Purpose: The authors analyzed 2.48 million interlibrary loan (ILL) requests entered in the National Library of Medicine's (NLM's) DOCLINE system from 3,234 US and Canadian medical libraries during fiscal year (FY) 2005 to study their distribution and nature and the journals in which requested articles were published.

Methods: Data from DOCLINE and NLM's indexing system and online catalog were used to analyze all DOCLINE ILL transactions acted on from October 2004 to September 2005. The authors compared results from this analysis to previous data collected in FY 1992.

Results: Overall ILL volume in the United States and Canada is at about the same level as FY 1992 despite marked growth in online searching, knowledge discovery tools, and journals available online. Over 21,000 unique journal titles and 1.4 million unique articles were used to fill 2.2 million ILL requests in FY 2005. Over 1 million of the articles were requested only once by any network library. Fifty-two percent (11,022) of journals had 5 or fewer requests for articles from all the years of a journal by all libraries in the network. Fifty-two percent of the articles requested were published within the most recent 5 years.

Conclusion: The overall ILL profile in the libraries studied has changed little since FY 1992, notable given other changes in publishing. Small changes, however, may reveal developing trends. Total ILL traffic has been declining in recent years following a peak in 2002, and fewer of the articles requested were published in the most recent five years compared to requests from 1992.

INTRODUCTION

The last decade has been one of remarkable progress in information dissemination. Beginning in the mid-1990s, publishers began offering electronic versions of print journals online via the Web. Libraries saw the value in improved access for their communities. In 1997, the National Library of Medicine (NLM) was funded to offer access to PubMed free of charge to users worldwide. New services such as Google Scholar broaden the scope and ease of knowledge discovery through free searching of scholarly databases (including MEDLINE via PubMed) in numerous disciplines, as well as from repositories, preprint archives, full-text resources, and many other types of sources [1]. OCLC's WorldCat database makes library holdings visible worldwide to Web users using search engines such as Yahoo and Google [2]. Thousands of electronic journals are now available in full text, some of them free to the public and, on many academic campuses, freely available to students, researchers, and staff. The integration of technologies for identifying needed information and obtaining it immediately online or from a library, document supplier, or directly from the publisher has eased the burden on students, scholars, and librarians.

The impact of these developments on interlibrary loan (ILL) does not appear to be uniform across libraries. The Association of Research Libraries reported in its 2003/04 statistics that interlibrary borrowing in its 105 member research libraries in the United States and Canada has increased an average 7.2% annually from 1991 to 2004 [3]. The OCLC annual reports have revealed that ILL transactions using their system have increased 16% from 8.2 million in 1998 to 1999 to 9.5 million in 2004 to 2005. The rate of increase at OCLC has slowed, however, as the data from 2005 showed only a 1% increase over the previous year [4–6]. The 2003 to 2004 statistics published by the Association of
Academic Health Sciences Libraries showed a decrease of 7.5% in the mean value of ILLs borrowed in those libraries between 1999 and 2004 [7]. Librarians abroad have reported possible trends affecting ILL as well. Schopfel sees a direct relationship between the nationwide academic licenses and a recent decrease in document requests in France’s major research organizations CNRS and INSERM [8].

At the individual library level, research has sought to show the impact of online journals on the use of print copies and interlibrary loan. Document demand from the Canada Institute for Scientific and Technical Information (CISTI) peaked in 2000/01 and has declined since then [9]. Similarly, interlibrary loan demand at NLM declined 14% since its peak in 1999 [10]. De Groote showed that online versions of journals caused a decline in both the use of the print version and requests for ILL [11]. Burrows recently completed a study of ten years of electronic journal use in a medical school library, concluding that the significant growth in e-journal collections could be correlated to a decline in use of print collections and interlibrary loan activities [12]. Egan completed a similar study with similar results at a college specializing in criminal justice [13].

Background

In the United States, health sciences libraries are organized into the National Network of Libraries of Medicine (NN/LM), through which they can share resources. In 1985, NLM, with the input of the major medical libraries, built the DOCLINE system for automatically routing requests for needed items to libraries that held the material. In the early 1990s, over 300 Canadian health sciences libraries also joined the DOCLINE network.

The DOCLINE ILL system is unique in its ability to route requests based on detailed library holdings [14]. DOCLINE contains the serial holdings of nearly all of the medical libraries in the United States and Canada. Libraries maintain a profile in which they indicate libraries from which they wish to borrow, starting with local, then regional, and finally to last resort libraries such as NLM and CISTI. The system automatically finds a library that holds the needed item and sends the request to that library.

