# The relationship between journal use in a medical library and citation use*

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The purpose of the study was to investigate the relationship between library journal use and journal citation use in the medical sciences. The six-month journal use study was conducted in the Library of the Veterans General Hospital in Taipei. The data on citation frequency and impact factors were obtained from *Journal Citation Reports*, 1993 microfiche edition. The study explored the use, citation, and impact factor data, especially for heavily used, highly cited, or high-impact-factor journals. The correlations between frequency of use and citation frequency and between frequency of use and impact factor were determined by using the Spearman rank and Pearson correlation tests. The same comparisons were also made within four subject categories: clinical medicine journals, life science journals, hybrid journals publishing both clinical medicine and life science papers, and journals that publish neither clinical medicine nor life science articles. The results of the study showed that there is a significant correlation between frequency of use and citation frequency, and between frequency of use and impact factor for all titles. There is also a significant correlation between frequency of use and citation frequency and between frequency of use and impact factor for journals that publish either clinical medicine or life science articles, or both. However, the correlation is not significant for other journals.

## INTRODUCTION

Many methods, such as journal citation analysis, surveys of library journal use, and evaluation by subject experts, are used to judge the value of journals. Any of various factors, or many interacting factors, can form the basis for journal selection or deselection in a library. A policy based on a survey of library journal use, for instance, will result in a collection for which the frequency of in-house use is the major criterion for inclusion. Citation analyses have frequently been used to produce lists of journals ranked according to the number of citations received; it has often been stated or implied that such lists form a valid guide for the selection of library materials. Studies ranking the use of journals at many libraries have long been reported as aids in purchasing, cancellation, and storage decisions. It is not known, however, whether the most-used items in a collection are also those that have the most citations.

The relationship between library journal use and journal citation patterns in the medical sciences may provide a basis for journal collection management in that area. Collection managers might be able to predict in-house journal use on the basis of information about worldwide journal citations, or vice versa. Thus, collection management could be performed more effectively. The correlation between library journal use and citation patterns is, therefore, of great interest.

## LITERATURE REVIEW

Only a few published studies have investigated the relationship between library journal use and citation frequency, although studies focusing on these topics separately are abundant [1]. Broadus, in reviewing pre-1977 information about the correlation between journal use and citation analysis in several fields, including some sciences, concluded that "there do seem to be

* This research was supported by grant no. NSC85-2413-H-032-002 from the National Science Council, Republic of China.

parallels between use of materials (not limited to journals) as indicated by citation patterns and as shown by studies of requests in libraries" [2]. Scales compared lists of science journals ranked according to frequency of use as part of the National Lending Library stock, with similar lists from *Journal Citation Reports* (*JCR*). Using the Spearman rank correlation test, she found that the rank order correlation between the two lists was low ($r_s$=.27) [3]. A group of 169 journals held by six biomedical libraries was studied by Pan. Applying the Spearman rank correlation and chi-square tests, Pan found no correlation between the ranking of journals by impact factor and frequency of use. However, there was a statistically significant correlation ($r_s$=.47) between the ranking of journals by the citation and use count [4].

Rice studied the use of science periodicals at the State University of New York at Albany and verified an insignificant correlation between use rankings and citation rankings reported in *JCR* [5]. Stankus and Rice studied the correlations between library journal use and gross citations and between library use and impact factors. The subject fields they selected were biochemistry, cell biology, ecology, geoscience, and pure and applied mathematics. They concluded that a correlation will exist if the following conditions are met: (1) comparisons are made only among journals of fairly similar subject scope, purpose and language; (2) with respect to the correlation between the citation data for a journal and the use of that journal, only if there is heavy journal use in that specialty or library [6].

Sridhar studied the patterns of the publishing of papers in journals by Indian space technologists and the use and citation of those papers. The Pearson correlation coefficient was calculated and a slight positive correlation between citations and publishing in journals was found [7]. A journal's visibility, as measured by its circulation, is one measure of the importance of that journal. Peritz conducted a rank correlation study between journals' impact factor and their circulation in twenty-one disciplines and found correlations were between 0.25 and 0.5 [8].

The study reported here investigated the relationship between library journal use and journal citation frequency in the medical sciences. The correlations between pairs of variables, including frequency of use and citation frequency, and frequency of use and impact factor, were determined by using the Spearman rank correlation test and Pearson correlation test.

## STUDY HYPOTHESES

On the basis of the literature review, two hypotheses were developed with regard to the relationship between library use and citation use:

1. The ranking of journals according to their use in a particular medical library is not significantly different from the ranking based on general use as measured by citation frequency or impact factors reported in *JCR*.
2. The frequency of journal use in a particular medical library is not significantly different from the frequency of general use as measured by citation frequency or impact factors reported in *JCR*.

