

World Biomedical Journals, 1951-60:

A Study of the Relative Significance of 1,388 Titles Indexed in *Current List of Medical Literature**

BY L. MILES RAISIG

*Head, Acquisitions Section, and Research Assistant
Yale Medical Library
New Haven, Connecticut*

ABSTRACT

This study is an application of the relationship of serial articles published to serial articles cited, developed in theory in the author's "Statistical Bibliography in the Health Sciences" (BULLETIN 50: 450-461, July 1962). A ranked list of the indexes of significance of most of the serials indexed in *Current List of Medical Literature* was derived and erected from 21,000 citations secured in a random sampling of 1962 and 1961 biomedical journals regularly received in the Yale Medical Library. The author measures the gross indexing effectiveness of *Current List* against his indexes of significance, offers his method and results as means to reach objective standards for indexing and abstracting, and projects his results as measures of general value of the serials analyzed.

EVERY biomedical journal exists basically as a vehicle for the communication and dissemination of ideas related to medicine, and as such a vehicle it has a definite and measurable significance to its reader and citer users. "Significance" is used throughout this paper to denote measure of value. Within the framework of the analytic relationships following, the more articles (and, presumably, the more ideas) cited from a journal, the more significance that journal possesses as a vehicle for the communication of ideas capable of use by others. Published ideas, as citations, can be recorded and related; the resulting interpreted relative measure of value of each vehicle can be projected as the general significance of that journal to all its reader users, whether citers or not.

This investigation into the characteristics and significance of certain biomedical journals, indexed in *Current List of Medical Literature*

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during the period 1951-60, has attempted to satisfy three research needs.

First, this project has applied in practice the improved citation analysis based upon the relationship of serial articles published to serial articles cited, discussed at length in my "Statistical Bibliography in the Health Sciences" (1). Second, it has produced an objective, related list of the significance to users of *Current List of Medical Literature* of most of the serials indexed there. Third, it has served to indicate in some measure the effectiveness of this national indexing vehicle and to suggest the use of both analysis and list to establish standards for indexing and abstracting.

The results of any articles-cited/published-ratio analysis become particularly meaningful when used as estimates of the probable future significance of the serials studied. Thus, it is predicated here that the mathematical relationship of the number of articles published in any given unit of a serial and the number of these articles cited later can be interpreted as the significance of that serial with reference to other serials so measured.

It is believed further that the future significance of any journal with a stable editorial policy, an established subscriber and contributor support, an invariable proportion of the languages of its articles, and inclusion in a readily available indexing tool exhibiting consistent currency and depth of subject treatment can be projected from a measurable past significance. It appears likely that the probable significance of a majority of the serials in a statistically valid citation analysis will be affected little by the continued fragmentation of specialty journals and by the ebb and flow of waves of subject interest. It follows that the significance of

a scientific serial in the last decade will remain about the same in the present decade.

The merit of the universal type analysis over the local title count of journals borrowed is the merit of the frequency-adjusted, article-citation-related study over the unadjusted, unrelated tally of the physical out-and-back movement of journal titles. The former offers the interested librarian the objectivity of relative significance and can free him from the inherently subjective weaknesses of the latter, which is too often solely a popularity list lacking so basic an element as a record of issue dates and units (unbound or bound) borrowed.

The relative significance of such a heavily used weekly as *Lancet* or *Journal of the American Medical Association* can be seen in true perspective in the articles-cited/published-ratio analysis. This significance is lost, however, in the frequency bias found in the unadjusted circulation study. Here the simple fact of greater frequency assures the weekly an inaccurately high rank. It is obvious that serial circulation statistics, if they are to be realistically interpreted, must be related to the numbers of articles published by each journal under study. Only in this way can the advantage of greater frequency be nullified.

This discussion is not intended to minimize the *potential* value of *valid* circulation statistics in libraries of special interests, responsibilities, or subject orientation. An analysis of the merits, lacks, relationships, and interpretation of the journal circulation statistical study is properly the subject of another paper, in which this device as a possible measure of use may be carefully examined.

The articles-cited/published-ratio analysis serves primarily as a measure of the significance of all of the published articles in a given unit of a journal in the aggregate. It can also serve well to measure the significance of any single article, by the identification and totaling of citations to that article. It can check or reinforce or even replace Freund's "publication profile" method, which measures the "value" or significance of a journal by the critical analysis of the multiple facets (methods, results, conclusions) of each article published (2). The citation analysis has the definite advantage of indicating the universal judgment, in any given period of time, of the relative significance of a

journal article; it requires sufficient time to elapse to assure adequate diffusion of the article for judgment and citation. Freund's method can be used as a pre- or postpublication analysis, but it depends necessarily upon the judgment of a very small group and so loses the universality of judgment measured by the citation analysis.

MATERIALS AND METHODS

The project was built around a serials index and a citation population. The index, *Current List of Medical Literature*, published by the U. S. National Library of Medicine, was chosen because it was in English, comprehensive, and easily available, and particularly because its article entries were listed by the physical units of titles indexed and were serially numbered.

The first part of the study was devoted to creating an estimate of the number of articles published during the period 1951-60 by each serial with a frequency of four or more times in a twelve-month period indexed in *Current List of Medical Literature*. This was done by examining the entries for each title for the single years 1953 and 1957, assumed arbitrarily to be years representative of the decade. The actual numbers indexed were recorded on cards; the totals for 1953 and 1957 were averaged and the result multiplied by the actual number of years the serial had published during the 1951-60 period. If a serial had published in neither 1953 nor 1957, one or more alternate years was used to provide an estimate. If a serial was indexed incompletely or not at all in an estimate-based year, an adjoining year was used, providing at least three-fourths of the issues during the calendar year chosen were indexed.

All indexed serials with a frequency of less than four times in a twelve-month period were rejected during the establishment of estimates of articles published. They were rejected largely to eliminate the annual, yearbook, and review type publications, with their lack of original articles and appended citations.

Some few journals, either just ending publication in the early years of the 1951-60 decade or just beginning publication in the late years of the decade, were coincidentally omitted from the study by reason of the arbitrary selection of 1953 and 1957 as estimate years.