Commercial document delivery activity is prohibited in DOCLINE, and all members are required to comply with the copyright law that applies in their geographic region [15]. It should be noted that though DOCLINE is the primary system used for ILL in health sciences libraries in North America, libraries do use other systems for some requesting, therefore, this study covers the majority of ILL requests, but not 100% of them.

Online searching: PubMed

In biomedicine, most researchers, clinicians, students, and even the public search NLM’s PubMed (also known as MEDLINE) to identify articles indexed in the MEDLINE databases. Currently, about 5,000 journals are indexed for MEDLINE annually.

The bars in Figure 1 show that in 1997, about 30 million searches of PubMed took place. In 2005, 825 million searches took place, an astonishing growth in the use of a citation database. Compared to searches over this same period, the trend line in Figure 1 clearly illustrates that, despite the growth in the searching of biomedical citations, ILL requesting in health sciences libraries through DOCLINE has been relatively flat starting with 2.7 million requests in 1997, peaking at 3.03 million in 2002, and then decreasing to 2.48 million in 2005.

In 1993, Lacroix conducted a large-scale study of all ILL transactions requested through the DOCLINE network during two twelve-month periods beginning October 1, 1990, and ending September 30, 1992 [16]. The authors undertook this follow-up study to explore, with all of the changes in information technologies—the growth of electronic publishing, open access initiatives, consortia building, and limited library budgets and space—whether major changes in the nature of ILL in health sciences libraries have taken place.

The scope of this study covers ILL items requested through DOCLINE during the period October 1, 2004, through September 30, 2005, the federal government’s fiscal year. It is important to note that this study covers use through ILL only. Journals are heavily used in the library, and certainly physicians and researchers have personal subscriptions to the major journals in their field. The results of the current study (hereafter 2005) will be compared with the findings from the analysis of the 1992 data (hereafter 1992) where possible.

METHODS

This study used DOCLINE transaction data including the basic bibliographic details of the request with its journal and article identifiers. Supplemental bibliographic data including language, MEDLINE indexing category, and subject terms were retrieved from NLM’s serials extract file (SEF), which is built from key data extracted from several sources including the online catalog, the citation system for MEDLINE (DCMS), and NLM’s integrated library system, Voyager.

Data were analyzed via SQL queries primarily
against the DOCLINE database, which is a series of Oracle tables. Summary data were exported from Oracle and imported into Excel for the authors to browse, study, format, and present. Data from NLM’s online catalog, including information for over 124,000 journal and serial titles, were used to supplement bibliographic information in the DOCLINE transaction data. Most bibliographic data at the title and article level were available in a standard format because libraries placing ILL requests use NLM standard keys: the PubMed ID (PMID) or the NLM bibliographic record number. Only requests that had an NLM unique identifier (UI) in the citation for the journal title were included in the study, because these could be consistently identified.

Citation level data entered manually by users via the DOCLINE “Manual” ordering method were generally unusable, as they could not be confidently matched to standard bibliographic data by computer. Manual orders accounted for only 1.6% of all journal requests.

RESULTS AND DISCUSSION

Total DOCLINE requests and network use

In FY 2005, 2.48 million requests were entered into the DOCLINE system by 3,234 health sciences libraries (Table 1). Ninety-eight percent of the requests were for journal articles, with 2% being for original materials, such as loans of books and audiovisuals. The present study focuses on the journal requests, primarily on the title and article level. About 2,600 journal titles (12%) had more than 5 or fewer requests for articles from any publication year of the journal by all of the libraries in the network. About 2,600 journal titles (12%) had more than 100 requests across the entire network.

In 1992, requests were filled from 16,335 unique titles. Nearly 9,000 (56%) of the journal titles had 10 or fewer requests for articles from any issue over the life of the journal. About 3,000 titles (18%) had more than 100 requests in 2005. Of these unique titles, 52% (11,022) had 5 or fewer requests for articles from any publication year of the journal by all of the libraries in the network.

In 1992, requests were filled from 16,335 unique titles. Nearly 9,000 (56%) of the journal titles had 10 or fewer requests for articles from any issue over the life of the journal. About 3,000 titles (18%) had more than 100 requests in 2005. Of these unique titles, 52% (11,022) had 5 or fewer requests for articles from any publication year of the journal by all of the libraries in the network.