## METHODOLOGY

The journals covered in *JCR* and available in the Library of Veterans General Hospital in Taipei were selected as the focus of the present study. The library was chosen because the hospital is one of the two largest hospitals and the major educational hospital in Taiwan, and because the hospital is the most productive in Taiwan in terms of the journal papers published by its researchers. Journal use should therefore reflect the full range of activities in medicine—education, research, and clinical practice.

### Description of the library

The Veterans General Hospital Library, established in 1958, is a division of the Medical Research Department. The library provides a core collection of materials that are used for the courses in each discipline of medical science. In 1995 the library held 28,502 books (17,489 were in Western languages, 11,013 in Chinese); 4,692 audiovisual items; and approximately 52,000 volumes of periodicals, with 1,499 current issue titles (1,146 were English titles). Library users included 1,317 medical staff; 3,340 paramedical staff; 845 engineering and administrative staff; and 915 artisans, who provide general services. The photocopy service provided approximately 160,000 to 170,000 copies per month. The periodical collection was open to all users, meaning that patrons were asked to retrieve their own periodicals. None of the journal issues, bound or unbound, circulated.

### Library in-house use

The use study was designed to be simple enough to gain the most useful information possible without placing an unreasonable burden on the librarian or intruding on users. The "sweep" survey method was used. That is, bound and unbound journals were counted as they were reshelved after being picked up, several times each day, from tables and carts where they were left by users. The study period lasted for six months, from November 1, 1994, to April 30, 1995.

The study was based on the assumption that it is possible to develop an accurate picture of in-house journal use despite known shortcomings of the survey method. First, journals reshelved by a user were not

counted. It was assumed that such reshelving was done immediately, and that if a user reshelved a volume immediately after examining it, then the use was negligible. Furthermore, because a bound volume is too heavy to hold and read in the stacks, most users tend to bring it to a study area, a practice that reduced the likelihood of journal reshelving by the user. Second, it was counted as a single use when patrons picked up an issue already used by someone else and placed it on a shelving cart, or when patrons photocopied more than one article from an issue. Although the study design did not account for certain types of uses, this approach did not necessarily limit the reliability of the results on the use of journals relative to each other. The greatest limitation of this study may be that it underestimates the total use; however, such underestimation would prevail on each journal, and it is not expected to influence significantly the ranking of journals based on frequency of use.

### Citation use

For journal citation studies in the sciences, the most reliable sources are the annual editions of *JCR*. The first *JCR* was published in 1975 and analyzed citations for the 1974 *Science Citation Index*. The citation use of this study was based on the data listed in the 1993 microfiche edition of *JCR*.

The data for the library use study were collected by April 30, 1995, whereas the corresonding data on citations can be derived only from the 1993 issue of *JCR* because of the time lag in the production of *JCR*. Although there are somewhat different time periods—literature used in a particular year versus citations to earlier literature—there is a fair degree of stability from year to year in citations to the most-cited journals.

New titles would clearly be at a disadvantage, but for established titles the difference in ranking based on citations would change little in two years. Impact factors no doubt shift from year to year, but the relative rankings are probably more stable. A comparison of the *JCR* issues from 1992 to 1995 reveals the stability of the citation distribution. For example, the journals with the highest impact factors in general and internal medicine are quite similar in those four years. Therefore, the difference in time periods can be acknowledged as a limitation of the study, but not a serious limitation.

### Data analysis

According to Stankus and Rice, gross citations to a journal are likely to exhibit good correlations with library use of that journal if "all the journals in the subject specialty are long-established and publish approximately the same large number of papers annually" [9]. Taking this point into account, the study compared citation frequency with library use. In addition, impact factor, defined as "the number of citations received in year 3 by articles published in years 1 and 2 divided by number of articles published in years 1 and 2" [10], was also compared with library use.

Recently, doubts about the accuracy of impact factors have been raised in the literature because of inappropriate definitions of citation documents [11] and the biases of the Institute for Scienctific Information's methods of deriving impact factors [12, 13]. However, this issue should not influence a comparison of journal use and impact factor.

The data obtained in the study were analyzed with statistical tests of the correlation between frequency of journal use and citation frequency and between frequency of use and impact factor.

The Spearman rank correlation and Pearson correlation tests were performed to test the two hypotheses by using the SAS program.