All changes during the decade of the fre-

quency of the serials studied have been taken into account in the computation of the estimates of articles published.

It must be noted here that the term "articles published" is equal to "articles indexed" and necessarily excludes nonresearch material (book reviews, society news, etc.) appearing in a serial but rejected for indexing in *Current List of Medical Literature*.

There were created next a list of abbreviated titles of the accepted serials and series of two-, three-, and four-character code words for serial frequency, language of publication, country of origin, and subject or specialty. These words were abbreviated in anticipation of the expected punching of the data into machine-sort cards and also to permit keyword scanning of titles and characteristics in list form. Brandon's serial subject list of 1962 (3) was used to assign to each title its subject or specialty. All titles and codes were combined finally into a single authority list, which with accompanying instructions served as a guide for the choice and recording of citations.

The second data source of the project—the citation population to be analyzed—was found in the issues of accepted serials published in 1962 and 1961 (in that order) and received in the Yale Medical Library. These years were chosen to yield the highest number and greatest spread of citations to articles published in the 1951–60 decade. In spite of the concentrated efforts of twelve analysts, it was not possible to examine within the time limit of the project all of the accepted serials for their citation contents. The large number of citations actually gathered made it impossible to identify and eliminate replicate citations to any single article, a practice suggested in my earlier discussion (1). Some small mathematical advantage in significance may accrue to any title with replicate citations; this advantage does not extend to the title cited once only. Russian journals whose citations were published in Russian only were rejected as citation sources, as none of the analysts was able to translate them.

In practice, the analyst was instructed to find on shelf the first serial alphabetically in the group allotted to him, to open the first acceptable issue of this title, to find the first citation, and to count that and successive citations until he reached the fiftieth. He was to reject this citation if its year fell outside the 1951–60 pe-

riod or if in spite of its falling within the period it referred to an unpublished article or private communication, to a book or other monograph, to a serial title not contained in the authority list, or to a serial supplement indexed separately from its serial in *Current List of Medical Literature* and considered to be a monograph. If the citation was acceptable it was recorded, and the count was begun again to lead to the examination of the fiftieth citation beyond. This successive counting was continued without break from issue to issue and in reasonably close alphabetized order from serial to serial. The analyst kept no record of missing issues, nor did he attempt to recover them at a later time for analysis.

At the time any fiftieth citation was rejected, the reason for rejection was recorded on a special tally sheet, and the next following citation was examined. This process continued, citation by citation, until an acceptable citation was recorded, and the fifty count was resumed. In the first half of the analytic period the title of each rejected journal was recorded; in the second half of the period the rejected title was tallied only. Each recorded observation consisted of two parts: (1) the title of the source journal, its year, language, frequency, country of origin, and subject, and the number of authors of the citing article; and (2) the title of the cited journal, its volume, year, language, frequency, country of origin, and subject, the number of authors and the first page of the cited article, and the interval in years between the publication of the cited article and its citation in the source journal.

The observations were hand printed on a recording sheet, which was edited for correctness and completeness before delivery for processing. Each complete observation was punched into one machine-sort card.

With all observations in card form, it became necessary to find for each cited journal its relative index of use and its position in a numeric series. This was done with the formula

$$\frac{\text{number of subsequent citations to articles}}{\text{number of articles originally published}} \times 100,000,$$

which offered for any title a whole number of two to five digits as a quotient.

The following steps were taken in working and interpreting the data gathered: (1) the

punched cards were passed through an IBM 1401 data processing system, where all observations were transferred to tape; (2) an alphabetic grouping by cited journal was done in a 709 sorter; (3) citations were tabulated in the 1401 system; (4) a grouping of cited journals by totals of citations was done on the 709 sorter, then returned to the 1401 for listing by its high speed printer; (5) citation totals were transferred individually from the list to the recording cards bearing estimates of articles published, and from these new machine-sort cards were punched, each bearing the cited serial title, its language, frequency, country of origin, and subject, the estimate of articles published, the total number of citations found, and notation of its use as a citation source and acceptance or rejection of any cited supplements; (6) these cards were alphabetized by title in an IBM 082 sorter and passed through the 1401 system, which computed the quotients or indexes of use, punched these into the cards, and printed an alphabetized list of the results; (7) in the 082 sorter the cards were grouped by index of use, from high to low, and the results listed by the 1401 high speed printer; (8) further sorting and listing was done to group the titles by language, subject and specialty, and frequency, retaining the high-to-low indexes of use within each grouping.

The time used on the 1401 system was approximately one and one-quarter hours. Sorting on the 709 machine used one-quarter hour, and on the 082 one-half hour.

From the list arranged primarily by index of use, an adapted and final list was created. In this each serial title carries an index of significance, assigned by a nonmachine method and demonstrating the sharing of an index of use by two or more titles. Journals indexed in *Current List of Medical Literature* and chosen for analysis but not cited, are arranged in alphabetized order in a separate table. Spanier's *Bio-medical Serials 1950-1960* (4) was used as an authority guide to determine the form of titles. Serial title changes occurring during the 1951-60 decade are listed separately within the same entry, with the last title listed first. The basic language and subject-specialty characteristics of cited and uncited journals are illustrated in two other tables.

RESULTS

The entries of 1,552 titles appearing in *Current List of Medical Literature* were examined in the assembling of estimates of published articles. Of this total, 164 titles (11 percent) were rejected before analysis, 134 (9 percent) for unwanted frequency, and 30 (2 percent) for incomplete indexing; 985 titles (63 percent) were subsequently cited; and 403 titles (26 percent) remained uncited.

The citation population available for analysis was found to have been 1,090,851. Of this sum, 61,850 citations (6 percent) were examined during the analysis, and a pool of 1,029,000 was left untapped. Of the 61,850 citations, 21,000 (34 percent) were accepted.

