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PaperChase®, a self-service computerized literature search (SSCLS) service, was compared to conventional resources for accessing recent medical information by assessing user attitudes, search costs, and number of searches performed. The study was designed as a randomized controlled trial using survey instruments before and after the intervention. Accounting of PaperChase searches was monitored electronically, and costs of librarian searches were provided by the hospital library. Participants included 57 physicians in several specialties who were members of a group practice located in a suburban ambulatory care center. Responses were received from 67%.

The experimental group received free, unlimited access to PaperChase over a one-year period, while the control group used conventional resources (manually self-performed searches and computerized MEDLINE™ searches performed free-of-charge by hospital librarians). The study disclosed no change in attitude of either those employing computers or SSCLS. Attitude scores in the experimental group showed statistically significant worsening in preference for SSCLS over textbook use and the estimation of SSCLS utility in the outpatient setting. The cost of PaperChase compared favorably to literature searches done by librarians. The self-reported numbers of literature searches of all types increased in the experimental group. PaperChase searches changed physicians' perceptions of patient treatment and outcome in some cases. While computerized literature searches may have a role in the outpatient setting, other resources remain important. Although only certain physicians are interested in using this method, this study shows that PaperChase can be a cost-effective alternative to MEDLINE searches performed by hospital librarians. (Henry Ford Hosp Med J 1990;38:57-61)

The unspoken assumption underlying much medical education and clinical practice is that the quality of patient care is improved if clinicians incorporate into their practice patterns the most current and relevant information. The expansion of the medical literature, especially journal articles, makes this a formidable task for all physicians, particularly generalists. Physicians in General Internal Medicine and Family Practice must remain appraised of developments in multiple areas, including those outside of their "core" discipline. The advent of computerized systems to perform MEDLINE™ literature searches offers a potentially valuable tool to all physicians attempting to keep their medical knowledge current.

Traditionally, MEDLINE searches have been performed by specially trained librarians affiliated with hospital or medical center libraries. The initial evolutionary advance in improved access to computerized literature searches by clinicians came with the development of the clinical librarian. The clinical librarian periodically attends inpatient rounds with the clinical team to identify and later obtain medical literature pertinent to cases encountered. Studies of the effects of these programs have been performed in Departments of Obstetrics and Gynecology (1) and Internal Medicine (2,3). The number of literature searches performed increased in each case with most being directly related to patient care.

The problems of time delays, lack of access to librarians, and the difficulties in utilizing the standard MEDLINE system have led to the development of computerized bibliographic search systems suitable for use by clinicians with little or no background in computer science and/or library science (4-8). PaperChase® (Center for Clinical Computing, Beth Israel Hospital, Boston, MA) is a "user-friendly," self-instructional, online bibliographic retrieval system for end-users. It has progressed from an index for reprint files (9) to a system accessible by terminals in the hospital library (4,10), and is now a commercially available resource. Users may subscribe to PaperChase and conduct literature searches from any location in the United States and from several foreign countries over standard telephone lines. Equipment required to use PaperChase includes a modem, personal computer or telecommunications terminal, and a printer (11,12).

This study compares access to recent medical information via PaperChase and currently available resources in an outpatient

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setting. Variables investigated include physician attitudes, usage patterns, and cost in comparison to literature searches performed by the medical librarian.

Methods

The nonrandomized three-month pilot study involved 38 health care providers (senior staff physicians, residents, and physician assistants) evenly divided between two Internal Medicine practice groups in the Henry Ford Hospital Fairlane Center, a large ambulatory care center located in a suburb of Detroit. The final one-year study involved 57 physicians (56 senior staff physicians and one resident) from the same location, randomized using blocked randomization on an alphabetized list of potential participants, excluding the participants of the pilot study. In the pilot phase, questionnaires were sent to all 38 participants, and responses were obtained from 32 (84%) (16 from the experimental group and 16 from the control group). During the final phase, questionnaires were sent to all 57 physicians, and responses were obtained from 46 (81%) in the preintervention period (25 from the experimental group and 21 from the control group) and from 38 (67%) in the postintervention period (22 from the experimental group and 16 from the control group). Participants in the final phase were from the following departments or divisions: Allergy, Ambulatory Surgery, Audiology, Cardiology, Dentistry, Dermatology, Emergency Medicine, Otolaryngology, Obstetrics and Gynecology, Ophthalmology, Optometry, Pediatrics, Psychological Services, and Rheumatology.

