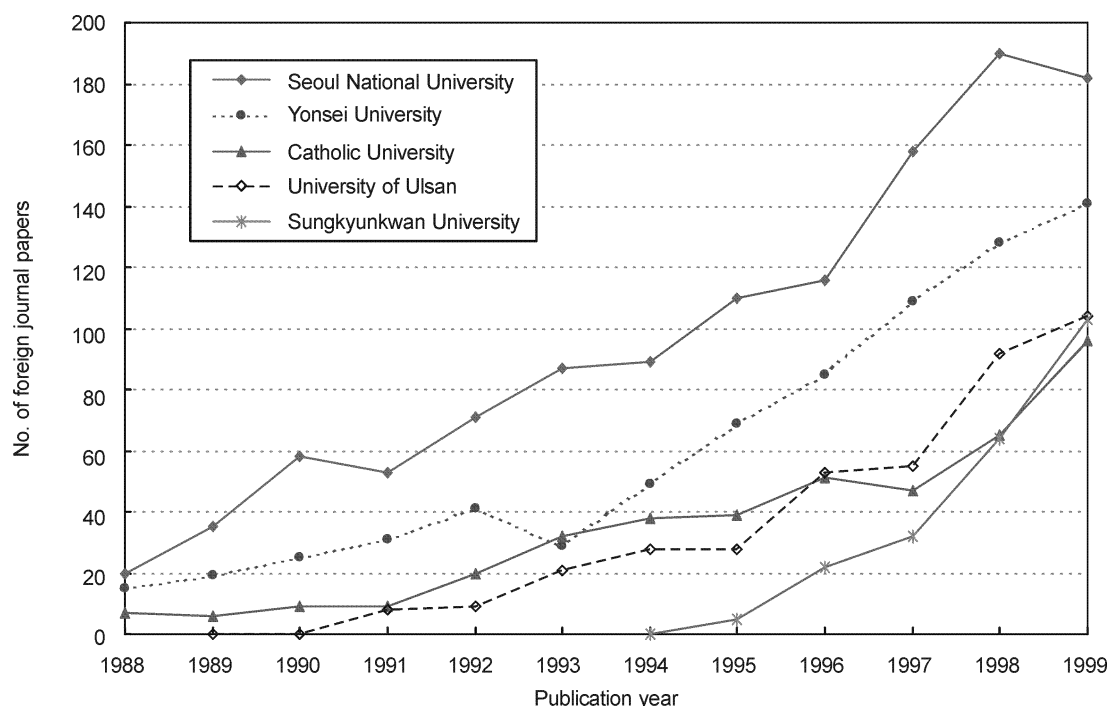


Fig. 2. Growth of MEDLINE papers of five most productive Korean medical colleges.

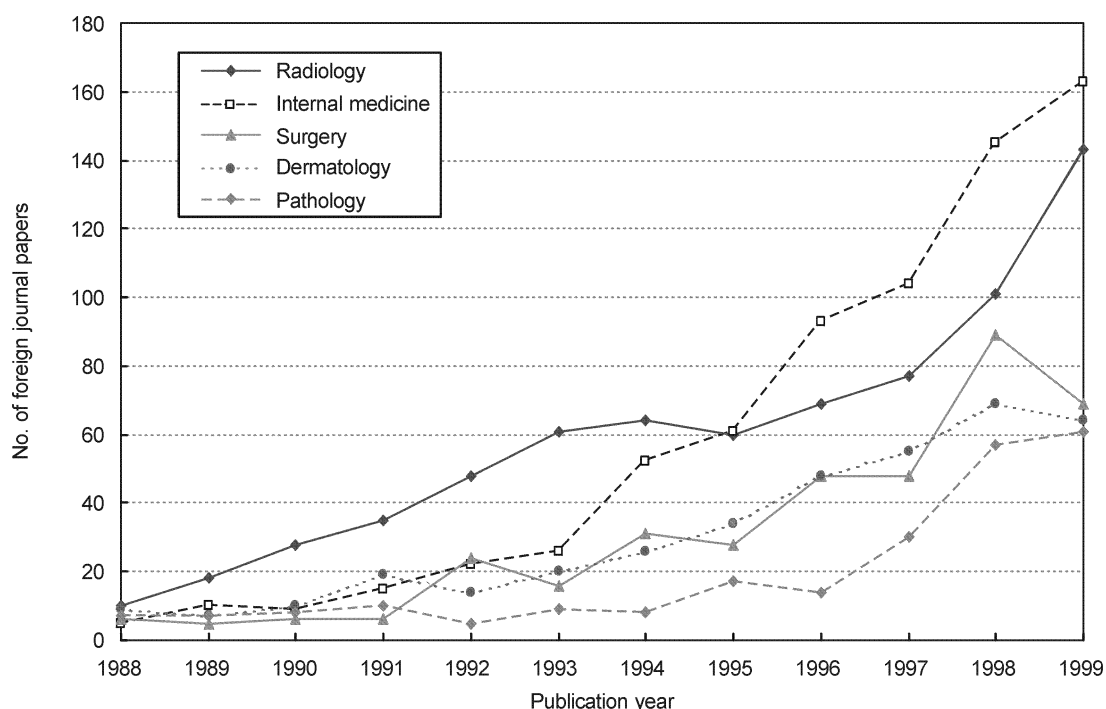


Fig. 3. Growth of MEDLINE Korean papers of five most productive medical specialties.