The 40,851 rejected citations were distributed as follows: 23,314 (57 percent) referred to all types of publications in years outside the study period of 1951-60; within the 1951-60 period 10,750 (26 percent) referred to books and other monographs, 5,637 (14 percent) referred to serial titles not listed for analysis, 810 (2 percent) referred to private communications and unpublished articles, and 340 (1 percent) referred to serial supplements considered to be monographs.

A remarkable variety of subject serials were cited in the 5,637 referrals rejected by reason of the exclusion of the serials from analysis. These included titles in chemistry, botany, zoology, general science, law, dairy science, biology, genetics, criminology, food technology, horticulture, physics, education, data processing, dentistry, astronomy, economics, mathematics, poultry science, paleontology, nutrition, pharmacology, and acoustics.

The 21,000 acceptable observations were found upon computer processing to yield citations to 985 serial titles. These are listed with their related indexes in Table 1.* This general and master listing has been arranged necessarily to offer the greatest possible amount of information in the least possible space. The very

* The complete tables are not published here, but are on deposit and may be obtained by ordering Document No. 8760 from the ADI Auxiliary Publications Project, Photoduplication Service, Library of Congress, Washington, D. C. 20540, and remitting \$3.00 for microfilm (35 mm.) or \$8.75 for photocopies. Advance payment is required. Make checks or money orders payable to: Chief, Photoduplication Service, Library of Congress.

large number of characteristics illustrated forbid the inclusion here of tables devoted to special interests or applications. Serial characteristics have been arranged in abbreviated keyword (*not* keyword in context) form; any librarian may become his own researcher and by scanning the table create his own lists based on any wanted language, frequency, country, subject characteristic, or combination of these. All needed data have been provided for comparative use by investigators interested in citation analysis. An abstract of Table 1, listing the 217 analyzed journals with highest indexes of significance, is offered here.

In Table 2 are listed the 403 serials not cited

in the analysis. Of the total of 1,388 serials analyzed, 641 (46 percent) were used as citation sources. Of the 985 cited serials, 590 (60 percent) were used as citation sources; of the 403 uncited serials, 51 (13 percent) were so used. Tables 1-A and 2-A offer basic language and subject-specialty characteristics of the cited and uncited serials.

With the indexes of significance now available, let us examine some of their implications. At the same time we can review earlier analytic claims based on statistically invalid samples and unadjusted raw citation totals.

Journal of the American Medical Association is recognized as a powerful force in Ameri-

TABLE 1 (Abstract)
WORLD BIOMEDICAL JOURNALS—ARTICLE-CITATION ANALYSIS

Legend

I Index of significance			
II Journal title; number of years published during 1951-60, if less than ten, shown in brackets			
III Journal supplements rejected in published article analysis			
IV Journal not used as citation source			
V Language of publication			
EN English		SP Spanish	
GE German		VA Various	
IT Italian			
VI Frequency of publication			
BM Bimonthly	IR Irregular	QT Quarterly	4x 4/year
BW Biweekly	MY Monthly	WK Weekly	11 11/year
VII Country of origin			
ARL Australia	ENG England	NET Netherlands	
AUS Austria	FRA France	NWY Norway	
BEL Belgium	GDR Germany, East	SCO Scotland	
BRA Brazil	GFR Germany, West	SWE Sweden	
CAN Canada	ITA Italy	SWZ Switzerland	
CZK Czechoslovakia	MEX Mexico	USA United States of America	
DEN Denmark			

TABLE 1—Continued

VIII Subject or specialty

ALLY Allergy	MICR Microbiology
ANAT Anatomy, cytology, and embryology	NEOP Neoplasms
BCHM Biochemistry	NEUR Neurology
BIOL Biology	NUTR Nutrition
CARD Cardiovascular system	OPHT Ophthalmology
DERM Dermatology	ORTH Orthopedics
ENDO Endocrinology	OTOR Otorhinolaryngology
EXPE Experimental medicine	PATH Pathology
GAST Gastroenterology	PEDI Pediatrics
GENE Genetics and heredity	PHAR Pharmacy and pharmacology
GERI Geriatrics	PHLG Physiology
GMED General medicine	PSCG Psychology
GYNE Gynecology and obstetrics	PSYC Psychiatry
HEMA Hematology	PUBL Public Health
IMMU Immunology	RADI Radiology and nuclear medicine
INFE Infectious diseases	RESP Respiratory system
INST Instrumentation and technics	RHEU Rheumatism
	SCIE Science
	SURG Surgery
	UROL Urology

IX Estimated total number of articles published during 1951-60, based upon average derived from actual count of articles published in 1953 and 1957

X Total number of 1962 and 1961 citations (including replicates) to articles published during 1951-60

XI Index of use

TABLE 1—Continued

I	II	III	IV	V	VI	VII	VIII	IX	X	XI
1	Gastroenterology			EN	MY	USA	GAST	202	109	53960
2	Physiological Reviews	X		EN	QT	USA	PHLG	215	91	42325
3	Excerpta Medica; Section 12, Ophthalmology	X		EN	MY	NET	OPHT	10	4	40000
4	Federation Proceedings			EN	QT	USA	EXPE	495	166	33535
5	Pharmacological Reviews			EN	QT	USA	PHAR	115	37	32173
6	Geburtshilfe und Grauenheilkunde			GE	MY	GFR	GYNE	115	31	26956
7	Medicine (Baltimore)			EN	QT	USA	GMED	75	20	26666
8	Journal of Clinical Investigation			EN	MY	USA	EXPE	1655	403	24350
9	Journal of Biophysical and Biochemical Cytology[6]			EN	MY	USA	ANAT	630	128	20317
10	Geriatrics			EN	MY	USA	GERI	102	18	17647
11	British Journal of Haematology[6]			EN	QT	ENG	HEMA	252	42	16666
12	Immunology[3]			EN	QT	ENG	IMMU	90	13	14444
13	American Journal of Pathology			EN	MY	USA	PATH	660	95	14393
14	Circulation			EN	MY	USA	CARD	1830	261	14262
15	Zentralblatt für Chirurgie			GE	WK	GDR	SURG	338	48	11201
16	Brain; A Journal of Neurology			EN	QT	ENG	NEUR	335	47	14029
17	Journal of Neurochemistry [4.5]			EN	IR	ENG	NEUR	187	26	13903
18	Journal of Experimental Medicine			EN	MY	USA	EXPE	1160	158	13620
19	American Journal of Medicine			EN	MY	USA	GMED	1825	240	13150
20	Journal of Histochemistry and Cytochemistry[8]			EN	BM	USA	ANAT	412	53	12864
21	Quarterly Journal of Medicine			EN	QT	ENG	EXPE	265	34	12830
22	International Journal of Applied Radiation and Isotopes[4.5]			VA	5X	USA	RADI	81	10	12345
23	Virology[5.67]			EN	MY	USA	MICR	527	65	12333
24	Blood; the Journal of Hematology			EN	MY	USA	HEMA	1030	125	12135
25	Bacteriological Reviews			EN	QT	USA	MICR	140	16	11428
26	Comptes-rendus des Travaux du Laboratoire Carlsberg[2.5]			VA	IR	DEN	BCHM	18	2	11111

