Clinical Trials of Interactive Computerized Patient Education: Implications for Family Practice

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A systematic review of randomized clinical trials was conducted to evaluate the acceptability and usefulness of computerized patient education interventions. The Columbia Registry, MEDLINE, Health, BIOSIS, and CINAHL bibliographic databases were searched. Selection was based on the following criteria: (1) randomized controlled clinical trials, (2) educational patient-computer interaction, and (3) effect measured on the process or outcome of care.

Twenty-two studies met the selection criteria. Of these, 13 (59%) used instructional programs for educational intervention. Five studies (22.7%) tested information support networks, and four (18%) evaluated systems for health assessment and history-taking. The most frequently targeted clinical application area was diabetes mellitus (n=7). All studies, except one on the treatment of alcoholism, reported positive results for interactive educational intervention. All diabetes education studies, in particular, reported decreased blood glucose levels among patients exposed to this intervention.

Computerized educational interventions can lead to improved health status in several major areas of care, and appear not to be a substitute for, but a valuable supplement to, face-to-face time with physicians.

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Communication between the patient and the family physician is a key factor affecting both the process and outcome of care. Well-informed patients are more likely to become active partners in the management of their own health.[1-3] Occasionally, evidence contrary to this accepted belief points in a different direction. An educational intervention presented to mothers did not improve the rate of immunization in infants by the age of 12 months.[4] Two simple educational interventions that encouraged adult patients to seek health maintenance information did not have a significant impact on their desire to initiate discussions about or make lifestyle changes for health maintenance.[5]

Computers are gaining popularity as a tool for providing information and education in the health care field. Still, there is some disbelief concerning patient acceptance of computers and the successful contribution of computerized educational interventions. For example, an evaluation of a psychiatric patient interview system revealed that 10 of 27 subjects were not comfortable interacting with a computer.[6] In another study, investigators found that many patients were apprehensive about touching the screen or using the mouse.[7] What is needed as a guide to clinical practice is a systematic evaluation of past experience about patient acceptance of computers and the impact of computerized patient education on health care processes.

With the explosive growth of Internet access, many more patients are now online than just a few years ago. Moreover, some patients are coming to their family physicians after researching the Internet about their condition. In advising the use of this tech-

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nology for the educational benefit of their patients, family physicians should be equipped with the scientific evidence about how this technology can be used effectively. Web sites could become clinical resources if they incorporated the most successful interactive computerized patient education techniques that have been substantiated in clinical trials.

Many questions, however, need to be answered. Do interactive computer-patient educational interventions contribute to improved health status? Will computers continue to be adjuncts rather than substitutes for health care? Will certain clinical areas benefit more than others? Systematic analysis of controlled evidence from previous studies on the effect of computerized patient education may answer these questions. In this review of randomized controlled clinical trials, educational computer-patient interactions were evaluated for usefulness, acceptability, and impact on health care processes and outcomes.

REVIEWING THE LITERATURE

Systematic literature searches identified controlled clinical trials in which patients interacted directly with a computer system to receive or provide information. We searched the Columbia Registry of Information and Utilization Management Trials[8] (an electronic database established in 1991 to provide researchers with a comprehensive collection of randomized controlled trials), MEDLINE, Health, BIOSIS, and CINAHL. Search terms included: computer, patient education, interactive, randomized controlled trials, and controlled clinical trials. The retrieved studies were screened to select those that met the selection criteria, namely: (1) randomized controlled clinical trials, (2) educational computer-patient interaction, and (3) effect of measures on the process or outcome of care. Studies were selected only if they met all three selection criteria.

The quality of eligible trials was evaluated using a quality evaluation form consisting of 20 questions aimed at assessing site, sample, randomization, process of observation, data quality, and statistical analysis.[9] Each study could score points from 1 to 100. Quality assessments were performed independently by trial investigators, and discrepancies were eliminated by arriving at a consensus through discussion. The mean quality score for the studies was 78.8 (range 64 to 94). All studies exceeded the predetermined threshold of methodologic quality. Following quality assessment, practical information was summarized using a data extraction form. Each summary included a description of the subjects, setting, types of intervention, the effect of the variables measured, and the direction of effect. The effectiveness guidelines were analyzed to assess the results of the educational patient-computer interaction in terms of outcomes and their significance.