## USE, CITATION, AND IMPACT FACTOR DATA

Eight hundred and thirty-five different journal titles were used over the six-month study period, resulting in a total of 116,217 transactions. Each journal was used an average of 139 times in the survey period. Thirty-nine journals for which citation data are available were never used during the survey period. The 835 journals were cited a total of 5,545,248 times; each journal was cited an average of 6,641 times in 1993. The impact factors of the 835 journals in 1993 ranged from 66.27 to 0.031. Twenty-one journals had no impact factor listed in *JCR*, 1993 edition.

### Top fifty most-used journals

In Table 1, the top fifty most-used journals are ranked in descending order. The table also lists publication frequency and subject field, taken from *The Serials Directory*, 1995 CD-ROM edition, and corresponding citation frequency and rank, as well as impact factor and rank, as listed in *JCR*. A complete list of journal use frequency and ranks for all 835 titles is provided by Tsay [14].

The *New England Journal of Medicine* was the most-used journal, used a total of 3,650 times, or approximately twenty times per day. The second most-used journal, *The Lancet* was used 2,528 times. Each of the top fifteen journals was used more than 1,000 times during the survey period.

The publication frequency is related to the use frequency. Table 1 shows that the most-used journals are likely to be published weekly, whereas monthly journals tend to be used less frequently. Seven of the fifty top most-used journals are published weekly. Thirty-three journals (including one journal published fourteen times a year and one journal published sixteen

**Table 1**
Top fifty most-used journals and corresponding citation frequency and impact factor

| Title | Pub freq*† | Subject* | Use‡ | | Citation§ | | Impact factors§ | |
|---|---|---|---|---|---|---|---|---|
| | | | Rank | Freq | Rank | Freq | Rank | Freq |
| New Engl J Med | w | medical sci | 1 | 3,650 | 7 | 92,729 | 5 | 23.762 |
| Lancet | w | medical sci | 2 | 2,528 | 8 | 80,055 | 12 | 15.888 |
| Cancer | se | oncology | 3 | 2,030 | 29 | 37,762 | 213 | 2.249 |
| Nature | w | general sci | 4 | 1,632 | 3 | 226,827 | 6 | 22.326 |
| Circulation | se | cardiology | 5 | 1,500 | 20 | 47,233 | 32 | 8.994 |
| Proc Natl Acad Sci USA | se | general sci | 6 | 1,400 | 1 | 234,319 | 23 | 10.325 |
| Science | w | general sci | 7 | 1,365 | 4 | 170,514 | 7 | 21.074 |
| Chest | m | cardiology | 8 | 1,285 | 88 | 12,909 | 325 | 1.584 |
| Cell | bi | biol/cytology | 9 | 1,216 | 6 | 113,325 | 4 | 37.192 |
| JAMA | w | medical sci | 10 | 1,209 | 30 | 37,230 | 50 | 5.597 |
| Am J Cardiol | se | cardiology | 11 | 1,180 | 47 | 24,225 | 223 | 2.164 |
| J Biol Chem | w | biol/biochem | 12 | 1,168 | 2 | 231,324 | 41 | 6.793 |
| Ann Intern Med | se | internal med | 13 | 1,165 | 37 | 29,871 | 28 | 9.297 |
| Radiology | m | radiology | 14 | 1,143 | 46 | 24,252 | 118 | 3.317 |
| Cancer Res | se | oncology | 15 | 1,125 | 14 | 60,626 | 45 | 6.011 |
| J Urol | m | urology/neph | 16 | 947 | 55 | 19,409 | 217 | 2.231 |
| Am J Med | m | medical sci | 17 | 936 | 50 | 21,463 | 154 | 2.8 |
| Am Rev Respiratory Dis | m | respiratory sy | 18 | 931 | 40 | 27,068 | 68 | 4.716 |
| J Am Coll Cardiol | 14/y | cardiology | 19 | 876 | 56 | 19,082 | 43 | 6.341 |
| Gastroenterology | 16/y | gastroenterol | 20 | 875 | 38 | 28,929 | 46 | 5.856 |
| Arch Intern Med | se | internal med | 21 | 857 | 89 | 12,764 | 115 | 3.393 |
| BMJ British Medical Journal | w | medical sci | 22 | 830 | 32 | 35,904 | 70 | 4.498 |
| AJR Am J Roentgenol | m | radiology | 23 | 783 | 97 | 11,734 | 314 | 1.621 |
| Obstet Gynecol | m | gynecol/obstet | 24 | 762 | 98 | 11,713 | 239 | 2.071 |
| Am Heart J | m | cardiology | 25 | 743 | 95 | 11,922 | 333 | 1.542 |
| Am J Obstet Gynecol | m | gynecol/obstet | 26 | 727 | 53 | 20,394 | 229 | 2.148 |
| Blood | se | hematology | 27 | 719 | 23 | 44,029 | 35 | 8.12 |
| Kidney Int | m | urology/nephrol | 28 | 718 | 80 | 14,295 | 94 | 3.776 |
| Am J Physiol | m | bio/physiol | 29 | 711 | 11 | 71,574 | 131 | 3.139 |
| Am J Gastroenterol | m | gastroenterol | 30 | 697 | 228 | 4,727 | 339 | 1.515 |
| Neurology | m | neurology | 31 | 669 | 49 | 22,224 | 85 | 3.99 |
| Ann Surg | m | surgery | 32 | 649 | 82 | 13,882 | 74 | 4.38 |
| J Bone Joint Surg Am | m | surgery/orth | 33 | 639 | 126 | 9,496 | 351 | 1.45 |
| J Clin Invest | m | medical sci | 34 | 632 | 15 | 58,670 | 34 | 8.519 |
| Hepatology | m | gastroenterol | 35 | 618 | 100 | 11,664 | 62 | 5.072 |
| Clin Orthop | m | orthopedics | 36 | 592 | 132 | 9,084 | 543 | 0.769 |
| J Clin Oncol | m | oncology | 37 | 572 | 78 | 14,475 | 36 | 7.533 |
| Am J Surg | m | surgery | 38 | 534 | 137 | 8,843 | 218 | 2.23 |
| Ann Thorac Surg | m | surgery | 39 | 528 | 176 | 6,723 | 276 | 1.839 |
| J Prosthet Dent | m | dentistry | 40 | 527 | 353 | 2,225 | 732 | 0.327 |
| Brit J Surg | m | surgery | 41 | 511 | 125 | 9,613 | 256 | 1.958 |
| Ophthalmology | m | ophthalmology | 42 | 506 | 199 | 5,791 | 209 | 2.264 |
| J Immunol | se | allergy/immun | 43 | 497 | 9 | 78,615 | 39 | 7.065 |
| J Thorac Cardiovasc Surg | m | surgery/cardiol | 44 | 483 | 123 | 9,663 | 200 | 2.328 |
| Gut | m | gastroenterol | 45 | 476 | 110 | 10,617 | 148 | 2.858 |
| Stroke | m | cardiol/neurol | 46 | 473 | 109 | 10,764 | 92 | 3.851 |
| J Clin Endocrinol Metab | m | endocrinol | 47 | 464 | 44 | 24,900 | 81 | 4.22 |
| J Neurosurg | m | neurol/surg | 48 | 461 | 77 | 14,568 | 164 | 2.688 |
| J Nucl Med | m | nuclear med | 49 | 456 | 128 | 9,309 | 100 | 3.601 |
| Anesthesiology | m | anesthesiol | 50 | 453 | 85 | 13,442 | 72 | 4.442 |