TABLE 1—Continued

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	
27	Journal of Biological Chemistry				EN	MY	USA	BCHM	5925	658	11105
28	Clinical Science				EN	QT	ENG	EXPE	515	56	10873
29	Journal of Clinical Endocrinology and Metabolism; Journal of Clinical Endocrinology				EN	MY	USA	ENDO	1600	155	9687
30	Circulation Research[8]				EN	BM	USA	CARD	812	78	9605
31	Arthritis and Rheumatism[3]				EN	BM	USA	RHEU	177	17	9604
32	Laboratory Investigation[9]				EN	BM	USA	EXPE	459	43	9368
33	Biochemical Journal				EN	MY	ENG	BCHM	3640	337	9258
34	American Journal of Anatomy				EN	BM	USA	ANAT	305	28	9180
35	Endocrinology				EN	MY	USA	ENDO	1915	174	9086
36	Journal of Neurophysiology				EN	BM	USA	NEUR	435	39	8965
37	Journal of General Physiology				EN	BM	USA	PHLG	585	52	8888
38	Journal of Laboratory and Clinical Medicine				EN	MY	USA	EXPE	2265	200	8830
39	Archives of Pathology; A.M.A. Archives of Pathology				EN	MY	USA	PATH	1331	117	8790
40	Annals of the New York Academy of Sciences	X	EN	IR	USA	SCIE			2365	204	8625
41	Wiener Beiträge zur Chirurgie[6]	X	GE	IR	AUS	SURG			12	1	8333
42	Cancer				EN	BM	USA	NEOP	1410	116	8226
43	Radiation Research[6.92]	X	EN	MY	USA	RADI			671	55	8196
44	Archives of Internal Medicine; A.M.A. Archives of Internal Medicine				EN	MY	USA	GMED	1905	156	8188
45	Journal of Ultrastructure Research[3.5]				VA	QT	USA	ANAT	112	9	8035
46	Cancer Research	X	EN	11	USA	NEOP			1585	127	8012
47	Bulletin of the Johns Hopkins Hospital				EN	MY	USA	GMED	470	37	7872
48	British Heart Journal				EN	QT	ENG	CARD	665	52	7819
49	Anatomical Record				EN	MY	USA	ANAT	1075	84	7813
50	American Journal of Diseases of Children; A.M.A. Journal of Diseases of Children; A.M.A. American Journal of Diseases of Children				EN	MY	USA	PEDI	1480	114	7702

TABLE 1—Continued

I	II	III	IV	V	VI	VII	VIII	IX	X	XI
51	Clinica Chimica Acta[5]			VA	BM	NET	BCHM	430	33	7674
52	Metabolism[9]			EN	MY	USA	NUTR	621	47	7568
53	American Journal of Hygiene			EN	BM	USA	INFE	555	42	7567
54	Journal of the American Psychoanalytic Association[8]			EN	QT	USA	PSYC	284	21	7394
55	Annals of Internal Medicine			EN	MY	USA	GMED	2235	163	7293
56	Journal of Applied Physiology			EN	BM	USA	PHLG	1720	124	7209
57	Beiträge zur pathologischen Anatomie und zur allgemeinen Pathologie			GE	6X	GFR	PATH	375	27	7200
58	Annals of Surgery			EN	MY	USA	SURG	2415	173	7163
59	Journal of Pathology and Bacteriology			EN	QT	ENG	PATH	1265	90	7114
60	Thorax			EN	QT	ENG	RESP	480	34	7083
61	American Journal of Physiology			EN	MY	USA	PHLG	4305	304	7061
62	Quarterly Journal of Experimental Physiology and Cognate Medical Sciences			EN	QT	SCO	PHLG	330	23	6969
63	Journal of Thoracic and Cardiovascular Surgery; Journal of Thoracic Surgery			EN	MY	USA	SURG	1320	91	6893
64	American Journal of Cardiology[3]			EN	MY	USA	CARD	624	43	6891
65	Pediatrics			EN	MY	USA	PEDI	1925	131	6805
66	Journal of the National Cancer Institute			EN	MY	USA	NEOP	1186	80	6745
67	Annals of the Rheumatic Diseases			EN	QT	ENG	RHEU	460	31	6739
	Folia Haematologica (Frankfurt)[5]			GE	IR	GFR	HEMA	120	8	6666
68	Obstetrical and Gynecological Survey	X	EN	BM	USA	GYNE		60	4	6666
	Survey of Ophthalmology[5]			EN	BM	USA	OPHT	15	1	6666
69	Fortschritte der Neurologie, Psychiatrie und ihrer Grenzgebiete			GE	MY	GFR	NEUR	230	15	6521
70	Biochimica et Biophysica Acta			VA	IR	NET	BCHM	4110	268	6520
71	American Journal of Human Genetics			EN	QT	USA	GENE	295	19	6440