Interventions used in the studies were grouped into one of the following categories: interactive instructional computer programs, computerized health assessment and history-taking, and computerized information support networks. The studies were organized by clinical area under each of these three categories.

RESULTS OF SEARCH

Studies were selected only if they met all three selection criteria named in the preceding section. Searches originally produced 31 articles that were manually screened to ensure direct patient-computer interaction. Studies that produced printed outputs to be mailed to the patient were excluded, as were those in which the computer generated information for the providers to convey to the patients. The criteria of random assignment were applied rigorously. A study was included only if the subjects were assigned randomly to control and experimental groups. This eliminated nine articles, leaving 22 clinical trials that met the selection criteria.

Sample size in the 22 studies ranged from 18 to 1003 subjects and population age ranged from 12 to 91 years. There were three studies involving adolescents (age range, 12 to 20 years). Of the 19 studies that used adults, two included only male subjects and three included only female subjects. Eight studies provided data about the educational level of the subjects, but only two studies[10,11] reported testing the computer experience of participants through a baseline survey. Education or computer experience was not a prerequisite for participation in any of the studies.

The clinical areas covered by the studies included diabetes, asthma, AIDS/HIV, arthritis, Alzheimer's disease, stress management, hypertension, occupational rehabilitation, alcoholism, and general health management. Thirteen eligible studies (59%) tested interactive instructional computer programs that

allowed users to input data or respond to questions. Four studies (18%) used a format of questionnaires to assess the health or clinical condition. Five studies (23%) applied computer network technology to educate patients.

Instructional Computer Programs

In clinical trials of interactive computer programs, educational information was provided about general health-related problems, diseases, or a specific diagnosis (Table 1). Six trials provided patient education related to diabetes mellitus. Two trials tested asthma education. The instructional programs in the articles were menu-driven and offered self-paced learning by allowing users to input data or respond to prompted questions.

One study applied interactive multimedia (interactive computer programs that combine audio, video, text, and graphics to communicate educational messages) to enhance an instructional program about hypertension.[10] In general, the intervention period was long for diabetes studies, lasting between 3 and 12 months, but in one study the intervention period lasted as long as 19 months.[12]

The average duration of computer-assisted intervention was 30 minutes (range, 10 to 210 minutes). An educational module on the medical effects of alcohol, however, took between 45 and 50 minutes,[13] and a self-paced instruction program on rheumatoid arthritis lasted up to 3.5 hours.[14] User satisfaction with most of the instructional programs was evaluated by using a 20- to 30-item questionnaire, which required additional time.

Study results on the following subjects were noted:

Diabetes mellitus. Studies that provided diabetes education on how to monitor blood glucose levels and information on other preventive care measures reported a 10% to 20% decrease in patient blood glucose levels.[15,16] Although there was no significant difference between groups in the knowledge scores, increased involvement in the management of their diabetes was reported by 40% more subjects in the intervention group than in the control group.[16] Use of instructional computer programs also resulted in increased knowledge about diabetes (40% higher)[16] and nutrition.[17] One study demonstrated that use of the instructional computer program using complex corrective feedback instead of the simple right or wrong feedback was associated with higher knowledge scores (85.85% vs 76.25%).[18] In another study, patients in the computer intervention group spent, on average, 39% more time with their physicians (21.2 minutes vs 12.9 minutes) than did patients in the control group who kept a logbook to monitor blood glucose levels.[19] In addition, the intervention patients were more satisfied with care delivery and exhibited a more positive attitude toward monitoring their own blood glucose levels than did the control group.[19] A wallet-sized computerized decision-support system for adjusting insulin dosage was equivalent to direct consultation with a medical team, but more readily available.[20]

Asthma. The two asthma studies evaluated instructional computer programs to educate patients about allergen-avoidance activities.[21,22] The studies reported that patients who used the computer programs in addition to traditional education showed greater gains in knowledge (6% higher scores) and compliance (56% lower mean daily asthma symptom scores in weeks 9 and 10) with asthma management strategies than those who received only traditional instruction.