* *The Serials Directory*, 1995 (CD-ROM edition).
† w = weekly; se = semimonthly; m = monthly; bi = biweekly.
‡ Data obtained at Library of the Veterans General Hospital in Taipei, November 1994–April 1995.
§ *Journal Citation Reports*, 1993.

times a year, are published monthly. Most of them rank below number 22; The *Journal of Immunology* (ranked 43), and *Blood* (ranked 27), both semimonthly publications, are exceptions. The remaining ten most-used journals are published biweekly or semimonthly. No journals published quarterly, semiannually, or annually made the list.

The subject field of a journal is also related to frequency of use. As indicated in Table 1, most of the top fifty journals deal with general medical science, clinical medicine, and biology. The exceptions are *Science, Nature,* and *Proceedings of the National Academy of Sciences of the U.S.A.,* which are weekly or semimonthly interdisciplinary publications that contain literature on various scientific disciplines, including medical science and biology. These journals have been chosen for the announcement of many major medical or biomedical discoveries. It is, therefore, not surprising that these

three general science journals are used often and rank in the top ten. One of the most important general medical journals is the *New England Journal of Medicine,* which, as noted earlier, ranked first in frequency of use. Other, similar leading journals are *The Lancet, Journal of the American Medical Association, American Journal of Medicine, British Medical Journal,* and *Journal of Clinical Investigation.* They all carry original papers, reviews, news, correspondence, and advertising.

In summary, the most-used journals are major scientific or general medical journals. Apart from providing the latest medical knowledge, most general medical journals provide information on diagnostic methodology (e.g., *The Lancet*) and clinical practice (e.g., *Journal of Clinical Investigation*), thereby bridging the gap between the investigator and clinician. Journals in specific medical subject areas also receive heavy use. The specialties of modern medicine are frequently divided into three areas: diagnosis, therapy, and prevention. In general, diagnostic journals overlap the biological sciences [15]. Three biology-oriented journals on the list are *Cell, Journal of Biological Chemistry,* and *American Journal of Physiology.*

Therapeutic journals cover various clinical medical sciences, including cardiology and surgery, the two most popular subjects. Seven cardiology journals are among the top fifty most-used journals and three of them rank in the top eleven. The Cardiology Division of the Veterans General Hospital provides sixteen windows for outpatient service simultaneously every day [16]. The prolific use of cardiology journals may be due to the large number of patients served by physicians in this specialty area.