The experimental group received free 24-hour access to PaperChase through equipment located in a central area. General instructions on equipment usage and passwords for PaperChase were sent to all individuals in the experimental group. No formal instruction sessions in the use of PaperChase were held during the pilot phase, but a one-hour voluntary training session was held during the final phase. Control group participants did not have system access but were able to perform literature searches manually (eg, using *Index Medicus*) or have computer searches done free-of-charge by librarians located at the main hospital in Detroit. The medical librarian monitored requests from both groups for computerized searches during the final phase of the study and also obtained data on the number of searches performed in the preceding 12 months. At the end of the one-year intervention period, a second questionnaire was sent to all participants on the final day.

The initial survey sent to both groups was identical. All questions were either open-ended or used a numerical response scale, with lowest to highest values ranging from 1 to 5. Questions obtained information on demographics, experience with computers and computerized literature searching, attitudes toward computers and computerized literature searching, and preferences for literature searching (manual versus librarian-mediated MEDLINE searches versus self-service computerized literature searches [SSCLS]). Participants were also asked to quantitate the number and types of literature searches performed in the preceding one month and classify them in terms of reason performed.

The completion survey contained the questions of the initial survey. In addition, the control group was asked about PaperChase usage during the study period, to exclude the borrowing of a password. The experimental group completed additional questions regarding attitudes toward the PaperChase system; members of the experimental group who did not use PaperChase did not complete these questions.

Statistics quantitating number of uses per participant, elapsed time of system use, dates used, and cost were available from the PaperChase computer.

Comparison of the preintervention survey results were made using two-sample t tests on ranked data. The differences were calculated between the preintervention and postintervention surveys (with negative change signifying a decrease from preintervention to postintervention), and these ranked difference values were used in two-sample t tests to compare experimental and control groups at the end of the study. The means obtained from some of the pilot phase responses were incorporated as single additional observations when the group comparisons were performed, because each of the two pilot groups should be viewed as whole clusters due to the way in which pilot group placement was performed.

Results

Four of the 25 responding members of the experimental group used PaperChase. In the pilot study, 12 of 16 members of the experimental group used PaperChase. In the final phase, 28 searches were performed, lasting a total of 428.17 minutes and costing a total of $280.19. The average search lasted 15.29 minutes and cost $10.01 ($0.65/min). Data provided by the Sladen Library at Henry Ford Hospital indicated that the average librarian-mediated computerized literature search over the same one-year period lasted 8.1 minutes online and cost $13.91 ($1.72/min online).

No difference in experience in using personal computers was noted between the control and experimental groups in the preintervention period ($P > 0.56$, Fisher's two-tailed exact test) or postintervention period ($P > 0.72$, χ^2 analysis). A summary of the remaining survey responses is presented in Table 1. No significant differences existed between the two groups in the preintervention survey. In the experimental group, postintervention data showed significant decreases in preference of SSCLS to textbook usage and in perceived SSCLS utility in the outpatient setting.

The sum of self-reported manual searches, librarian-mediated computerized searches, and SSCLS showed a significant increase in the postintervention period for the experimental group (Table 2). The experimental group underreported the number of PaperChase searches performed (11 reported, 28 actually performed). The Sladen Library was able to confirm the number of librarian-mediated computerized searches performed. All groups reported more than the actual number of librarian-mediated searches performed, but this was statistically significant only in the control group in the preintervention period (12 reported, 1 actually performed; $P = 0.02$).