Hypertension. In the hypertension study, the patients in the experimental group used a multimedia educational program, whereas those in the control group used a regular education program to learn about hypertension. The intervention led to significant increase in knowledge scores among users of the multimedia educational program. The greater difference was noted among patients whose initial knowledge score was low, who were less than 65 years old, and whose hypertension was diagnosed more than 6 months ago.[10]

Rheumatoid arthritis. The authors of the study on rheumatoid arthritis reported that patients who used the computer program had a 15% increase in knowledge scores, whereas there was no change in the scores of those in the control group receiving conventional education. In addition, 75% of the patients in the intervention group stated that the computer-based instruction was responsible for improvement in care taken to protect joints, amount of rest, increased hopefulness of a good prognosis, and an increased belief in a chance to affect their health status.[14]

Urine specimen collection. The study addressing urine specimen collection procedures compared computer-generated instruction with spoken and

TABLE 1

Randomized Trials of Instructional Computer Programs

Trial/Year	Quality	Site	Patient Sample	Intervention	Effect
Huss et al,[21] 1991	90	Allergy Clinic at a tertiary medical center, Washington, DC	52 newly diagnosed, atopic asthmatic outpatients	Asthma education with supplementary computer education	HDMRS and OCECM
Huss et al,[22] 1992	85	Allergy Clinic at a tertiary medical center, Washington, DC	52 newly diagnosed, atopic asthmatic outpatients	Asthma education with supplementary computer education	HDMRS and OCECM
Alterman and Baughman[13]	94	Medical Clinic and Alcoholic Treatment Program at the Philadelphia VA Medical Center	126 men receiving VA medical care	Interactive and highly structured computer program to educate on medical effects of alcohol	Information retention and significance of changes
Wetstone et al,[14] 1985	77	Multipurpose Arthritis Center, University of Connecticut School of Medicine, Kensington, Conn	36 rheumatoid arthritis patients who volunteered to participate when asked	A 10-topic, menu-driven, interactive education program on rheumatoid arthritis	Knowledge of rheumatoid arthritis, health locus of control (HLOC), compliance, reaction to the computer lesson
Horan et al,[16] 1990	81	Endocrinology clinic and drug store	20 diabetic outpatients	Problem solving and goal-setting using Diabetes-in-self-control (DISC) system	Diabetes knowledge scores
Kim and Phillips,[18] 1991	78	Information not provided	24 outpatients	Two 12-14 minute diabetes education videotapes, plus computer-based drill with complex corrective feedback	Diabetes knowledge scores, pre-dinner blood glucose levels, frequency of testing
Leche et al,[15] 1992	68	Department of Diabetology and Endocrinology	19 diabetic patients	Computer-assisted data management systems, using CamitS2 and Cadmo simulation programs	Blood glucose levels
Marrero et al,[19] 1989	81	Department of Pediatrics and Medicine, University of Indiana	29 insulin-dependent adolescents	Diabetic self-control by reviewing glucose data in computer-generated statistical graphical formats with the physician	Blood glucose levels, compliance, attitude, learning, self-monitoring and quality of interaction
Peters et al,[20] 1991	84	Diabetes education center	42 insulin-dependent patients	Wallet-size learning memory decision-support system to adjust insulin dose	Blood glucose level, self-monitoring frequency, hypoglycemic frequency
Wheeler et al,[17] 1983	64	Diabetes Research and Training Center	32 insulin-dependent patients	CAI/VIDEO, a menu driven system for diabetes education	Nutritional knowledge and skills
Said et al,[10] 1994	77	Department of Hypertension at Broussais Hospital in Paris, France	158 hypertensive patients	ISIS, an interactive multimedia computer program to provide education about hypertension	Knowledge about hypertension
Leirer et al,[24] 1988	72	Senior citizen community center	16 seniors with a mean age of 72 years	Computer-assisted instruction to teach medication recall techniques to the elderly	Nonadherence in hours and knowledge recall scores
Fisher et al,[23] 1977	84	Department of Medicine, Harvard Medical School and Beth Israel Hospital, Boston, Mass	99 women undergraduates recruited from 5 colleges in Boston, Mass	Interactive computer instruction on how to collect a clean specimen	Bacterial counts and number of patients reporting problems in carrying out the procedure

HDMRs denotes House Dust Mite Asthma Self-Rating Scale; OCECM, Observation Checklist of Environmental Control Measures.

written instruction and found that computer-based instruction resulted in the fewest procedural problems and the cleanest specimens (66% cleaner than that of the spoken and 54% cleaner than that of the written instructions groups) collected.[23]