TABLE 1—Continued

I	II	III	IV	V	VI	VII	VIII	IX	X	XI
72	Journal of Comparative Neurology			EN	BM	USA	NEUR	420	27	6428
73	Journal of Physiology			EN	15	ENG	PHLG	3630	232	6391
74	Surgery, Gynecology and Obstetrics			EN	MY	USA	SURG	2175	139	6390
75	Psychological Bulletin		X	EN	BM	USA	PSOG	360	23	6388
76	Journal of Immunology			EN	MY	USA	IMMU	1340	85	6343
77	Experimental Cell Research		X	VA	9X	USA	ANAT	1562	99	6338
78	Journal of Neurosurgery			EN	BM	USA	NEUR	885	56	6327
79	Psychosomatic Medicine			EN	BM	USA	PSYC	450	28	6222
80	Clinical Symposia			EN	BM	USA	GMED	65	4	6153
81	Yale Journal of Biology and Medicine			EN	6X	USA	GMED	430	26	6046
82	Journal of Pharmacology and Experimental Therapeutics			EN	MY	USA	PHAR	1690	101	5976
83	Surgery			EN	MY	USA	SURG	2455	146	5947
84	Diseases of the Colon and Rectum[3]			EN	BM	USA	GAST	186	11	5913
85	A.M.A. Archives of Neurology and Psychiatry[8.5]			EN	MY	USA	NEUR	1322	78	5900
86	Acta Pharmaceutica Internationalia[3]		X	VA	IR	DEN	PHAR	51	3	5882
87	Journal of Neuropathology and Experimental Neurology		X	EN	QT	USA	NEUR	410	24	5853
88	British Journal of Pharmacology and Chemotherapy			EN	QT	ENG	PHAR	890	52	5842
89	New England Journal of Medicine			EN	WK	USA	GMED	4995	290	5805
90	British Journal of Experimental Pathology Acta Physiologica Scandinavica			EN	BM	ENG	PATH	800	46	5750
91	Journal of Investigative Dermatology		X	VA	9X	SWE	PHLG	1050	60	5714
92	Journal of Anatomy			EN	MY	USA	DERM	1085	62	5714
93	Zeitschrift für Zellforschung und mikroskopische Anatomie			EN	QT	ENG	ANAT	440	25	5681
94	Psychiatry		X	GE	IR	GFR	ANAT	660	37	5606
				EN	QT	USA	PSYC	345	19	5507

TABLE 1—Continued

I	II	III	IV	V	VI	VII	VIII	IX	X	XI
95	International Journal of Psycho-Analysis			EN	4X	ENG	PSYC	385	21	5454
96	American Heart Journal			EN	MY	USA	CARD	1880	102	5425
97	American Journal of Clinical Pathology			EN	MY	USA	PATH	1715	93	5422
98	Acta Endocrinologica	X		VA	MY	DEN	ENDO	1295	68	5250
99	Deutsche Zeitschrift für Nervenheilkunde			GE	IR	GFR	NEUR	630	33	5238
100	Neurology (Minneapolis)			EN	MY	USA	NEUR	1200	62	5166
101	Thoraxchirurgie[7.67]	X	GE	BM	GFR	RESP		368	19	5163
102	Science			EN	WK	USA	SCIE	4545	233	5126
103	Scandinavian Journal of Clinical & Laboratory Investigation	X		EN	QT	NWY	EXPE	785	40	5095
104	American Journal of Roentgenology, Radium Therapy and Nuclear Medicine			EN	MY	USA	RADI	1985	101	5088
105	Diabetes (New York)[9]			EN	BM	USA	ENDO	747	38	5087
	Annales d'Anatomie Pathologique[5]			FR	QT	FRA	PATH	140	7	5000
	Bibliotheca Gynaecologica			VA	IR	SWZ	GYNE	20	1	5000
106	Journal of Bone and Joint Surgery. American Volume			EN	8X	USA	ORTH	1320	66	5000
	Medical Research Council Special Report Series	X	EN	IR	ENG	GMED		40	2	5000
	Ophthalmic Literature	X	EN	6X	ENG	OPHT		20	1	5000
107	Journal of Bone and Joint Surgery. British Volume			EN	QT	ENG	ORTH	985	49	4974
108	Blut[6]			GE	6X	GFR	HEMA	181	9	4972
109	Proceedings of the Society for Experimental Biology and Medicine			EN	11	USA	EXPE	7765	383	4932
110	International Archives of Allergy and Applied Immunology			VA	BM	SWZ	ALLY	508	25	4921
111	Neuro-chirurgie[6]			FR	QT	FRA	NEUR	246	12	4878
112	Journal of Clinical and Experimental Psychopathology & Quarterly Review of Psychiatry and Neurology	X	EN	QT	USA	PSYC		185	9	4864

TABLE 1—Continued

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	
113	Archives of Biochemistry and Biophysics				EN	MY	USA	BCHM	3710	175	4716
114	American Journal of the Medical Sciences				EN	MY	USA	GMED	1595	75	4702
115	Acta Radiologica	X			VA	MY	SWE	RADI	1130	53	4690
116	Fertility and Sterility				EN	BM	USA	GYNE	475	22	4631
117	American Journal of Obstetrics and Gynecology				EN	MY	USA	GYNE	3630	168	4628
118	Journal of Clinical Pathology				EN	BM	ENG	PATH	845	39	4615
119	Pflügers Archiv für die gesamte Physiologie des Menschen und der Tiere				GE	IR	GFR	PHLG	1000	46	4600
	Archives of General Psychiatry; A.M.A. Archives of General Psychiatry[1.5]				EN	MY	USA	PSYC	242	11	4545
120	Perspectives in Biology and Medicine[3.25]				EN	QT	USA	BIOL	88	4	4545
	Review of Allergy and Applied Immunology[4]				EN	BM	USA	ALLY	44	2	4545
121	Journal of the American Medical Association				EN	WK	USA	GMED	8820	400	4535
122	Journal of Gerontology				EN	QT	USA	GERI	575	26	4521
123	Journal of Psychosomatic Research[5]				EN	QT	ENG	PSYC	90	4	4444
124	Lancet				EN	WK	ENG	GMED	9665	429	4438
125	Nature (London)				EN	WK	ENG	SCIE	8615	381	4422
126	Archives of Surgery; A.M.A. Archives of Surgery				EN	MY	USA	SURG	2695	118	4378
127	American Review of Respiratory Diseases; American Review of Tuberculosis and Pulmonary Diseases; American Review of Tuberculosis				EN	MY	USA	RESP	2079	91	4377
128	Comptes Rendus des Travaux du Laboratoire Carlsberg. Série Physiologique[7.5]	X	VA	IR	DEN	PHLG			23	1	4347
129	Archiv für Kreislaufforschung				GE	IR	GFR	CARD	300	13	4333
	Canadian Journal of Biochemistry and Physiology;				EN	MY	CAN	BCHM	1205	52	4315
	Canadian Journal of Medical Sciences										
130	Journal of Endocrinology				EN	7X	ENG	ENDO	950	41	4315