Table 1
Survey Results

Question	Group	Preintervention Mean (SD)	Rank	P-value	Pre- and Postintervention Difference Mean (SD)	Rank	P-value
Time with personal	C	2.75 (1.49)	10.3		0.40 (1.67)	7.8	
computer	E	2.83 (1.59)	10.6	0.91	0.22 (1.72)	7.3	0.84
Estimated utility	C*	2.61 (1.32)	21.4		0.49 (1.66)	16.9	
personal computer	E*	2.45 (1.37)	19.7	0.64	−0.49 (1.30)	13.2	0.24
Manual searches	C	0.30 (0.66)	21.3		0.15 (0.69)	16.3	
	E	0.54 (1.02)	23.5	0.46	0.11 (1.63)	16.6	0.93
Library searches	C	0.57 (0.87)	24.5		0.21 (1.05)	17.1	
	E	0.37 (0.88)	21.7	0.35	0.50 (2.57)	16.1	0.74
Sum manual plus	C	0.90 (1.41)	21.9		0.33 (1.07)	15.6	
library	E	0.96 (1.77)	22.1	0.97	0.65 (4.15)	14.6	0.73
Utility SSCLS	C*	2.56 (0.98)	22.2		0.43 (1.02)	17.5	
	E*	2.69 (1.36)	22.8	0.86	0.10 (1.06)	14.8	0.4
Utility home SSCLS	C*	2.04 (1.20)	19.2		0.66 (1.38)	17.4	
	E*	2.58 (1.26)	24.6	0.15	0.01 (0.76)	12.7	0.12
Instruction required	C	3.12 (0.93)	18.4		0.09 (0.83)	13.3	
for SSCLS	E	3.20 (0.89)	19.5	0.72	−0.55 (0.82)	9.7	0.13
Use SSCLS over	C*	2.37 (0.80)	19.9		0.50 (0.85)	20	
textbook	E*	2.67 (0.94)	24	0.26	−0.24 (1.21)	13.7	0.05†
SSCLS over manual	C*	3.83 (0.87)	21.7		0.16 (0.53)	19	
search	E*	3.62 (1.43)	21.3	0.93	−0.39 (1.69)	13.6	0.07
SSCLS over librarian	C*	3.20 (1.17)	24.3		−0.46 (0.78)	15.8	
search	E*	3.03 (1.33)	21.8	0.52	−0.35 (1.53)	16.1	0.93
SSCLS increase	C*	2.47 (1.08)	19.3		0.11 (1.44)	18.9	
research project	E*	3.04 (1.19)	25.4	0.1	−0.41 (1.03)	14.6	0.19
Estimated utility SSCLS	C*	3.02 (0.92)	23.3		0.30 (0.72)	20	
outpatient setting	E*	2.88 (1.12)	21.8	0.68	−0.36 (0.97)	13.8	0.04†
Estimated utility SSCLS	C*	3.10 (1.12)	17.6		−0.06 (1.04)	13.8	
inpatient setting	E*	3.38 (1.14)	21.2	0.31	−0.16 (1.07)	13.2	0.82
Estimated utility SSCLS	C*	3.12 (0.92)	19.8		0.14 (0.83)	17.4	
utilization review	E*	3.41 (1.15)	23.9	0.27	−0.07 (1.39)	14.7	0.41

*Includes pilot study data.
†Statistical significance.
Note: C = control, E = experimental.

The reasons listed for why literature searches were performed (more than one response possible) included direct patient care (sum = 24), presentations such as medical rounds or conferences (sum = 26), research indirectly related to patient care (sum = 21), and "other" such as looking for a specific article or for educational purposes (sum = 5).

In the postintervention period, experimental group participants showed mean responses to the following attitude questions above (better than) the median (3.0): 1) importance of time saved using PaperChase (mean 4.5 ± 0.67), 2) how often the entire article was read (3.8 ± 0.73), 3) how often the title and abstract displayed sufficient information to answer the search question (3.6 ± 0.95), 4) information availability on PaperChase compared to alternate sources (3.6 ± 1.4), and 5) how often PaperChase saved time (3.6 ± 1.5). Responses limited to residents and senior staff who teach residents that were above the median included: 1) the value of literature searches to residency programs (mean 4.4 ± 0.52), and 2) the value of timely literature searches to residency programs (4.4 ± 0.5). On the final questionnaire, control group participants indicated a slightly greater than the median desire to have a PaperChase password (mean 3.2 ± 1.2).

Table 2
Total Reported Searches (Manual + Librarian + SSCLS)

	Control N	Mean (SD)	P-Value	Experimental N	Mean (SD)	P-value
Preintervention	18	0.30 (0.67)		17	0.24 (0.58)	
Postintervention	20	0.49 (1.0)	0.26	42	0.71 (1.72)	0.002

Note: All reported searches were significantly increased after the intervention.

The following questions had mean responses below (worse than) the median in the experimental group in the postintervention survey: 1) how often feedback from PaperChase added to the search (mean 2.6 ± 1.4), and 2) how often PaperChase feedback suggested new topics (mean 2.6 ± 1.4).