Medication-recall training. The medication-recall training study reported that the subjects in the computer-assisted instruction group showed 20% less total nonadherence than those in the control group who received object-recall training (30% vs 10%).[24]

Alchoholics. Alcoholics who used an interactive education program on medical effects of alcohol had no greater information gain or overall learning than subjects who received videotaped instruction, although both groups showed an increase in baseline knowledge. The computer group, however, reported a higher level of satisfaction with the program.[13]

Computerized Health Assessment and History-taking

Computerized health assessment and history-taking was evaluated in four of the 22 studies (Table 2). In each of these studies, interviewer and paper-based format was replaced with a computer system that obtained responses to routine health questions or gathered information about an illness. The responses were scored, analyzed, and reported by the computer program, sometimes with feedback on negative responses.

The results are presented below:

Alcohol treatment. Patients presenting for alcohol treatment rated computer-administered interviews more favorably than physician-conducted interviews and reported 30% higher levels of consumption of alcohol. The increased consumption reported was presumably a more accu-

TABLE 2

Randomized Trials of Computerized Health Assessment and History-taking

Trial	Quality	Site	Patient Sample	Intervention	Effect
Alemi and Higley,[26] 1995	81	Cleveland State University, Cleveland, Ohio	96 university faculty and staff	Computerized health-risk assessment and advisement using AVIVA, a talking computer program	Intent to change behavior, satisfaction with AVIVA regarding accuracy, understanding, convenience, ease of use and accessibilty
Lucas et al,[25] 1977	77	Alcohol Clinic of the Southern General Hospital, Glasgow, United Kingdom	36 male alcoholic patients	Computer-administered questionnaire to assess alcohol problem	Alcohol consumption, drinking behavior, symptoms
Maitland and Mandel,[27] 1994	79	Occupational Rehabilitation Center, University of Calgary, Alberta, Canada	36 men and 12 women occupational rehabilitation patients	Computer-assisted intake evaluation, using Sickness Impact Profile (SIP)	Comfort, understanding, ease of use, preference of method
Millstein and Irwin,[28] 1983	82	Adolescent Medicine Unit, Department of Pediatrics, School of Medicine, University of California, San Francisco	108 adolescent girls	Interactive computerized interview for health and sexual history	Preference for the method of interview, and reasons for their choice

rate report in comparison with a face-to-face interview, where there is a desire to present oneself in the best possible light. When subjects were asked to compare psychiatrists and computers as interrogators of patients with alcohol-related illnesses, 64% of patients returned their questionnaires. Seventy-five percent of these patients rated the acceptability of the computer interview higher than that of a personal interview.[25]

Health-risk assessments. AVIVA is a talking computer program that assesses health risks for smoking, high blood pressure, high cholesterol, lack of seat belt use, physical inactivity, alcohol abuse, and obesity, and advises program users on how to reduce risks as well as referring them to additional information. Of all subjects in the experimental group, 71% accessed AVIVA, and 61% found the system "accurate, current, easy to understand, convenient, affordable, easy to use, interesting and accessible." They also rated AVIVA higher in quality of information than other sources such as television and magazines.[26]

Occupational rehabilitation. Significantly greater scoring efficiency (average time 309 vs 39 minutes) was noted in an occupational rehabilitation study that documented the development and testing of a computerized version of the Sickness Impact Profile for patients. In the study, the computer was chosen over the paper-based format for ease of use by 90% of the users, for preference of the method by 83%, for comfort by 43%, and for understanding by 30% of the users.[27]

Sex behavior in adolescents. A study that assessed the acceptability of computerized history-taking of sexual behavior in adolescent girls documented that subjects in face-to-face and written interviews denied engaging in the specific sexual behavior 75% more often (on six of eight items) than subjects who were interviewed by a computer. Although the proportion of subjects who denied engaging in specific sexual behavior was the same in the three groups, 20% more subjects in the computer group than in the face-to-face group said that they enjoyed the survey because it was easy to use and fun. Confidentiality and privacy of the method were other reasons for their preference of the computer format over other methods.[28]

Computerized Information Support Networks

Five trials evaluated computers with modems and interactive telephone systems to establish information support networks for provider-patient and patient-to-patient communication (Table 3). The networks were used to provide distance delivery of clinical advice, assistance in decision-making, and emotional support. Patients in the studies used communications technology to access the computers from a remote location. No time constraints were reported because the networks were accessible 24 hours a day.