Scientific and technical progress have created new surgical specialties, which have advanced rapidly in recent years. Most of the primary information can be found in the journal literature. Thus, surgery is another popular subject. Seven surgery journals are listed, all ranked after 30. The Department of Surgery of the Veterans General Hospital consists of eight divisions. The department has achieved some remarkable breakthroughs in the field of organ (e.g., kidney, heart, and lung) transplantation as most of these techniques were first implemented in Taiwan [17]. The intensive use of professional journals supports the information needs of clinical practitioners.

### Top fifty most-cited journals

The fifty most-cited journals, together with publication date, publication frequency, and subject field are listed by Tsay [18]. Table 1 displays many of them. A complete list of citation frequency and the ranking of all 835 titles is also given by Tsay [19]. *Proceedings of the National Academy of Sciences* was the most frequently cited journal, with 234,319 citations.

The relationship between publication frequency and total number of citations is similar to that between publication frequency and journal use. In general, the more frequently a journal is published, the more citations it is likely to receive. Twelve of the top fifty cited journals (including one journal published ninety-one times a year and one published sixty-three times yearly) are published at least weekly. Eighteen journals on the list are published twice a month and eighteen journals (including two journals publishing sixteen issues a year each) are published monthly. The longest interval of publication is one month. Most semimonthly journals rank in the middle of the list, whereas most monthly journals rank below 38.

The subject fields of the fifty most-cited journals can be grouped into five broad areas: general science, general medical science, clinical medicine, biology, and chemistry. The general science journals, *Proceedings of the National Academy of Sciences, Nature,* and *Science,* are cited as often as their popularity in the Veterans General Hospital Library would suggest: All rank within the top five. Six highly cited general medical journals, *New England Journal of Medicine, The Lancet, Journal of Clinical Investigation, Journal of the American Medical Association, British Medical Journal,* and *American Journal of Medicine,* also appear in the list of fifty most frequently used journals.

### Fifty journals with the highest impact factors

The titles of the fifty journals with highest impact factors, together with their rankings, publication frequency, and subject field are presented by Tsay [20]. The impact factors of these journals range from 66.27 to 5.6. Many of these journals also appear in Table 1 among the most-used journals at Veterans General Hospital Library. *Clinical Research* had the highest impact factor. A complete list of impact factors and ranks for all 835 titles is provided by Tsay [21]. The impact factor ranking was derived from the number of citations per article published in a given period.

Unlike the most-used or most-cited journals, the journals with the highest impact factors have diverse publication schedules, from weekly, semimonthly, and monthly to bimonthly, quarterly, and annually. This result indicates that publication frequency is not closely related to impact factor but rather reflects the characteristics of the journals. Some journals provide up-to-date research results, whereas others serve as comprehensive reviews of the state of the art in a specific area.

On the other hand, title variation, review characteristics, and subject field are related to impact factor. For example, almost all of the journals with the highest impact factors are well established and have never undergone a name change. Most have been published under the current title from the first issue or first volume.

Review journals tend to have high impact factors

(eighteen are listed in the top fifty titles). Generally, review journals or review series are published infrequently: annual review series are typical examples. Some review journals appear more frequently, often quarterly. The high rank of various review journals is not surprising. Indeed, ranking by impact factor may favor review journals. The advantage of ranking journals by impact factor is that it reflects citations per article rather than per journal, eliminating the bias in favor of journals that publish a large number of papers. Therefore, a ranking based on impact factor may favor the smaller journals, such as review journals publishing few papers.

Journals with high impact factors can be grouped into four categories: general science, general medical science, clinical medicine, and biology.

Many general science and medical journals have a high impact factor. They include *Nature, Science, Proceedings of the National Academy of Sciences, New England Journal of Medicine, The Lancet, Journal of the American Medical Association, Journal of Clinical Investigation,* and *Clinical Research.* These leading journals are cited often, as discussed previously.

Among clinical medical subjects, immunology is the focus of five journals with high impact factors. Four journals with high impact factors cover the fields of oncology. Pharmacy and pharmacology journals also have high impact factors. Three important pharmacological titles with high impact factors are review journals. Neurology is the focus of three journals with high impact factors.