The experimental group reported that PaperChase caused them to investigate new topics one to two times more than had they not used PaperChase (mean 1.6 ± 1.5). Two users reported that at least one PaperChase search changed their perception of patient treatment, leading to a new treatment or modification of the current treatment plan. The perception of change in patient outcome was improved in one participant and unchanged in the other.

Discussion

The expected increase in total number of searches performed which has been reported in institutions with clinical librarians (1,3) and another SSCLS study (6) did occur, based on self-reporting. However, only a minority of potential PaperChase users performed their own searches. Costs were found to compare favorably with those of searches done by the medical librarian, in contrast to the expectation (7) that PaperChase would be considerably more expensive. Exposure to PaperChase did not increase experience in using personal computers, probably because our equipment consisted of a terminal rather than a personal computer.

A confounding factor may be inaccurate self-reporting of the various types of literature searches undertaken. The experimental group in the postintervention period showed a significant increase in the total number of self-reported literature searches performed, but confirmation was not possible for all search types. There was not a large increase in the number of measured librarian-mediated searches nor a significant over-reporting of these searches in the experimental group. The increase may be due to the additional PaperChase searches, although these were performed by a minority of the experimental group. The measured PaperChase usage indicates that users actually perform more searches than they report. Accurate measurement of the total number of searches performed probably presents insurmountable difficulties unless a compulsive record-keeping system is used by all participants.

The difficulty in objectively measuring changes in attitudes toward various factors is obvious. Lower attitude scores after PaperChase experience may represent the moderating of unrealistically high initial expectations in some participants. Literature searches may be more useful for scholarly activities or difficult cases involving hospitalized patients than for most cases encountered in the outpatient setting. Pressures of time in strictly scheduled outpatient practices may make a textbook a more accessible source of information than an electronic search, as was reflected in our participants' attitude scores. The baseline attitude scores on computers and SSCLS usage were near the median and presented in a somewhat different format from previously reported favorable medical student or physician attitude scores (13,14). A previous study which attempted to measure preferences regarding information systems in an Internal Medicine residency program (15) found a general preference by residents for textbooks and other alternatives to librarian-mediated computer searches. Residents and their preceptors rated the value of literature searches and their timely results relatively highly in the present study. PaperChase users agreed with the initial report (4) that titles and abstracts could sometimes provide the answer to the question which precipitated the search. Our participants reported a lower rate of reading the complete articles than previously reported in a clinical librarian setting (2), which may indicate that the title or abstract had answered the question. Attitudes also appeared favorable toward PaperChase in terms of availability "off hours" and its time-saving value. Features that increase the user-friendliness of PaperChase, such as feedback in suggesting medical subject heading (MeSH) terms corresponding to the non-MeSH search term used and new, related MeSH terms (10), were not rated highly by our participants as they were in a previous study (16). Our experimental group participants may have overlooked how often the program suggested the synonymous MeSH term because of the quick and effortless nature of the substitution. The suggestion of related MeSH terms would mainly be helpful should the individual wish to expand the search or include overlooked, pertinent topics into a current search.

Most previous studies of methods to improve access to medical literature have taken place in the library or inpatient hospital setting (1-4,6,10) rather than the outpatient setting of this trial. A study in a family practice clinic (17) showed significant usage of computerized searches and favorable ratings by participants. Two-thirds of their usages were related to research or other scholarly activities, with one-third being related to patient management. The most frequent response from those not using PaperChase in our study was "lack of time," which has been noted in another study of end-user searching (18).

The reported reasons for performing literature searches correspond to those in the literature (3,18). A previous survey (2) showed that literature searches done by clinical librarians affected management of patients by 20% of house officers. The changes were apparently reported as uniformly positive. In contrast, our data indicate higher reported change in management (two of four users), with both favorable and unchanged perceptions of change in patient outcome. Because of the difficulty in measuring outcomes, the physician's perception of outcome was the variable measured, with the inherent limitations of bias and differing criteria to measure positive and negative outcomes.

In summary, data suggest that the PaperChase system was used by only a minority of potential users, while attitude data show lowered scores in some areas after PaperChase exposure. However, total self-reported literature searches increased in the experimental group, suggesting a beneficial effect of PaperChase availability. Perception of patient management was changed in some cases. Although only certain physicians may be interested in performing computerized literature searches, PaperChase can be a cost-effective alternative to searches performed by the hospital library.

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