TABLE 1—Continued

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	
131	Archives of Ophthalmology; A.M.A. Archives of Ophthalmology				EN	MY	USA	OPHT	1860	80	4301
132	British Journal of Cancer				EN	QT	ENG	NEOP	655	28	4274
133	Obstetrics and Gynecology[8]				EN	MY	USA	GYNE	1756	75	4270
134	Proceedings of the Staff Meetings of the Mayo Clinic				EN	BW	USA	GMED	1180	50	4237
135	Helvetica Paediatrica Acta	X	X	VA	6X	SWZ	PEDI		360	15	4166
136	Australasian Annals of Medicine[9]				EN	QT	ARL	GMED	314	13	4140
	American Journal of Psychiatry				EN	MY	USA	PSYC	1885	78	4137
137	Proceedings of the Royal Society. Series B. Biological Sciences				EN	IR	ENG	BIOL	580	24	4137
138	Psychiatric Quarterly	X			EN	QT	USA	PSYC	415	17	4096
139	Journal of the Royal College of Surgeons[5.5]	X	EN	QT	SCO	SURG			171	7	4093
140	Revue d'Hématologie	X	FR	QT	FRA	HEMA			465	19	4086
141	Archives of Disease in Childhood				EN	BM	ENG	PEDI	955	39	4083
142	Psychoanalytic Quarterly				EN	QT	USA	PSYC	295	12	4067
143	Acta Virologica; English edition				EN	BM	CZK	MICR	124	5	4032
	Archiv für Gynäkologie				GE	IR	GFR	GYNE	1175	47	4000
144	Urological Survey				EN	BM	USA	UROL	25	1	4000
145	Acta Haematologica				VA	MY	SWZ	HEMA	755	30	3973
146	Experimental Parasitology[9.25]				EN	BM	USA	MICR	378	15	3968
147	Quarterly Journal of Studies on Alcohol				EN	QT	USA	PSYC	430	17	3953
148	British Journal of Preventive & Social Medicine[8]				EN	QT	ENG	PUBL	228	9	3947
149	Clinical Chemistry[6]				EN	BM	USA	BCHM	408	16	3921
150	Klinische Wochenschrift				GE	SM	GFR	GMED	3300	129	3909
151	Radiology				EN	MY	USA	RADI	2060	80	3883
152	Helvetica Medica Acta	X			VA	5X	SWZ	GMED	645	25	3875
153	Psychological Review				EN	BM	USA	PSYC	465	18	3870

TABLE 1—Continued

I	II	III	IV	V	VI	VII	VIII	IX	X	XI		
154	Journal of General Microbiology				EN	9X	ENG	MICR	1355	52	3837	
155	Annals of Human Genetics; Annals of Eugenics				X	EN	IR	ENG	GENE	287	11	3832
156	Revue de Chirurgie[5]				X	FR	BM	FRA	SURG	105	4	3809
157	Acta Anatomica				X	VA	IR	SWZ	ANAT	1005	38	3781
158	Archiv für Ohren-, Nasen- und Kehlkopfheilkunde vereinigt mit Zeitschrift für Hals-, Nasen- und Ohrenheilkunde					GE	IR	GFR	OTOR	635	24	3779
159	Electroencephalography and Clinical Neurophysiology				X	EN	QT	CAN	NEUR	665	25	3759
160	British Journal of Surgery				X	EN	BM	ENG	SURG	1335	50	3745
161	American Journal of Clinical Nutrition; Journal of Clinical Nutrition[8.33]					EN	BM	USA	NUTR	643	24	3732
162	Virchows Archiv für pathologische Anatomie und Physiologie und für klinische Medizin					GE	IR	GFR	PATH	620	23	3709
163	Biochemische Zeitschrift					GE	IR	GFR	BCHM	840	31	3690
164	Acta Medica Scandinavica				X	VA	MY	SWE	EXPE	1790	66	3687
165	Journal of Mental Science					EN	QT	ENG	PSYC	760	28	3684
166	Diseases of the Nervous System					EN	MY	USA	NEUR	815	30	3680
167	Journal of Cellular and Comparative Physiology					EN	BM	USA	ANAT	870	32	3678
168	Journal of Infectious Diseases					EN	BM	USA	INFE	735	27	3673
169	Angiology					EN	BM	USA	CARD	580	21	3620
170	Stain Technology					EN	BM	USA	INST	585	21	3589
171	Acta Societatis Medicorum Upsaliensis				X	EN	IR	SWE	GMED	280	10	3571
172	Journal of Bacteriology					EN	MY	USA	MICR	2845	101	3550
173	Journal of Allergy					EN	BM	USA	ALLY	650	23	3538
174	Deutsche medizinische Wochenschrift					GE	WK	GFR	GMED	4965	175	3524
175	Journal of Hygiene					EN	QT	ENG	PUBL	455	16	3516
176	Acta Allergologica				X	VA	QT	DEN	ALLY	285	10	3508
177	Transplantation Bulletin[7.5]					EN	QT	USA	SURG	608	21	3453

