

Search Characteristics and the Effects of Experience on End Users of PaperChase

Natalie Schoch King

Transaction logs of 100 end users of PaperChase at the University of Michigan were examined in order to describe the use of various search features and to determine the effects of search experience on the use of search features. A large number of searchers used a variety of important MEDLINE search features. Although advanced searchers showed a significant increase in the use of some features as they gained experience, these increases were not large, and experience seemed to have little effect on searcher utilization of most features.



Interest in the searching of bibliographic databases by non-librarians and noninformation specialists has soared in recent years. Currently, library users and other information seekers are being encouraged to satisfy their own information needs directly through the use of a variety of information retrieval systems. These end-user systems are available through online and optical disk technologies and permit access to numerous information resources.

It has long been recognized in the field of medicine that rapid and convenient access to current information is critically important. In the 1950s and 1960s, the National Library of Medicine (NLM) developed an automated information retrieval system called MEDLARS (MEDical

Literature Analysis and Retrieval System) to facilitate information provision to health care professionals. Currently, MEDLARS contains more than 30 databases of medical and related literature. The largest and most popular of the MEDLARS databases is MEDLINE, which contains more than six million references to the biomedical literature from more than 4,000 journals in English and foreign languages. The print *Index Medicus* is a subset of MEDLINE.

With the rise in interest of end-user searching and the need for health care professionals to obtain timely information, it is not surprising that a variety of end-user searching systems for providing access to MEDLARS databases has been developed.¹ One such system that provides access to MEDLINE is an online

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information service called PaperChase. Developed by physicians at Beth Israel Hospital in Boston, PaperChase was designed to be used with minimal or no training. A menu interface guides users through searches, and the program provides specific suggestions for improving the search. Descriptions and a review of PaperChase are available; however, studies of use, user behavior, and user satisfaction are scarce.^{2,3} Gary L. Horowitz and Howard L. Bleich report that PaperChase users at Beth Israel Hospital¹ were generally satisfied with the system and that many staff members were repeat users.⁴ Other studies of PaperChase primarily have been comparisons between PaperChase and other user-friendly systems providing access to MEDLINE.⁵

At the University of Michigan, MEDLINE searching using PaperChase has been available to all members of the university free of personal charges since January 1989. Use of the system, called UM-MEDLINE, has been tremendous, with thousands of staff and students registered for its use. This study was an attempt to examine UM-MEDLINE use and to provide further insights into end users and their searching behaviors. It seemed particularly interesting to study the users of this system because PaperChase is extremely user-friendly and was designed to require little or no training to use. Although this study was confined to users of a particular end-user system in a single environment, it was hoped that the findings might shed some light on end-user behavior in general.

PURPOSE OF THE STUDY

The purpose of this study was twofold. The first purpose was to examine transaction logs of a selected group of UM-MEDLINE searchers and to describe quantitatively some characteristics of their searches. The second purpose was to determine whether experience with the system causes changes in searching characteristics. Horowitz and Bleich postulated that users employ more sophisticated search techniques as they gained experience with the PaperChase system.⁶ It was, therefore, of interest to know whether repeated

use of the system resulted in increased use of various search features.

END-USER STUDIES— A REVIEW OF METHODS

Various methods have been used to study end users and the usefulness of end-user searching. Questionnaires and interviews have been used extensively to determine user satisfaction and to glean descriptive data about how users operate the systems.⁷ However, growing evidence in the literature on end-user searching suggests that users often express satisfaction with searches even if they do not obtain particularly good results.⁸ Another technique employed in end user studies has been to ask users to compare results of searches performed by novice searchers with those of searches by experienced librarian searchers.⁹ Simply observing the activities of end users has also been employed.¹⁰ The case study method has been used to study searching behaviors of librarian searchers;¹¹ however, this method has not yet been applied to the study of end users. Transaction log analysis is also used to study end users.

A number of use studies of Online Public Access Catalogs (OPACs) have used the technique of transaction log analyses.¹² In addition, a few studies of users of online and CD-ROM bibliographic databases exist. For example, Naomi Miller and her colleagues examined search statements from Compact Cambridge MEDLINE (a CD-ROM product) and identified errors in the use of the system.¹³ Transaction logs of users of GRATEFUL MED, NLM's end-user system for access to the MEDLARS databases, were recently used to study search characteristics.¹⁴ Winifred Sewell and Sandra Teitelbaum performed an exhaustive study of transaction logs of online database users over eleven years.¹⁵ This study used transaction log analysis, questionnaires, and follow-up interviews to investigate the searching behavior of pathologists and pharmacists using NLM databases.