Biology is a vast interdisciplinary field encompassing various subfields that overlap research areas in other disciplines. Biology journals (seventeen of the top fifty) constitute another large category of journals with high impact factors. Three general biology journals are the *FASEB Journal* (official publication of the Federation of American Societies for Experimental Biology), *EMBO Journal* (European Molecular Biology Organization), and *Journal of Molecular Biology.*

## STATISTICAL CORRELATION TESTS

Because the three sets of rankings for the journals studied were clearly not identical, statistical tests were performed of the correlation between the lists for frequency of use and citation frequency, and between the lists for frequency of use and impact factors. The complete rankings (not just the top fifty lists) were used in the tests.

### Statistical tests based on all titles

Spearman rank order coefficients were calculated for each pair of lists. The $r$ values for the correlations between the use and citations rankings ($r_s$=0.55, $p < 0.05$) and between the use and impact factor rankings ($r_s = 0.35$, $p < 0.05$) were both significant. The total number of journals included in the latter comparison was only 814, because, as noted earlier, the *JCR* 1993 microfiche edition did not provide impact factors for twenty-one journals.

The Pearson correlations were also calculated for each pair of comparison. The $r$ values were 0.59 and 0.34 (both $p < 0.05$) for the correlations between frequency of use and citation frequency and between frequency of use and impact factor, respectively. Thus, the associations between these two pairs of lists are significant according to this test also.

### Statistical tests for four subject categories

To gain additional insight into the relationship between the two pairs of rankings, the 835 journals were divided into four subject categories, and the two correlations were calculated for each category. Journal classification was based primarily on *Journal Coverage of the Current Contents,* April 1992, a booklet listing all of the journals covered in the Current Contents database. For journals not listed there, several 1995 issues of Current Contents: Clinical Medicine and Current Contents: Life Science were consulted.

The initial groupings were as follows: Category A included 266 clinical medicine journals. Category B consisted of 328 life science journals. Category C included 206 journals that published both clinical medicine and life science articles. Category D encompassed the remaining 35 titles, which published neither clinical medicine nor life science papers. A complete list of journal titles in each of these four categories is provided by Tsay [22]. Once the twenty-one journals in *JCR* without impact factors were subtracted, the final grouping yielded 264 titles for category A, 317 titles for category B, 201 titles for category C, and 32 titles for category D.

The results of the Pearson and Spearman tests show that the $p$ values for categories A, B, and C are all less than 0.05, whereas $p$ is greater than 0.05 for category D (Table 2). In other words, journals in both clinical medicine and life science exhibit a strong association between frequency of use and citation frequency and between frequency of use and impact factor. By contrast, journals dealing with neither clinical medicine nor life science exhibit very low correlations between frequency of use and citation frequency and between frequency of use and impact factor.

Although the correlation coefficient for the comparison of frequency of use and impact factor in subject category A is small ($r$=0.16), with $p$<0.05 the correlation is still significant. Life science journals (category B) and hybrid journals (category C) exhibit a strong association between frequency of use and citation frequency, evidenced by a very high statistically significant correlation coefficient of 0.90 ($p < 0.05$).

**Table 2**
Pearson correlation and Spearman Rank Correlation Coefficients

| | Clin med (A) $n = 264$ | | Life sci (B) $n = 317$ | | Clin and life (C) $n = 201$ | | Other (D) $n = 32$ | |
|---|---|---|---|---|---|---|---|---|
| Category | U/C | U/I | U/C | U/I | U/C | U/I | U/C | U/I |
| Pearson | .70 | .16 | .90 | .37 | .90 | .73 | .22 | .16 |
| *P* value | .0001 | .010 | .0001 | .0001 | .0001 | .0001 | .203 | .392 |
| Spearman | .65 | .27 | .60 | .46 | .84 | .54 | .29 | .30 |
| *P* value | .0001 | .0001 | .0001 | .0001 | .0001 | .0001 | .0885 | .094 |

U/C: Correlation between frequency of use and citation frequency. U/I: Correlation between frequency of use and impact factor.

Table 2 illustrates that, in general, the correlation coefficient for the comparison between frequency of use and impact factor is smaller than for frequency of use and citation frequency. In other words, the association between frequency of use and impact factor is weaker than the association between frequency of use and citation frequency.

### The correlation between frequency of use and citation frequency

In this study the list of most-used journals is quite similar to the list of most-cited journals. Table 1 indicates that of the top fifty titles in the most-used list, twenty-four were in the top fifty of the most- cited list. Although the rank order differed, the ranking pattern of the two lists is similar. This suggests that journal use at the Veterans General Hospital Library closely matches the worldwide citation pattern for medical journals.