Most requested journals

Table 2 lists the 15 most frequently requested journals in 2005. Those in bold are also the most heavily re-

Table 2

| Title | Requests |
|-------|----------|
| New England Journal of Medicine 1928– | 6,556 |
| JAMA 1896– | 6,320 |
| Obstetrics and Gynecology 1953– | 6,000 |
| Nursing Times 1905– | 5,379 |
| Lancet 1823– | 5,264 |
| Academic Emergency Medicine 1994– | 5,185 |
| Obesity Surgery 1991– | 5,118 |
| Clinical Orthopaedics and Related Research 1963– | 5,084 |
| Annals of the New York Academy of Sciences 1877– | 4,820 |
| Spine 1976– | 4,777 |
| American Journal of Obstetrics and Gynecology 1920– | 4,146 |
| Annals of Pharmacotherapy 1992– | 4,047 |
| Expert Opinion on Pharmacotherapy 1999– | 3,971 |
| Journal of Clinical Psychiatry 1978– | 3,962 |
| Journal of Advanced Nursing 1976– | 3,938 |

Titles in bold also most requested in 1992.

Serials in biomedicine

To further put the data in context, it is important to note that during the period of this study, the NLM Voyager catalog listed approximately 44,680 currently published serials that were likely to have articles. In other words, dictionaries, annual reports, abstracts, indexes, and directories were excluded. NLM currently indexes about 5,000 journals for MEDLINE in PubMed; 10,767 have been indexed in MEDLINE since its inception. In 1992, an estimated 24,000 serial titles contained articles.

Journal title use

There were 21,258 unique titles used to fill article requests in 2005. Of these unique titles, 52% (11,022) had 5 or fewer requests for articles from any publication year of the journal by all of the libraries in the network. About 2,600 journal titles (12%) had more than 100 requests across the entire network.

In 1992, requests were filled from 16,335 unique titles. Nearly 9,000 (56%) of the journal titles had 10 or fewer requests for articles from any issue over the life of the journal. About 3,000 titles (18%) had more than 100 requests. Thus in 2005, more titles were being requested, but fewer titles were being requested multiple times.
quested in the 1992 study. Many core biomedicine titles are included in this list, indicating that many libraries may need to order from titles to which they subscribe, given space considerations associated with housing older volumes. In addition, analysis of the request data shows that libraries request the most recent issue of titles they own but have not yet received in print.

Unique article use
Figure 2 illustrates that 2.2 million articles were supplied in 2005, and it took 1.4 million unique articles to fill those requests. Over 1 million articles were used only once during the entire period, and 97% (1,375,403) of the articles were used 5 or fewer times throughout the network. Only 47 articles were used more than 100 times. These findings were comparable to the 1992 study, in which 97% (1,214,275) of articles were used 5 or fewer times as well.

Articles cited in PubMed
Of the 2.2 million requests filled through DOCLINE, 2 million (89.4%) were cited in PubMed. At the journal title level, 21,258 journal titles were used to fill requests, and nearly 10,000 (46.8%) of these titles were cited in PubMed.

These findings differed noticeably from the 1992 study. In that year, 84% of articles and 39% of all journals used by the network were ever indexed in MEDLINE, and searching that database has been free of charge since 1997. More journals are now cited in MEDLINE/PubMed. Both of these factors might account for the broader range of journal titles used and higher percentage of requested articles that were cited in PubMed.

Date distribution of article requests
In FY 2005, 95% of filled requests were for articles published in the last 25 years (Figure 3). This was also true in 1992. However, requests have undergone a marked shift away from more recently published articles in the latest 25 years. In 2005, 72.7% (1,615,365) of articles filled were published in the previous 10 years, compared to 85% in 1992. Articles with publication dates within the most recent 5 years accounted for 52.5% (1,169,760) in 2005, compared with 67% (1,429,284) in 1992. The authors attribute this change to the increased availability of full-text articles online for the most recent years of publication, the increased number of citations to older materials, and the continual need to access landmark articles. Both studies reveal that libraries request articles throughout the life of journals back to their first publication year.

Language of publication
Not surprisingly for US and Canadian libraries, 94.3% of all articles supplied were from English-language journals, an increase from 92% in 1992. Only 2% were from journals that contained no English articles. Of the journals that contained no English articles, the most heavily requested were in French, German, Italian, and Spanish.
Most frequently requested articles

The 100 most requested articles accounted for 11,878 ILL transactions, less than 1% of the 2.2 million articles supplied. Only 47 of these articles were requested more than 100 times. The most frequently requested article, “Current Evaluation of Amenorrhea” by the Practice Committee of the American Society for Reproductive Medicine [17], was requested 721 times.

All of the 100 most requested articles were published in English-language journals. The articles were published in 52 different journals produced by 33 different publishers including large and small commercial publishers as well as many associations. All but one of these articles were cited in PubMed, and 84% of the articles were published in the last 5 years. As with the date distribution for the entire dataset, this last finding differed from the 1992 study, in which 96% were published within the previous 4 years.