Both Thomas A. Peters and Mitchell A. Cahan discuss the advantages and disadvantages of transaction log analysis as

a method for studying end users.¹⁶ Advantages include that these studies are relatively cheap, they provide insights for librarians into patron problems so that better training can be provided, and they can supply information leading to better system design. In addition, users' attitudes do not affect the results as they can in questionnaires and interviews. The primary disadvantage of studying end users through transaction logs is that user intentions and satisfaction are not recorded on the logs. In addition, database producers do not generally intend for transaction logs to be used for extensive research; thus, information is often missing or incomplete.

METHODS

Selection of Users and User Anonymity

A random sample of 50 house officers (physicians in residency training programs) and 50 medical students who had been searching UM-MEDLINE for approximately six months (from mid-May to mid-November 1989) was chosen. These two groups were selected because they were identifiable on the PaperChase tapes and because they are among the groups for which PaperChase was designed.¹⁷

The reason these individuals were selected was to determine whether experience with the system improved effectiveness of searching. The author originally thought that searches performed in the first month could be compared to searches performed in the last month in order to determine the effect of experience on searching. However, as will be seen later, the number of searches performed proved a more useful measure of experience than the length of time the users had been searching.

To ensure anonymity, the author removed the subjects' names and social security numbers from the printed logs and numbered the subjects sequentially. Subsequent analyses used only these numbers. This procedure was approved by the Human Subject Review Board of the School of Education at the University of Michigan.

Descriptive and Operational Definitions

The following is a list of the terminology used to describe transaction logs and a description of how each variable was measured. An example of a typical transaction log can be found in table 1.

New or Old Searches. One of the features available to PaperChase users is the option to return to an old search. PaperChase saves users' searches for up to six months. Old searches (i.e., searches displayed after the initial search was performed) were identifiable because all searches carry a unique identifier number. Because little new information was available from old searches, only the first occurrence of a search (i.e., a "new" search) was analyzed.

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Statements. The number of statements for each search was counted as a crude estimation of search complexity. The search in table 1 has 19 statements.

Displays. Values given for the number of records displayed represent the total number of items displayed in the new search. However, these figures do not necessarily represent the total number of records displayed for that search because additional records were often displayed in subsequent returns to an old search. Only the records displayed in the first session of the search were counted, however, and no attempt was made to determine whether more records were displayed in old searches.

Print. Although the transaction logs provide figures for the number of records selected to be printed, no analysis of this variable was performed for the following reasons. Throughout the time covered by this study, printers were often unavailable in the hospital; thus, a majority of house officers and students did not print any records. In addition, even when printers were available, searchers commonly used the "print screen" op-

TABLE 1
TRANSACTION LOG

List	Description (Search Number 701)	Seconds	REFS	Display	Print
A	ARTHRITIS,RHEUMATOID <MeSH>	0	28805	0	0
B	ARTHRITIS, . . .	0	37069	0	0
C	METHOTREXATE <MeSH>	0	12153	0	0
D	ENGLISH	0	4375452	0	0
E	REVIEW <MeSH>	0	280096	0	0
F	1985 . . . 90	0	1673113	0	0
G	*ON A&C&D&E&F	0	40	9	6
H	ARTHRITIS,RHEUMATOID /MX	0	20453	0	0
I	METHOTREXATE /MX	0	5101	0	0
J	METHOTREXATE /AE	0	1878	0	0
K	*ON 'A&B	0	30000	0	0
L	ANTI-INFLAMMATORY AGENTS, NON-STEROIDAL	0	3919	0	0
M	*SUM CL	0	16072	0	0
N	ANN INTERN MED	0	11665	0	0
O	ABSTRACT ONLINE	0	2270739	0	0
P	CHILD, PRESCHOOL <MeSH>	0	283255	0	0
Q	*ON D&E&F&H&I&N&O&P	0	0	0	0
R	*ON G&N	0	2	2	2
S	TREATMENT	0	239703	0	0

tion or simply sat with pencil and paper jotting down citations. Thus, the transaction log record of citations selected for printing underestimates the number of citations found to be relevant.