Several interesting phenomena can be identified in the comparison between the fifty most heavily used and most-cited titles, as partially presented in Table 1:

1. The top ten titles in the two lists are similar, but not identical. The six titles in common are *New England Journal of Medicine, The Lancet, Nature, Proceedings of the National Academy of Sciences of the U.S.A., Science,* and *Cell.* All are general scientific or general medical journals except *Cell,* a biology publication. There is less agreement among the rest of the top ten titles, however. For example, *Cancer* ranked 3 in the most-used journal list but only 29 in the citation list. *Chest* ranked 8 in the use study but only 88 in the citation list.
2. Twelve of the fifty most-used and most-cited journals are dedicated to cardiology, oncology, gastroenterology, internal medicine, neurology, immunology, and other medical fields.
3. Twelve of the fifty most-used journals deal with general science, general medical science, and biology, and are all among the fifty most-cited journals. *Nature, Science,* and *Proceedings of the National Academy of Sciences* are three general science journals. Six of the most-used journals deal with general medical science: *New England Journal of Medicine, The Lancet, Journal of Clinical Investigation, Journal of the American Medical Association, British Medical Journal,* and *American Journal of Medicine.* They also appear in the most-cited list.
4. Two popular subjects, cardiology and surgery, do not appear at all in the most-cited journal list. Users of the Veterans General Hospital Library demonstrated high interest in six cardiological journals, but only two of them are cited very often. Local surgical researchers use the journal literature extensively. Seven journals dealing with surgery are used very frequently. Yet none of these seven journals receives a large number of citations. This result reflects the finding, noted earlier, that general medical journals are more likely to be cited than are those dealing with a particular specialty.

Some of the differences between the rankings in the use and citation studies can be attributed to differences in the way certain journals are used. The *Journal of Prosthetic Dentistry* is ranked 40 in the most-used list but only 353 in the most-cited list. Similarly, the *American Journal of Gastroenterology* ranks 30 in the most-used list but only 228 in the most-cited list. These two journals focus on a special clinical field. Therefore, they could be heavily used in a local medical library but not cited very often worldwide. Other specialties addressed by heavily used journals that appear never or only once in the list of fifty most-cited journals are urology and nephrology, gastroenterology, and gynecology and obstetrics. This asymmetry may reflect heavy local interest in these fields.

Because the Veterans General Hospital is not a university or college hospital but rather is open to all, most of the research performed there is of a clinical nature. Therefore, journals dealing with fundamental science such as biology, are not used very often.

### The correlation between frequency of use and impact factor

As Table 1 illustrates, the list of journals with the highest impact factors shows fairly good agreement with the most-used list, and, therefore, yields a significant Pearson correlation coefficient. Of the top fifty titles in the impact factor list, only seventeen are in the top

fifty most-used list, compared to twenty-four in the most-cited list. This difference explains why the coefficient (0.34) for the comparison between frequency of use and impact factor is smaller than that for frequency of use and citation frequency (0.59). Furthermore, their rank order disperses quite randomly. For example, *Circulation* ranks 5 in the frequency of use list but only 32 by impact factor. Another example is the *Journal of the American Medical Association,* which ranked 10 for frequency of use and only 50 for impact factor.

Four of the top ten most-used journals (*Cell, New England Journal of Medicine, Nature,* and *Science*) remain on top of the impact factor list, although the rank order changed slightly. Coincidentally, *Science* ranks 7 in the impact factor list as well as in the most-used list. *The Lancet, Proceedings of the National Academy of Sciences* and *Circulation* all rank above 10 by frequency of use but rank much lower by impact factor. Three of the top ten most-used journals (*Cancer, Chest,* and *American Journal of Cardiology*) are excluded from the top fifty journals ranked by impact factor.

Of the top ten titles by impact factor, only *Cell, New England Journal of Medicine, Nature,* and *Science* are close to their frequency-of-use ranks, whereas the other six all rank much higher by impact factor than by frequency of use. The top fifty journals by impact factor are widely dispersed in the frequency of use list with rankings ranging from 1 to 792.

### The relationships among frequency of use, citation frequency, and impact factor

As described earlier, there are two types of journal use: One is local use that occurs in a particular library, and the other is global use reflected by long-term citation patterns. Impact factor is also a form of citation-rate measure. This study thoroughly investigated the three categories of journal popularity rankings. In this section, use patterns are differentiated in terms of journal publication frequency and subject category.

Frequently published journals are used and cited more frequently than other journals. All of the fifty most-used journals and almost all of the fifty most-cited journals are published at least monthly. The same pattern prevails for the impact factor list: Thirty-six of the fifty journals with the highest impact factors are published monthly, biweekly, or weekly. Such consistency suggests one reason for the significant correlation between frequency of use and citation frequency and between frequency of use and impact factor: Frequently published journals provide more than the usual number of articles to be used or cited.