Major producers of international papers: medical departments

The departments with more than 40 papers in 12 years are listed in Table 5 as the best 20 (21 to be exact) medical departments. If a medical department has published 3 or 4 papers a year, they are the best 20 out of at least 1,000 medical departments which exist in Korean medical colleges. An insightful guess on the productivity of average departments of Korean medical colleges can be made by looking at the lower left corner of Table 5. They are mostly zeros and ones. Further down the table, there will be hardly any bigger numbers.

Table 4 and Table 5 show distinctively that any medical department of a medical college which produced more than 25 papers a year is the leading center of international research not only of the college but also of Korea. The Department of Radiology at Seoul National University which ranked the first by far (more than twice the number of the second department) has been publishing that much every year since 1992.

There are some medical departments which produced a major portion of papers published in a specialty. The Department of Neurology at the University of Ulsan, the Department of Otorhinolaryngology and the Department of Pathology at Seoul National University have published more than 40% of Korean papers published in MEDLINE journals in each specialty.

Another thing to be noted is that the best 20 medical departments belong only to those five most productive

medical colleges. Nine medical departments of Seoul National University, five of Yonsei University and two of Catholic University of Korea are included in the list. Four medical departments of the University of Ulsan are included among the best 20 departments. If the short history of the medical colleges are taken into account, it is very impressive. The performance of Sungkyunkwan University with even shorter history is also noticeable.

In summary, the 12-year review of medical publication outputs contributed from Korean medical colleges reveals that two universities, Seoul National University and Yonsei University, are the major centers of medical research internationally recognizable. The newly established medical colleges at the University of Ulsan and Sungkyunkwan University made an outstanding progress in less than ten years. Radiology is the most productive specialty identified in this study for the period covering the late 1980s and a decade of the 1990s. Radiology has led the internationalization of Korean medical papers at the momentous, therefore critical, period in the early 1990s. The productivity of Internal medicine is on the rise from the mid-1990s, and the field began to produce the most number of papers since then. However, considering the wide scope of the subspecialties the field covers and the size of faculty involved in the field, the higher publication productivity is expected. Overall, the Department of Radiology at Seoul National University certainly deserves the credit for being the forerunner of internationalization of Korean medical papers. The Department of Internal Medicine at the University of Ulsan,

Yonsei University and Seoul National University did their shares in making Korean medical research visible in the international scene.

REFERENCES

1. Lee CS. *Medical papers published by Korean scientists during the 1980s: a comparison with chemistry* [dissertation]. Chicago: Univ Chicago, 1994.
2. Lee CS. *Publication output and contribution rate of SCI Korean medical papers: 1990-1995*. *J Korean Soc Info Manag* 1999; 16: 137-56.
3. Lee CS. *Productivity of SCI Korean medical papers: 1996-1997*. *J Korean Med Sci* 1999; 14: 351-8.
4. Braun T, Glänzel W, Schubert A. *The newest version of the facts and figures on publication output and relative citation impact of 100 countries*. *Scientometrics* 1988; 13: 181-8.
5. Braun T, Glänzel W. *A topographical approach to world publication output and performance in the sciences, 1981-1985*. *Scientometrics* 1990; 19: 159-65.
6. Ministry of Science & Technology of Korea (KMST). *National rankings of science & technology publication outputs: analysis of SCI database*. KMST Research reports. Kwacheon: KMST, 1998.3.
7. Ministry of Science & Technology of Korea (KMST). *National rankings of science & technology publication outputs and citation rate: analysis of SCI database*. KMST Research reports. Kwacheon: KMST, 1999.11.
8. DIALOG bluesheet. [cited 1999 October 1]. Available from: URL: <http://library.dialog.com/bluesheets/html/bl0154.html>.
9. The PubMed help. [cited 1999 September 15]. Available from: URL: <http://www.ncbi.nlm.nih.gov/PubMed/pubmedhelp.html>.
10. The NLM PubMed Project. [cited 2000 January 2]. Available from: URL: <http://www.ncbi.nlm.nih.gov/PubMed/overview.html#DatabaseCoverage>.
11. Council of Korean Medical College Deans. *Present status of Korean medical college education: 1998-1999*. Seoul: Council of Korean Medical College Deans, 1998.