Boolean Operators. The number of each Boolean operator—AND, OR, NOT—was counted for each search analyzed. The AND operation is accomplished by selecting an option from the PaperChase main options menu and is identifiable on the logs (see table 1, statements G, Q, and R).

Several means of performing an OR operation exist in PaperChase. The searcher can select an option from the main options menu, and this can be identified in the transaction logs (see table 1, statement M). The searcher can also pool search terms by selecting a number of items from a list, which produces a search statement followed by ". . ." (see table 1, statement B). It is important to

note that PaperChase truncates single subject terms that have more characters than can be displayed in a single line and that these truncated terms are also followed by ". . ." The investigator could not distinguish between truncated single subject terms and lists of pooled terms; therefore, all lists ending with ". . ." were counted as OR operations. Truncation of single terms appeared to occur infrequently, but the OR category described in this study may be somewhat inflated. In addition, certain subject terms are followed by ALL, indicating that the use of that term will include a number of related subject terms. All of these methods for pooling terms and references were counted in the OR category.

The NOT operation was performed in only one search and was not analyzed further. The PaperChase options menu lacks a separate option for performing the NOT operation, although it can be

accomplished by selecting the AND option and placing a minus sign (hyphen) between the letters of the lists to be combined (see table 1, statement K).

MeSH and Title Words. It was possible to determine which subject terms were Medical Subject Headings (MeSH), the controlled vocabulary terms used by NLM in producing MEDLINE (terms followed by <MeSH>; see table 1, statements A and C), and which were title words (terms without trailing notation; see table 1, statement S). Only the occurrence of a MeSH term or a title word was counted. Collecting categorical data seemed reasonable given that the study was attempting to analyze the users' awareness of certain system features.

Limit Categories. Searchers could reduce the number of records obtained or "limit" a search by year of publication, review articles, human age categories, topical subheadings, language, articles from a particular journal, or articles with an abstract online. Table 1 displays the appearance of the various limit categories on the transaction logs.

A searcher can access these features in a variety of ways. The searcher can use the limit feature without any assistance from the system. For example, a user may use subheadings (part of the controlled vocabulary) by entering a MeSH term followed by a forward slash (/) and the two-letter abbreviation for the subheading. However, the user need not remember these conventions because PaperChase prompts the user to select a limit feature in many cases. For instance, when displaying a long list from a single MeSH term search statement, PaperChase suggests appropriate subheadings to narrow the search. Similarly, displaying a long list will result in a prompt to select options such as limiting to review articles only or articles with an online abstract only. In addition, simply typing the word *limit* at "LOOK FOR," the prompt to enter a query, provides a list of limiting features from which users can choose. PaperChase will also prompt the searcher to use a limit feature when a word entered at "LOOK FOR" is known to be related to a limit feature (e.g., a user

entering the word *pediatric* is asked to select an age category).

When a limit feature appears on the transaction log, there is no way to tell which method was used to enter it. Was the user aware of the feature? Did the user know how to enter the term in the proper format, or did PaperChase prompt the user to limit the search? However, use of these features is important for effective MEDLINE searching, and the occurrence of these features in the searches indicates use of important searching techniques. Thus, as with MeSH terms and title words, the occurrence per search of these features was recorded.

Descriptive Study

This portion of the study provided descriptive data on the use of UM-MEDLINE by house officers and medical students and determined whether differences in search performance existed between the two groups. The results of this analysis assisted in determining the appropriateness of pooling user group data for subsequent analyses.

A random sample of three new searches was selected from the logs of each of the 100 individual searchers ($n=300$). The number of total, new, and old searches was determined for each searcher. In addition, transaction log analysis as described above was performed for each variable in each of the searches. The number of searches performed, statements created, records displayed, and Boolean operators used was compared among user groups using a one-way analysis of variance (ANOVA). The categorical data (MeSH, title word, and limiters) were analyzed by calculating proportions and by performing a two-by-two contingency table analysis. A significance level of .05 was used throughout the study.

Effect of Experience on Search Performance

This portion of the study was performed to determine whether experience increases searchers' abilities to utilize any of the PaperChase searching features more effectively. Because of high variability in their overall use of UM-MED-

LINE, the 100 subjects were assigned to one of three experience groups: (1) beginner—those who had performed ten or fewer searches during the course of the study ($n=38$); (2) intermediate—those who had performed between 11 and 20 searches ($n=41$); and (3) advanced—those who had performed more than 20 searches ($n=21$).