As shown in Table 1, the distribution of subject field is obviously different in the use and citation lists, whereas it is similar in the citation and impact factor lists. Three leading general scientific journals appear in all three lists. In other words, no matter how many times and how many papers these three journals publish yearly, they always exhibit a strong association (correlation) between frequency of use and citation frequency and between frequency of use and impact factor. They are *Nature, Science,* and *Proceedings of the National Academy of Sciences.*

Two journals with high impact factors, *Circulation* and *Journal of the American College of Cardiology,* also rank among the top fifty most-used journals and receive a large number of citations (47,233 and 19,082, respectively). Both are primary journals that publish original clinical and experimental research results dealing with all aspects of cardiovascular disease. This is one of the subjects for which consistent patterns are evident among local use, gross citations, and impact factor measures.

A highly cited journal may not have a high impact factor. For example, *Journal of the American Chemical Society,* which receives a large number of citations (148,900), was not among the top fifty journals with the highest impact factors. It receives about 100 times the number of citations that *Chemical Society Reviews* (with 1,526 citations) receives, yet the latter ranks among the top fifty journals by impact factor.

Journals with high impact factors cover a wider variety of subjects than do those with high numbers of citations. This phenomenon creates a significant difference between these two measures. For example, psychiatry, pathology, and genetics are three subjects that did not appear in the highly cited list.

## CONCLUSIONS AND IMPLICATIONS

Data on frequency of use, citation frequency, and impact factor for 835 journals were analyzed. The results reveal that each journal was used an average of 139 times in the Veterans General Hospital Library during the six-month survey period. Each journal was cited an average of 6,641 times in 1993. Their impact factors ranged from 66.27 to 0.031.

Publication frequency and subject field are related to the frequency of use. In general, the more frequently a journal is published, the more use it will receive. Journals dealing with general medical science, clinical medicine, and biology are used the most, along with the general science journals *Science, Nature,* and *Proceedings of the National Academy of Sciences.*

The relationship of publication frequency and subject field to citation frequency was also investigated. In general, the more frequently a journal is published, the more citations it receives, because more articles are available to be cited. The least-cited journals tend to be published infrequently. The most-cited journals can be grouped into five categories: general science, general medical science, clinical medicine, biology, and chemistry.

Title changes, review characteristics, and the subject

field of a journal were related to its impact factor. Journals with a high impact factor are, in general, well established and have been published since inception under the same title. Review journals tend to have higher impact factors than other journals. The journals with high impact factors can be grouped into four categories: general science, general medical science, clinical medicine, and biology.

There is a significant correlation between frequency of use and citation frequency for all titles in the aggregate; between frequency of use and impact factor for all titles in the aggregate; between frequency of use and citation frequency for the subject categories A, B, and C (clinical medicine, life science, and hybrid journals, respectively); and between frequency of use and impact factor for categories A, B, and C. Neither correlation is significant for category D (all other journals).

The results of this study clarify the relationship between journal use in a particular medical library and citation patterns worldwide, and help establish a basis for making decisions about a library's journal subscriptions. The study results may also help information system designers select journals to be included in or removed from the databases of indexing and abstracting services.

This study confirms that a statistically significant relationship exists between the frequency of use, at least in the library studied, and numbers of citations to journals in the medical sciences. If such a relationship can be identified for other types of libraries, then collection managers could use citation frequency or impact factor as an objective basis for journal selection. Data on both citation frequency and impact factor can be drawn from *JCR*, so it would not be necessary to conduct labor-intensive in-house use studies. This is a valuable advantage for today's libraries, many of which are facing budget cuts.

Although the study indicates that impact factor is a somewhat poorer predictor of the importance of a journal to local users than are citation analyses, the correlations between frequency of use and impact factors are still significant. Thus, the impact factor is also a significant measure of importance that could be used for journal selection.

The most-used and most-cited journals are in some way the journals that are most important to the medical sciences. The capability to predict which journals are likely to be used most often is a valuable tool for establishing a journal collection in a new library. Citation data can also be used to identify low-ranking journals as candidates for cancellation. The results of this study could also be useful in planning a shared journal collection. Networks could be formed to make the most-used titles accessible in local libraries and less popular journals accessible through regional and national libraries.

## ACKNOWLEDGMENT

The author gratefully acknowledges Professor Linda C. Smith of the Graduate School of Library and Information Science at the University of Illinois at Urbana-Champaign for her contribution to valuable discussions during the course of this study.

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*Received January 1997; accepted June 1997*