TABLE 1—Continued

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	
178	British Journal of Radiology			EN	MY	ENG	RADI	1365	47	3443	
179	Archivos del Instituto de Cardiología de México			SP	BM	MEX	CARD	320	11	3437	
180	Acta Dermato-venereologica	X		VA	BM	SWE	DERM	525	18	3428	
181	Anatomischer Anzeiger			GE	IR	GDR	ANAT	380	13	3421	
182	Gynécologie et Obstétrique			FR	5X	FRA	GYNE	440	15	3409	
183	British Journal of Nutrition			EN	QT	ENG	NUTR	470	16	3404	
184	Archiv für Psychiatrie und Nervenkrankheiten vereinigt mit Zeitschrift für die gesamte Neurologie und Psychiatrie			GE	IR	GFR	PSYC	500	17	3400	
185	Journal of Chronic Diseases[6]			EN	MY	USA	GMED	618	21	3398	
186	Journal of Pediatrics Acta Paediatrica			EN	MY	USA	PEDI	1950	66	3384	
		X	X	VA	BM	SWE	PEDI	660	22	3333	
187	Archiv für die gesamte Virusforschung Modern Concepts of Cardiovascular Disease			GE	IR	AUS	MICR	240	8	3333	
				EN	MY	USA	CARD	120	4	3333	
188	Journal of Abnormal and Social Psychology			EN	BM	USA	PSOG	1322	44	3328	
189	American Journal of Orthopsychiatry			EN	QT	USA	PSYC	725	24	3310	
190	Archives of Dermatology; A.M.A. Archives of Dermatology; A.M.A. Archives of Dermatology and Syphilology			EN	MY	USA	DERM	2711	89	3282	
191	Zeitschrift für Immunitätsforschung und experimentelle Therapie			GE	MY	GFR	IMMU	495	16	3232	
192	Archivio Italiano di Anatomia e di Embriologia			IT	QT	ITA	ANAT	155	5	3225	
193	Cleveland Clinic Quarterly			EN	QT	USA	GMED	280	9	3214	
194	American Journal of Ophthalmology British Journal of Dermatology			EN	MY	USA	OPHT	3030	97	3201	
				EN	MY	ENG	DERM	625	20	3200	
195	Journal of Comparative Pathology and Therapeutics Guy's Hospital Reports			EN	QT	ENG	PATH	375	12	3200	
				EN	LX	ENG	GMED	315	10	3174	
196	Revista de Cirurgia de São Paulo[5.25]			X	SP	QT	BRA	SURG	63	2	3174
197	Helvetica Physiologica et Pharmacologica Acta	X	X	VA	QT	SWZ	PHAR	790	25	3164	
198	Acta Paediatrica Belgica British Journal of Plastic Surgery			X	FR	BM	BEL	PEDI	190	6	3157
				EN	QT	ENG	SURG	350	11	3142	
199	Revue Française d'Études Cliniques et Biologiques[5]			FR	10	FRA	EXPE	350	11	3142	
200	Journal of Obstetrics and Gynecology of the British Empire			EN	BM	ENG	GYNE	1440	45	3125	

can clinical medicine, medical research, and medical education. It is subjectively one of the most popular English-language serials in general medicine. Measured in Table 1 on a scale of possible significance ranging from 1 (highest) to 747 (lowest), the index of significance of the *Journal*, at 121, is lower than these other American journals of general medicine: *Medicine* (7), *American Journal of Medicine* (19), *Archives of Internal Medicine* (44), *Bulletin of the Johns Hopkins Hospital* (47), *Annals of Internal Medicine* (55), *Clinical Symposia* (80), *Yale Journal of Biology and Medicine* (81), *New England Journal of Medicine* (89), *American Journal of the Medical Sciences* (114). In comparison with foreign English-language serials in general medicine, the index of significance of the *Journal* is lower than *Medical Research Council Special Report Series* (106); it is followed closely by *Lancet* (124) and at some distance by *British Medical Journal* (206), *Canadian Medical Association Journal* (325), and *Medical Journal of Australia* (479). A long-nurtured belief has been held by citation analysts, e.g., Sherwood reporting in 1932 (5), that the *Journal* might serve as a "best" or single citation source. The folly of attempting either such use, in an objective analysis of significance, is obvious.

Casey's judgment in 1942 that American state medical periodicals exerted little direct influence on medical progress in the United States and Great Britain (6) is largely confirmed for the 1951-60 decade. We find, however, that there is a considerable range in the indexes of significance of these journals. Of 35 such titles analyzed, 23 (67 percent) were actually cited, and these vary in their indexes from a high of 435 (*California Medicine*) to a low of 717 (*Journal of the Kentucky State Medical Association*).

Other titles of significance following *California Medicine* are *Illinois Medical Journal* (446), *Minnesota Medicine* (468), and *New York State Journal of Medicine* (492).

There were 12 uncited state journals in the analysis, and these are listed in Table 2. It appears that most state medical journals attain greater significance as the voices of their respective societies than as vehicles for the reporting of medical knowledge. The promotion of the general and uncritical collection of Ameri-

can state medical journals for their possible use in research cannot be justified.

In commenting in 1962 on Gregory's 1935 study of periodicals in endocrinology, I noted that the specialized periodical for the field under study was not necessarily ranked first (1). In this study *American Journal of Physiology*, *Comptes Rendus de la Société de Biologie*, and *Endocrinology* were listed in importance in that order. I suggested that the computation of the publication-citation related index for each of these three journals might secure for *Endocrinology* the first place we would expect it to assume in its field. In our investigation of the serials of two decades later, *Journal of Clinical Endocrinology and Metabolism* attained in the field of endocrinology the highest index of significance (29), with *Endocrinology* having the next highest index (35). Since the former title did not begin to publish until 1941, and since it is unlikely that there was any great change in the significance generally of American journals within two decades, it appears that *Endocrinology* was of highest significance in its field in the 1931-40 period. The index of significance of *American Journal of Physiology* for 1951-60 is 61, and of *Comptes Rendus* is 488.

The publication of *Current List of Medical Literature* in the English language, and in the United States, has created within our study an as yet unmeasured bias for any journal in English. Also unmeasured is the possible bias against the few Russian journals not used as citation sources because of the analysts' failure to secure citations in Russian characters.