In order to determine whether greater use of PaperChase affected search performance, first (experience level 1) and last (experience level 2) searches performed by users within each experience group were selected. Therefore, a check of experience could be performed within and between groups. For intermediate and advanced searchers, the first five searches and the last five searches for each individual were selected. For beginners, the number of searches performed was divided by two, and the quotient was the number of searches selected. In cases of an odd number of searches, the median search was eliminated.

Using paired *t*-tests, the author compared mean number of searches performed, statements created, records displayed, and Boolean operators used between experience levels within a group. Between-group differences were analyzed with a one-way ANOVA, followed by multiple range tests (Duncan, Tukey, and least square means). The categorical data were analyzed using a log linear model for three-way categorical analysis. Additionally, a two-way ANOVA compared mean number of all limiters used between and within groups. Statistical analyses were performed using SAS.

RESULTS

Descriptive Study

Searching for articles according to subject was the most frequently used mode of searching. Seventy-five percent of searches performed by medical students and 84% of searches performed by house officers were searches by subject alone. An additional 10% of medical student searches and 9.3% of house officer searches were performed using a combi-

nation of subject and author. Searches for articles by author(s) were performed in 14.7% of medical student searches and 6.7% of house officer searches.

Medical students performed an average of 25.3 ± 17.3 total and 14.1 ± 10.8 new searches while house officers performed approximately 25.5 ± 21.3 total and 17.4 ± 14.7 new searches during the study. Thus, during the six months of the study, users in both groups searched UM-MEDLINE infrequently, averaging approximately two new searches per month. The number of each type of search varied widely, and no significant differences were found between house officers and medical students in any category.

Medical students performed searches with an average of nine statements and displayed an average of approximately 45 records. House officers averaged approximately eight statements per search and displayed approximately 47 records. The number of statements used varied widely, and the ANOVA showed no significant differences between medical students and house officers in this variable. The number of records displayed also showed great variability ranging from zero to 449 records displayed in one session. No significant difference between medical students and house officers was detected in the number of records displayed.

The AND operator was used on average 3.5 ± 3.9 times per medical student search and 3.3 ± 3.2 times per search performed by house officers. The OR operator was used less frequently, 0.6 ± 1.1 times per medical student search and 0.4 ± 0.9 times per house officer search. ANOVA showed that the two groups did not differ significantly in the use of either operator.

Table 2 compares the percentage of medical student searches and house officer searches containing the remaining search features. A two by two contingency table analysis of the raw data showed no significant differences between medical students and house officers in any category. While searching by MeSH headings was common, it is note worthy that over one-third of the searches

TABLE 2
COMPARISON OF CHARACTERISTICS OF SEARCHES
PERFORMED BY MEDICAL STUDENTS (N=150 SEARCHES)
AND HOUSE OFFICERS (N=150 SEARCHES).

Search Feature	Percentage of Searches*	
	Medical Student Searches	House Officer Searches
MeSH	82.7	93.3
Title Word	36.0	35.3
Year	28.7	25.3
Review	18.7	19.3
Age	9.3	8.7
Subheadings	18.7	20.7
English	10.7	16.0
Journal Title	6.7	4.6
Abstract Online	4.7	5.3

* Values represent the percentage of searches containing an occurrence of the variable. Two by two contingency table analyses indicate no significant differences between medical students and house officers in any category.