ComputerLink. A study that evaluated the use of a free public computer network called ComputerLink was designed to provide communication, information, and decision support. The system consists of an electronic encyclopedia of illness-specific information, electronic bulletin board, private e-mail, and decision-support system. The participants, 54 persons with AIDS and 102 caregivers of patients with Alzheimer's disease, were randomly assigned to the control and experimental groups. The study documented that AIDS patients used the system more often than the caregivers, and unlike caregivers, the AIDS patients tended to use the network more often during late night hours. Both groups used Private Mail and Forum, the communication functions of the ComputerLink network, approximately 10 times as frequently as they used the information and decision-support functions (10,412 vs 958 accesses for patients with AIDS, and 5,612 vs 609 accesses for caregivers of patients with Alzheimer's disease).[12]

CHESS. In another study that assessed CHESS, an information and decision-support communication network for HIV-infected patients, patients using the networks had decreases in ambulatory care costs (10%), in time spent with providers (21%), in average probability of hospital admissions (26%), in average length of a hospital stay (90%), and in cost of inpatient care ($605).[29]

Stress management. The stress management study, in which an interactive telephone system spoke in a digitized voice and advised callers by recognizing their touch-tone responses, found that active involvement by subjects and care providers was the key to more frequent use of the network and a higher rating score. The study documented that there was a 28% increase in the number of days subjects used the system and a 23% increase in the num-

ber of calls made if they were given homework of practicing stress-management techniques and if messages to them were personalized.[30]

Stanford Health-Net. The Stanford Health-Net study, which promoted appropriate self-care and preventive activities through electronic mail, bulletin board system, information and referral listings and self-help information library, documented a significant decrease (22.5%) in the mean number of ambulatory care visits among the intervention group as compared with the control group. Additionally, in the intervention group, subjects' perceived confidence in preventing sexually transmitted diseases was almost six times that of the control group, and their confidence in preventing herpes was more than double that of the control group. There were no significant differences, however, between groups in total hospitalizations and confidence ratings for self-care items and preventive care skills.[11]

Diabetes mellitus program. Diabeto is a system that connects diabetic patients through Minitel, the French public videotex network, for diet education and counseling. A 10% decrease in blood glucose level and 13% increase in knowledge about diabetes were reported in those who used the system.[31]

DISCUSSION

Interactive computerized educational interventions can produce significant benefits in major areas of patient care. While educational computer systems are developed by those who are believers of this technology, the tests involved randomly allocated patients, and most trials demonstrated

TABLE 3

Randomized Trials of Computerized Information Support Networks

Trial	Quality	Site	Patient Sample	Intervention	Effect
Brennan,[12] 1994	84	Case Western Reserve University, Cleveland, Ohio	54 patients with AIDS and 102 caregivers of Alzheimer disease	ComputerLink, a public computer network system	Number of encounters and function access to ComputerLink
Gustafson et al,[29] 1994	79	Center for Health Services Research and Analysis, University of Wisconsin at Madison	204 HIV-infected patients plus a pilot cohort of 9 women	CHESS,an interactive computer based communication system for decision support and networking	Quality of life, risk attitude and behaviors, health services utilization and average hospital cost per person, per month
Robinson,[11] 1989	94	Stanford University School of Medicine, Stanford, Calif	1003 graduate and undergraduate university students	Health-Net, a health promotion computer network consisting of e-mail, bulletin board, information and referral listings, and a self-help information library	Health-Net utilization and confidence ratings for self-care and preventive skills
Schneider et al,[30] 1994	72	Yale University School of Medicine, New Haven, Conn	267 people who enrolled in the stress management program	Computer interactive telephone access via digitized voice with touch tone recognized caller response for stress management	Helpfulness ratings, number of days calls were made, number of calls
Turnin et al,[31] 1992	90	Outpatient clinic in a French university hospital	105 insulin-dependent patients	Diabeto, individualized computer-assisted diet education and counseling system	Dietetic knowledge, dietary habits, metabolic balance

superior effect.

The results of some of the studies, such as those involving diabetes, asthma, and arthritis, indicate that computers may be the preferred educational method for patients with chronic diseases that require a high degree of self-management and involvement. Computers help patients take better care of their conditions by providing access to the necessary information. Increased understanding of the clinical disease, a benefit that was frequently noted, may have contributed to patients' positive attitudes by eliciting in the patients feelings of greater control and increased confidence in their ability to effect positive changes in their health status.