The oldest article requested in this top 100 group, “Mini-Mental State: A Practical Method for Grading the Cognitive State of Patients for the Clinician” by Folstein M et al. [18], was also heavily requested in 1992. This article is recognized as a key paper in geriatric psychiatry, outlining a method by which the physician can quickly evaluate the cognitive state of patients during an office visit. Known as the Mini-Mental State Examination, versions of this method are still widely used.

The subject areas covered in the top 100 articles differed completely from the 1992 study. Over a third (37) of the 2005 top 100 articles were in obstetrics and gynecology, 12 were health care administration, and the remainder were distributed over 25 major subject areas. In 1992, chronic fatigue syndrome, managed care programs, and laparoscopy were the subjects most frequently seen in the top 100 articles. Another notable characteristic was that 84 of the top 100 articles in 2005 were clinical in nature. Thirteen articles were administrative, and only 3 were research articles.

CONCLUSIONS

After more than a decade of remarkable improvements in knowledge discovery tools, including the Web and its many free meta-search engines and rapid delivery mechanisms for electronic delivery of printed documents, the volume and nature of materials being delivered by libraries through ILL in health sciences libraries has not changed markedly. Most notable are the findings that despite a 24-fold increase in searching of the medical literature in MEDLINE via PubMed, the total volume of ILL in DOCLINE via PubMed, the total volume of ILL in DOCLINE increased only a small fraction of the 22.5% to its peak in 2002 and has declined since then to nearly the same level as 1992. Also important is that, just as in 1992, over 1 million of the 2.2 million supplied articles were requested only once in the entire network in the United States and Canada. Equally significant is that in both 1992 and 2005, 97% of all articles were requested 5 or fewer times, with 73% being requested only once in the 2005 study—1 request for all of the publication years of the journal title by all of the 3,234 libraries in the network.

This study also shows that the proportion of requests for articles published within the previous 5 years has decreased significantly to just over half, rather than the two-thirds in the 1992 study. This shift away from the most recent material may be explained by the growth in consortia license agreements providing wider access to electronic titles; the increase in the total number of articles cited in MEDLINE/PubMed since the 1992 study, and the ever-increasing number of citations with links to full-text articles via the LinkOut feature in PubMed, as well as the growing number of articles available freely through PubMed Central and other sources [19]. At this writing, nearly 6 million of a total of 15 million articles cited in PubMed have full-text LinkOut links. There are now nearly 2,000 LinkOut providers, and more than three-quarters of them are libraries. Additionally, NLM internal statistics on the use of the free full-text articles in PubMed Central show that the most heavily used articles have publication dates within the most recent 5 years.

The evolving landscape of electronic subscriptions has yet to reveal its long-term impact for ILL. The availability of full-text articles online has been a great advantage to patrons and libraries, and immediate access to the most current bioscience literature is fundamental to health care professionals, researchers, and consumers. However, electronic journals are posing challenges to libraries requesting items via ILL. The growing trend of publisher restrictions on ILL from e-journals and time-based embargoes before ILL is permitted is limiting access to current material for libraries not licensing a title electronically. In DOCLINE, the overall fill rate of a request is 92%. Requests from MEDLINE/PubMed citations for articles published electronically ahead of the print issue have a significantly lower fill rate at 71% [20].

Given the dynamic nature of biosciences communication and the health sciences library environment, resource sharing among the NN/LM and Canadian medical libraries in DOCLINE helps ensure access to older issues, to the latest issues available electronically but not in print, and to articles from out-of-scope titles. NLM in the United States and CISTI in Canada serve as the libraries of “last resort,” providing access to hard to find titles and back issues most libraries do not have the space to house.

The authors anticipate that this evolution will continue with a further decrease in ILL activity over the next few years, which the authors predict will then stabilize as libraries, publishers, and consumers adjust to a changing publishing model. With just under 50% of requested articles more than 5 years old, an increased visibility of wide-ranging journal titles, collection space restrictions, and budget reductions, it is reasonable to expect that ILL will continue to play a key role for researchers, clinicians, and consumers in obtaining articles in biomedicine.

ACKNOWLEDGMENTS

Such an extensive study cannot be done without the assistance of special expertise in numerous areas. The
authors acknowledge and thank the following NLM staff for their assistance: Karen Kraly, NLM Office of Computer and Communications Services, for her assistance with data mining; Naomi Miller, manager, Consumer Health Information, for her review of the article subjects; Martha Fishel, deputy chief, Public Services Division, for guidance with PubMed Central; Dianne McCutcheon, Esther Baldinger, and Deena Action, Technical Services Division, for their guidance with serials information and analysis; Lou Wave Nychder Knecht, Bibliographic Services Division, for assistance with MEDLINE/PubMed data, and Ruth Hill and Jana Brightwell for their administrative support.