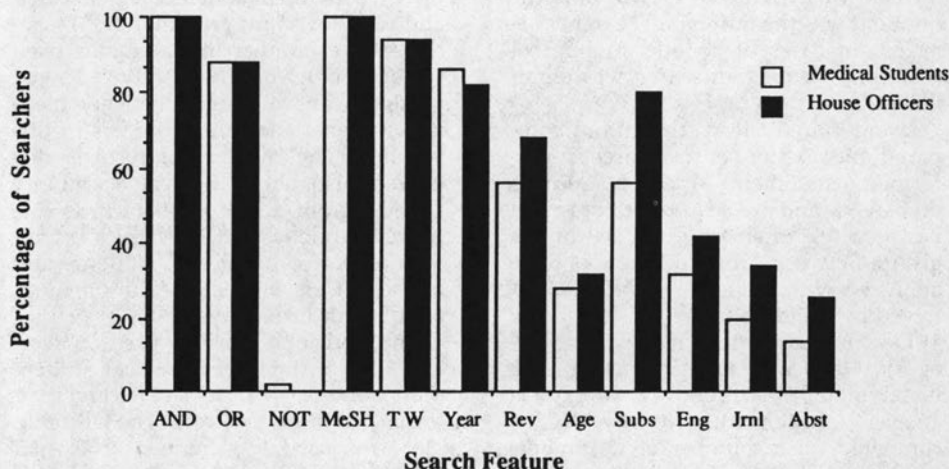


FIGURE 1

Percentage of searchers using various PaperChase search features

for both groups used title words for subject searching. Further, the limit features "year," "review," "subheadings," or "English language" were each used in over 10% of the searches.

Figure 1 shows the percentage of individual searchers in each group using the search features presented in table 2 and each of the Boolean operators. Every searcher used the AND operator and nearly 90% of the searchers in both groups

used the OR operator. One hundred percent of the searchers in both groups used MeSH terms but, clearly, title words were also heavily used (by more than 90% of the users). Users seemed to be remarkably aware of several limit features, with more than 80% of both groups using the limit feature "year," nearly 56% of medical students and 68% of house officers using "review articles," 56% of medical students and 80% of

TABLE 3
WITHIN GROUP COMPARISONS OF SEARCH VARIABLES
USED IN EARLY AND LATER SEARCHES*

Group	Variable	t-value	p
Beginner	statement	0.87	0.391
	display	1.25	0.218
	AND	0.99	0.327
	OR	-1.47	0.150
Intermediate	statement	-1.95	0.058
	display	0.57	0.575
	AND	-2.06	0.046
	OR	-0.68	0.499
Advanced	statement	-0.68	0.505
	display	0.47	0.643
	AND	0.36	0.723
	OR	-0.71	0.484

* Paired t-test comparisons for variables used in early searches (experience level 1) compared to later searches (experience level 2) within each group. Significant p values ($p < 0.05$) indicate difference is significantly different from zero.

TABLE 4
BETWEEN GROUP COMPARISONS OF SEARCH VARIABLES
USED IN EARLY AND LATER SEARCHES *

Variable	F-value	p
statement	1.80	0.171
display	0.56	0.571
AND	2.09	0.130
OR	0.17	0.848

* ANOVA indicates no significant differences between early and later searches (experience level 1 and 2) for the four search variables between groups. Multiple range tests (Duncan, Tukey, and Least Square Means) also indicate no significant differences between groups.

house officers using "subheadings," and approximately 40% of both groups using the limit feature "English language."

Effect of Experience on Search Performance

Table 3 shows the results of paired t-tests comparing experience levels (early searches [level 1] versus later searches [level 2]) within each experience group (beginner, intermediate, advanced) for the number of statements entered, the number of records displayed, and the number of Boolean operators (AND and OR) used. There were no significant differences except that the use of the AND operator decreased significantly in the intermediate group. The one-way ANOVAs for between-group comparisons of the differences between early and later searches indicated that there were

also no significant differences between groups for any variable (see table 4).

Table 5 shows the results of the log linear analysis for three-way categorical data. Only the limiters "language," "year," "review," and "subheadings" were analyzed separately because use of the other limiters was infrequent. The category "limiters" provides an analysis of the occurrence of any limiter at the experience levels. There were no significant differences with experience between and within groups, except for MeSH. The significant interaction between group and experience level for MeSH indicates that there was an increase in the use of MeSH with experience for those in the advanced and beginner groups, but not the intermediate group. The greatest increase in MeSH use with experience level occurred in the advanced group.

TABLE 5
COMPARISONS OF USE OF SEARCH VARIABLES
BETWEEN GROUPS AND WITHIN GROUPS*

Variable	χ^2	P
MeSH		
group	2.66	0.265
explvl	4.65	0.031
group*explvl	10.17	0.006
Title Word		
group	0.05	0.973
explvl	0.001	0.975
group*explvl	2.44	0.296
Language		
group	3.04	0.219
explvl	1.89	0.170
group*explvl	2.22	0.329
Year		
group	1.95	0.377
explvl	2.63	0.105
group*explvl	0.71	0.702
Review		
group	1.51	0.470
explvl	1.01	0.314
group*explvl	2.98	0.225
Subheadings		
group	1.95	0.377
explvl	0.86	0.314
group*explvl	2.02	0.365
Limiters		
group	0.48	0.785
explvl	1.61	0.205
group*explvl	2.24	0.327

* Results of comparisons between groups (group) and experience levels within groups (explvl), and for the interaction between groups and experience levels of search variables using the log linear model for three-way categorical data.