In some of the studies, the patients seemed more willing to confide in computers than in human interviewers, possibly because the computers were perceived as nonjudgmental or evoked less embarrassment on sensitive subjects. Some patients may have felt unable to adequately express themselves during a time-constrained patient-provider encounter. The results from the health assessment and history-taking studies indicated that computers were particularly useful when confidentiality and privacy were matters of concern. Regardless of the reasons underlying the preference for computer communication, this finding indicates that computerized educational intervention may be more effective than other educational methods for some patients. As an extension of computerized educational intervention supported by the evidence, network-based education may be appropriate for many other chronic diseases, and studies of such interventions are very much needed.

Subject age did not appear to affect the acceptability of the computerized educational methods used in these studies. Significant positive results were shown for studies dealing with subjects of all ages, from children to the elderly. Subjects in almost all the studies had reasonable reading and comprehension levels. The results in people with low reading ability have not been established. Computerized physician-patient communication may be facilitated, however, by programs that present, in language the patient can easily understand, information that can be obtained at the patient's individual pace and, in the case of network systems, at a time and location that are compatible with the patient's schedule, especially useful for patients with limited access to health care. Computerized educational methods may also be more efficient for physicians who, because of busy clinical schedules, are limited in the amount of time they can spend with a single patient.

A vast amount of health information is being made available on the Internet. New health sites are being created every day.[32,33] Creators of these sites believe that by providing health information electronically to people, the health of the world's population can be improved.[34] Given the thousands of Internet-based health education sites and the paucity of controlled trials on their efficacy, more research is needed to specify what sort of computerized patient education does really result in positive changes of health status.

Family physicians who recommend the use of patient education systems as they become widely available on the Internet may have to prepare themselves by identifying reliable Web sites. They will then be able to target their advice toward systems and sites likely to provide benefit for their patients. Such applications involve chronic diseases, diseases of a sensitive nature that benefit from privacy in communication, or diseases in which simplified language and self-paced instruction is of advantage. Equipped with the impressive results from the network studies and emphasis on applications of proven benefit by controlled evidence, family physicians can have a positive impact especially on the health status of their homebound patients as the access to the Internet expands.

Positive evidence from the reviewed studies opens up avenues not only for the use of the Internet for providing better care, but also for the use of in-office computer systems for education (ie, informed consent for prostate-specific antigen testing, information about flexible sigmoidoscopy, and other preventive care promotion). Increased use of computer technology, including Internet, as cost, access, and availability barriers decline should have a positive effect on computerized patient education. Although computers cannot be substitutes for physicians, dovetailing their face-to-face time with computerized patient education may be an approach with optimum benefits to all those involved in providing health care.