REFERENCES

1. Google. About Google Scholar. [Web document]. Mountain View, CA: Google. [cited 7 Jul 2006]. <http://scholar.google.com/intl/en/scholar/about.html>.

2. OCLC. OCLC WorldCat. [Web document]. Dublin, OH: OCLC. [cited 8 Jul 2006]. <http://www.oclc.org/worldcat/open/>.

3. Association for Research Libraries. ARL statistics 2003–04. [Web document]. Washington, DC: The Association, 2005. [cited 30 Jun 2006]. <http://www.arl.org/stats/arlstat/04pub/04intro.html>.

4. OCLC: Annual report 2004/2005. [Web document]. Dublin, OH: OCLC. [cited 8 Jul 2006]. <http://www.oclc.org/news/publications/annualreports/2005/2005.pdf>.

5. OCLC: Annual report 1998/1999. [Web document]. Dublin, OH: OCLC. [cited 8 Jul 2006]. <http://www.oclc.org/news/publications/annualreports/1999.pdf>.

6. OCLC: Annual report 2003/2004. [Web document]. Dublin, OH: OCLC. [cited 8 Jul 2006]. <http://www.oclc.org/news/publications/annualreports/2004.pdf>.

7. Annual statistics of medical school libraries in the United States and Canada ed. 27: (2003–004). [Web document]. Seattle, WA: Association of Academic Health Sciences Libraries, 2005. [cited 7 Jul 2006] <http://www.aahsl.org/new/display-page.cfm?fileId=293>. (Subscription required).

8. Schopfél J. Between open access and copyright: document supply in France. Interlending & Document Supply 2005; 33(3):158–61.

9. Brown B. Personal communication by phone to: Lacroix EM 7 Jul 2006.

10. NLM Official Reports. NLM programs and services annual reports. [Web document]. Bethesda, MD: National Library of Medicine, 2006. [cited 8 Jul 2006]. <http://www.nlm.nih.gov/pubs/reports.html>.

11. De Groote SL, Dorsch JL. Online journals: impact on print journal usage. Bull Med Libr Assoc 2001 Oct;89(4):372–8.

12. Burrows S. A review of electronic journal acquisition, management, and use in health sciences libraries. J Med Libr Assoc 2006 Jan;94(1):67–74.

13. Egan N. The impact of electronic full-text resources on interlibrary loan: a ten-year study at John Jay College of Criminal Justice. J Interlibrary Loan, Deliv Electronic Reserve 2005;15(3):23–41.

14. National Library of Medicine. DOCLINE fact sheet. [Web document]. Bethesda, MD: The Library. [rev. 6 Jul 2005; cited 30 Jun 2006]. <http://www.nlm.nih.gov/pubs/factsheets/docline.html>.

15. National Library of Medicine. DOCLINE eligibility guidelines. [Web document]. Bethesda, MD: The Library. [rev. 18 May 2006; cited 08 Jul 2006]. <http://www.nlm.nih.gov/docline/doclineguidelines.html>.

16. Lacroix EM. Interlibrary loan in U.S. health sciences libraries: journal article use. Bull Med Libr Assoc 1994 Oct; 82(4):363–8.

17. Practice Committee of the American Society for Reproductive Medicine. Current evaluation of amenorrhea. Fertil Steril 2004 Jul;82(1):266–72.

18. Folstein M, Folstein S, McHugh P. Mini-Mental State: a practical method for grading the cognitive state of patients for the clinician. J Psych Res 1975 Nov;12(3):189–98.

19. National Library of Medicine. LinkOut. [Web document]. Bethesda, MD: The Library. [rev. 9 Jan 2006; cited 8 Jul 2006]. <http://www.ncbi.nlm.nih.gov/entrez/linkout/>.

20. Collins ME. MLA 2005 DOCLINE update. [Web document]. Bethesda, MD: National Library of Medicine. [cited 10 Jul 2006]. <http://www.nlm.nih.gov/docline/doclinepresentations.html>.

AUTHORS’ AFFILIATIONS

Eve-Marie Lacroix, MS, FACMI, lacroixe@mail.nih.gov, Chief, Public Services Division (until April 2006); Maria Elizabeth Collins, collinm@mail.nih.gov, Technical Information Specialist, National Library of Medicine, 8600 Rockville Pike, Bethesda, MD 20894

Received August 2006; accepted November 2006