Figure 2 compares the change in the mean number of all limiters used with experience. A two-way ANOVA indicated that there was a significant interaction between group and experience level ($p=.019$), and the least square means comparison showed that the only significant difference in experience level was in the advanced group ($p=.03$).

DISCUSSION

Descriptive Study

Not surprisingly, the majority of searches were performed to find information about a subject. Studies of other end-user systems for searching MEDLINE have reported similar findings. For

example, Sewell and Teitelbaum reported that 13.5% of the searches in their study of end-user searching of NLM databases were performed for information about an author, while the remainder of the searches looked for information about a subject.¹⁸ Similarly, Naomi C. Broering observed that less than 5% of the searches in miniMEDLINE were for articles by an author.¹⁹ Likewise, Ann B. Hubble found that approximately 70% of the users of MELVYL-MEDLINE at UCLA were searching for information on a subject.²⁰

The infrequent use of UM-MEDLINE was somewhat surprising (on average, approximately two new searches were performed per month per individual). As noted previously, the sample of indi-

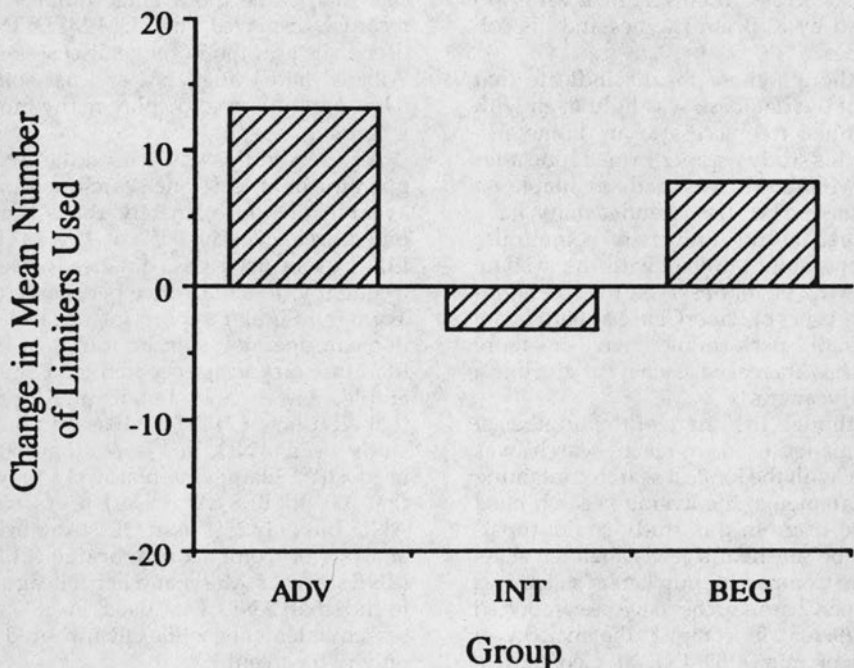


FIGURE 2

Change in the mean number of limiters used between experience levels for each experience group

viduals chosen for this study was originally based on the amount of time that users had been working with the system because the author believed this to be a valid measure of experience. The analysis of system use, however, showed that 38% of users had performed ten or fewer new searches (beginners) and that 41% had performed between 11 and 20 new searches over the six-month period (intermediate). For this reason, the research design was changed, and the number of new searches performed substituted as the factor in determining user experience.