Who publishes American medical journals of significance? Of the ten serials highest in significance in Table 1, *Gastroenterology* (1), *Pharmacological Reviews* (5), and *Medicine* (7) are published by Williams & Wilkins Company. *Geburtshilfe und Frauenheilkunde* (6) is the product of Georg Thieme Verlag, and *Geriatrics* (10) comes from the press of Lancet Publications, Inc. *Physiological Reviews* (2), *Excerpta Medica; Section 12, Ophthalmology* (3), *Federation Proceedings* (4), *Journal of Clinical Investigation* (8), and *Journal of Cell Biology* (9) (listed under its former title of *Journal of Biophysical and Biochemical Cytology*) are published by or for learned societies. The list position of each of these ten titles demonstrates a high level of editorial selection and of sub-

ject interest. The inclusion of two serials devoted to experimental medicine indicates the importance of research in American medicine.

The index of use of all of the serials in a given subject or specialty analyzed for the 1951-60 decade can be computed by using the basic relation-of-cited-to-published-articles formula. Here the total number of articles published in the specialized journals in a field is divided into the total of these articles subsequently cited. The result is multiplied by 100,000 to yield a whole number quotient. From Table 1 we find that the serials in the fields of neoplasms, anesthesiology, and nursing have relative indexes of use respectively of 3359, 1576, and 380, and in the same order, relative indexes of significance of 1, 2, and 3. Such computations are useful in offering standards upon which the librarian may base the proportions of subject serials in his collection.

Editorializing in *Chemical and Engineering News* in 1952, Murphy wrote:

From time to time during the past dozen years we have heard statements made to the effect that there are at least 50,000 currently appearing scientific periodicals and that no more than half of the million papers appearing annually in these publications are made available in practicable manner by abstracting and indexing (7).

He labeled his discussion of his claim, "Lost-Literature Legend," and expressed his belief that no *article of significance* relating to chemistry in any *journal of scientific research* was lost to the chemical investigator by its exclusion from *Chemical Abstracts*. His reduction of the claimed numbers to realism lay in defining "scientific paper" and "scientific periodical." Aptly he stated:

There are many periodicals appearing in various parts of the world, such as local medical bulletins reporting doctors' clinical experiences and the like, which are not journals of research.

The inclusion of an article entry in a reference tool as ably prepared and as widely distributed as *Current List of Medical Literature* would have literally guaranteed the diffusion of the article and would have reduced considerably any bias against its use by reason of its language of publication. Thus, no matter how obscure the journal carrying the article, nor how foreign its language to American readers, indexing it would assure it notice along with

thousands of other papers published in serials presumed to be significant in medicine.

It is remarkable that of 1,388 serials analyzed in this research, 403 (26 percent) were uncited. Of the 985 cited titles, 196 were cited *once only*. Let us assume that 20 (10 percent) of these 196 were self-cited and that none of these owed their referral to any indexing tool. Let us assume also that a single self-citation is of equal value in our analysis as no citation. Let us assume finally that serials self-cited once only and serials not cited were of little or no significance to the medical scientists and researchers using *Current List of Medical Literature* and whose articles filled the pages of the journals investigated here. We find 423 such titles (30 percent) in a total of 1,388 analyzed.

I must conclude on the basis of our results and assumptions that *Current List of Medical Literature* was 70 percent effective quantitatively in excluding insignificant articles from indexing while bringing notice of significant articles to its users. This conclusion suggests that the exclusion of a large number of these 423 uncited or singly self-cited titles, with deeper indexing of all analyzed titles remaining, might have made *Current List of Medical Literature* itself more significant to American medicine. It would appear that in retrospect the 1950's offered far more insignificant medical serial literature indexed than significant medical serial literature possibly lost in any failure to index.

CONCLUSIONS

I have presented a practical application of the citation analysis based on the article-published-article-cited relationship. The investigation reported here should be looked on as no more than a first step in discovering many more objective facts about this most important type of biomedical literature. We need to know more about the effect of self-citation on the index of significance of a journal, on the effect of the replication of citations in the serial analysis, on language bias, on levels of subject interest, and on the creation of indexing and abstracting standards. We will find the answers only in continued research.

Further study may make possible the production of indexes of significance derived from the comparison of citations of articles in a single journal with the total number of articles in

all journals in a given field, the interpretation of journal coupling (relating the titles from and to which citations refer), the adaptation of sampling techniques to computer processing, and other results of interest to all concerned with biomedical journals.

The computer production of indexes of biomedical serial literature offers speed, accuracy, flexibility, and the comprehensive inclusion of a wide range of titles. In the absence of objective standards of article and serial significance, comprehensive inclusion may well become a subjectively barrel-scraping technique which will fill index pages but not researchers' requirements.

The computer program itself provides an easy way to total by serial title the actual counts of all articles indexed. Related to a valid sampling of citation sources, the interpreted article counts can provide the bases for the choice of serials to index and abstract.

Infallibility of either method or result is not claimed for this articles-cited/published-ratio analysis; the usual credence placed by objective observers in statistical sampling and inferential reasoning is sought, and reporting of further application and testing of this method is awaited. The indexes of significance of individual journals may change in subsequent studies; in reflecting changes of relationship, these minor shifts in indexes will not invalidate method or result. It is hoped and expected that users of this analysis will balance reasonably its results with the needs, interests, and budgets of their local situations. In larger libraries the demands of researchers who must review even those journals considered here to be of little significance may require that their librarians ignore in part our indexes. In smaller libraries, where money is limited, these same indexes may serve as realistic guides for the practical purchase of journal subscriptions.

These final words are reserved for the historically minded librarian. As in the recent study of the research use of the medical thesis from 1850 to 1960 (8), it is possible to plot trends and shifts occurring over many years in the past use of serial literature and to measure the efficiency of indexes formerly used. Just

as it was possible to demonstrate the rise and fall of the use of the thesis, so is it possible to illustrate the shift in the dependence of American medicine from the classical European medical serials to the journals produced at home. The citation is the key.

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