Other researchers have observed similar infrequent use of bibliographic databases. For example, J.D. Montgomery, in a study of scientists' use of DIALOG at the Proctor and Gamble Company, observed that, in the nine-month period following a training session, a sample of 32 researchers had conducted a total of 34 searches and that approximately half of the researchers had

not conducted any searches.²¹ In a study of users of a CD-ROM version of MEDLINE, Ans Bleeker and her colleagues found that nearly 50% of the respondents to a survey performed searches less frequently than once per month.²² Similarly, a study conducted at the University of Michigan on users of Compact Cambridge MEDLINE (a CD-ROM product) found that more than 60% of the respondents to a survey claimed to search the system once per month or less frequently.²³ The author believed that the use of MEDLINE in this study would be higher than in studies of CD-ROM MEDLINE versions because of the convenience of remote access. In fact, 62% (the sum of intermediate and advanced users) of UM-MEDLINE users performed at least two searches per month, which is higher than it is in the CD-ROM studies and similar to the number of searches performed by physicians, house staff, and clinical clerks with un-

limited access to GRATEFUL MED reported by R. Brian Haynes and his colleagues.²⁴

Although these results indicate that use of the database was light even with unlimited free access to an online system, this study was performed soon after UM-MEDLINE was made available on campus. The use trends may have changed as the university community became more familiar with the system. Horowitz et. al. observed that the number of users of PaperChase at Beth Israel Hospital performing five or more searches increased each year during a three-year study.²⁵

Although the range of the number of statements used in each search was large, with the longest search containing 46 statements, the average search need of the users in this study could apparently be satisfied in fewer than ten statements. Comparable numbers of statements in PaperChase searches have been reported elsewhere.²⁶ In contrast, the majority of users of miniMEDLINE at Georgetown University Medical Center worked with single-subject searches.²⁷ More than 90% of GRATEFUL MED users performed their searches in five lines or fewer.²⁸

Medical students and house officers displayed an average of 45 and 47 records per session, respectively. These values are comparable to those reported in earlier studies of PaperChase users.²⁹ However, the wide range of references displayed (from 0 to 449) indicates tremendous variability in the number of records that users are willing to display. Stephen E. Wiberly and Robert Allen Daugherty provide a useful review of the literature on the number of records that users of bibliographic retrieval systems and OPACS are willing to accept.³⁰ They conclude that users seem to prefer between 50 to 70 references from an online search, while OPAC users seem to be satisfied with looking at fewer than 35 OPAC postings. They also indicate that OPAC users can be quite persistent in scanning long lists of references, although no comparable information was provided for users of bibliographic retrieval systems. The results of the present study indi-

cate that, while the average number of records displayed by UM-MEDLINE users falls near the 57 range discussed by Wiberly and Daugherty, at least some users are willing to display many more records.

All users in this study used the AND operator in at least one search, with an average of approximately three times per search. Nearly 90% of UM-MEDLINE users used OR, but used it less frequently (less than once per search on average). Similar reports of the use of Boolean operators can be found in the literature on end-user searching. For example, Sewell and Teitelbaum found that all users of NLM databases in their study used AND, but fewer than 50% used OR.³¹ Elaine Trzebiatowski found that 100% of BRS/After Dark users used AND, but only 25% used OR.³² And in an analysis of Compact Cambridge MEDLINE searches, Miller and her colleagues found that AND was used in 58% of search statements, while OR appeared in only two percent.³³

The substantially higher use of the OR operator in the present study, in contrast to its use in other studies, may be because the OR operation can be accomplished in several ways (as discussed in the methods section). Two of these methods—allowing users to choose a number of related terms to be included in one list and the <ALL> feature—are probably especially useful to users because neither requires the user to seek consciously an OR operation.

A unique feature of PaperChase is that the program monitors searches and suggests improvements to the user. The most frequent suggestion proposed to PaperChase users is that they conduct a search using a MeSH term rather than a title word.³⁴ It is commonly accepted that searching by MeSH terms usually results in greater success than searching by keyword; other MEDLINE studies suggest that failure to use MeSH terms is a common search problem.³⁵ That over 80% of searches by medical students and house officers contained MeSH terms and that 100% of individuals in both groups searched by MeSH terms in at least one

of the searches analyzed suggest that PaperChase is effectively leading end users to MeSH terms. However, approximately 35% of the searches included statements containing title words and more than 90% of the study subjects searched by title word in at least one of the selected searches. Therefore, users seem to be taking advantage of the ability to search for title words. To ascertain the true significance of title word searching in this study is difficult because the author did not perform an analysis of search content. Possibly, title words were used by necessity because no suitable MeSH term existed, or perhaps a title word was used to limit a larger search. However, the transaction logs indicate that searchers used title words when an appropriate MeSH heading or subheading was available.

A unique feature of PaperChase is that the program monitors searches and suggests improvements to the user.

Interestingly, approximately one-fifth of all searches employed subheadings, and more than 50% of the UM-MEDLINE users in this study applied subheadings in at least one search. Sewell and Teitelbaum noted that subheadings are extremely useful in MEDLINE searching but that end users have difficulty remembering and finding these subheadings when needed.³⁶ That such a large number of UM-MEDLINE searchers in this study used this feature indicates that PaperChase is probably helping searchers use this important MEDLINE search feature. No comparable figures for the use of subheadings by end users of other MEDLINE access systems could be found, although Sewell and Teitelbaum reported that failure to use subheadings by NLM database end users may have been among the most costly of the errors made.³⁷ Additionally, the many reports of end users' failure to employ MeSH implies that the use of subheadings in these systems is also likely to be quite low.

Similarly, PaperChase seems to be guiding users effectively toward other limiting features, such as "year of publication," "review articles," and "articles written in English." The only comparable figures found for the use of these features in MEDLINE are from a study of GRATEFUL MED users, which found that approximately eight percent of 1,310 searches were limited to review articles, while approximately 23% of these searches were limited to English.³⁸ UM-MEDLINE users in this study made greater use of the review article feature, but less frequent use of the ability to limit searches to English-language articles only. The less frequent use of limiting by English may be attributable to PaperChase display techniques, which show first 118 English-language journals in *Abridged Index Medicus*, a subset of *Index Medicus*. This may decrease the need for users to limit by this feature. The current study did not analyze search content or attempt to determine the purpose of the search. Possibly, the simple nature of many searches precluded the need for advanced limiting features. Likewise, features such as age or year of publication may have been unnecessary or undesirable in a particular query.

Effect of Experience on Search Performance

Only the advanced group showed a significant increase in use of MeSH terms with experience and an increase in overall use of limiters. Thus, users tended to increase their use of MeSH terms and become more sophisticated with limiters as they gained experience. The present study seems to support the earlier suggestion that users employ more sophisticated search techniques as they work with PaperChase.³⁹ However, these tendencies to increase the use of certain features are not overwhelmingly large and, overall, experience seemed to have little effect on utilization of system features.

Other studies of end users suggest that use of search features varies with searching experience. For example, Winifred Sewell and Alice Bevan observed that

relatively inexperienced end-user searchers of NLM databases tended to perform simple searches without utilizing more sophisticated search features.⁴⁰ Carol H. Fenichel performed an extensive study of the effect of experience in searching the ERIC database.⁴¹ She found that those who searched ERIC a great deal tended to use more commands and descriptors, to modify their searches more often, and to spend more time online. However, she also noted that there was no clear-cut pattern across the experience groups (similar to the results of this study).

CONCLUSIONS

The descriptive segment of this study shows that the UM-MEDLINE users observed used a variety of features for performing effective MEDLINE searches (i.e., MeSH terms and limiters). The infrequent use of these features in other MEDLINE end-user systems, coupled with the results of the present study, indicates that PaperChase and its user-friendly features are aiding searchers. Experience seemed to have little effect on searcher utilization of most features; however, the most experienced users tended to increase their use of a few search features.

The present study does not analyze search content or search results. Casual observations of search contents indicate that searchers were making at least some

mistakes (e.g., searching for "bone marrow" as a MeSH term and "transplantation" as a title word rather than applying the "transplantation" subheading to the MeSH term). Similarly, conversations with users indicate that a lack of understanding of PaperChase mechanics may also be impairing results. For example, explanations of MeSH tree structures and the inability to explode (a feature that allows the searcher to input a broad term and include narrower terms in the MeSH hierarchy) have usually led to user surprise and concern. These findings point to the importance of librarian searchers as trainers, consultants, and guides. The continued need for librarians to assist these end users is particularly noteworthy because PaperChase is considered to be extremely user-friendly.

Likewise, this study did not measure user satisfaction with PaperChase; a follow-up study in this area would be interesting. End users may be satisfied with searches even if they do not retrieve all or even a significant portion of the references on a topic. On this point, librarians should consider the user and the use of the information. The information needs of medical students or house officers may be amenable to quick and possibly incomplete answers. The needs of other end users (e.g., researchers, grant seekers, textbook writers, etc.) may be substantially greater.

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