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REFERENCES

1. Marcus SH, Tuchfeld BS. Sharing information, sharing responsibility: helping health care consumers make informed decisions. In: Safran C, ed. Proceedings of the Seventeenth Annual Symposium on Computer Applications in Medical Care; 1993 Oct 30 - Nov 3; Washington, DC. New York, NY: McGraw-Hill, 1994:3-7.
2. Greenfield S, Kaplan S, Ware JE Jr. Expanding patient involvement in care. Effects on patient outcomes. Ann Intern Med 1985; 102:520-8.
3. Allen TW. Patient involvement key to enhancing doctor-patient relationship [editorial]. J Am Osteopath Assoc 1992; 92:690, 695.
4. Oeffinger KC, Roaten SP, Hitchcock MA, Oeffinger PK. The effect of patient education on pediatric immunization rates. J Fam Pract 1992; 35:288-93.
5. Sander RW, Holloway RL, Eliason BC, Marbella AM, Murphy B, Yuen S. Patient-initiated prevention discussions. Two interventions to stimulate patients to initiate prevention discussions. J Fam Pract 1996; 43:468-74.
6. Greist JH, Klein MH, Van Cura LJ. A computer interview for psychiatric patient target symptoms. Arch Gen Psychiatry 1973; 29:247-53.
7. Roizen MF, Coalson D, Hayward RS, Schmittner J, Thisted RA, Apfelbaum JL, et al. Can patients use automated questionnaire to define their current health status? Med Care 1992; 30:MS74-MS84.
8. Balas EA, Stockham MG, Mitchell JA, Austin SM, West DA, Ewigman BG. The Columbia registry of information and utilization trials. J Am Med Informatics Assoc 1995; 2:307-15.
9. Balas EA, Austin SM, Ewigman BG, Brown GD, Mitchell JA. Methods of randomized controlled clinical trials in health services research. Med Care 1995; 33:687-99.
10. Said MB, Consoli S, Jean J. Comparative study between a computer-aided education and habitual education techniques for hypertensive patients. J Am Med Informatics Assoc 1994; 1:10-14.
11. Robinson TN. Community health behavior change through computer network health promotion: preliminary findings from Stanford Health-Net. Comput Methods Programs Biomed 1989; 30:137-44.
12. Brennan PF. Differential use of computer network services. In: Safran C, ed. Proceedings of the Seventeenth Annual Symposium on Computer Applications in Medical Care; 1993 Oct 30 - Nov 3, Washington, DC. New York, NY: McGraw-Hill, 1994:27-31.
13. Alterman AI, Baughman TG. Videotape versus computer interactive education in alcoholic and nonalcoholic controls. Alcohol Clin Exp Res 1991; 15:39-44.
14. Wetstone SL, Sheehan TJ, Votaw RG, Peterson MG, Rothfield N. Evaluation of a computer-based education lesson for patients with rheumatoid arthritis. J Rheumatol 1985; 12:907-12.
15. Leche AR, Engler H, Nutzi E, Berger M, Burger W. Clinical application of two computerized diabetes management systems: comparison with the log-book method. Diabetes Res 1992; 19:97-105.
16. Horan PP, Yarborough MC, Besigel G, Carlson DR. The computer-assisted self-control of diabetes by adolescents. Diabetes Educ 1990; 16:205-11.
17. Wheeler LA, Wheeler RD, Ours P, Swider C. Use of CAI/Video in diabetes patient nutritional education. In: Dayhoff RE, ed. Proceedings of the Seventh Annual Symposium on Computer Applications in Medical Care, 1983 Oct 23 - Oct 26, Washington, DC. Silver Springs, Md: IEEE Computer Society Press, 1983:961-4.
18. Kim JYL, Phillips TL. The effectiveness of two forms of corrective feedback in diabetes education. J Computer-Based Educ 1991; 19:14-18.
19. Marrero DG, Kronz KK, Golden MP, Wright JC, Orr DP, Fineberg NS. Clinical evaluation of computer-assisted self-monitoring of blood glucose system. Diabetes Care 1989; 12:345-50.
20. Peters A, Rubsmen M, Jacob U, Look D, Scriba PC. Clinical evaluation of decision support system for insulin-dose adjustment in IDDM. Diabetes Care 1991; 14:875-80.
21. Huss K, Salerno M Sr, Huss RW. Computer-assisted reinforcement of instruction: effects on adherence in adult atopic asthmatics. Res Nurs Health 1991; 14:259-67.
22. Huss K, Huss RW, Squire EN, Carpenter GB, Smith LJ, Salata K, et al. Computer education for asthmatics: what effects? J Nurs Care Qual 1992; 6:57-66.
23. Fisher LA, Johnson TS, Porter D, Bleich HL, Slack WV. Collection of a clean voided urine specimen: a comparison among spoken, written, and computer-based instructions. Am J Public Health 1977; 67:640-44.
24. Leirer VO, Morrow DG, Pariante GM, Sheikh JI. Elders' nonadherence, its assessment, and computer assisted instruction for medication recall training. J Am Geriatr Soc 1988; 36:877-84.
25. Lucas RW, Mullin PJ, Luna CB, McInroy DC. Psychiatrists and a computer as interrogators of patients with alcohol-related illnesses: a comparison. Br J Psychiatry 1977; 131:160-7.
26. Alemi F, Higley P. Reaction to a talking computer assessing health risks. Med Care 1995; 33:227-33.
27. Maitland ME, Mandel AR. A client-computer interface for questionnaire data. Arch Phys Med Rehabil 1994; 75:639-42.
28. Millstein SG, Irwin CE Jr. Acceptability of computer-acquired sexual histories in adolescent girls. J Pediatr 1983; 103:815-19.
29. Gustafson DH, Hawkins RP, Boberg EW, Bricker E, Pingree S, Chan CL. The use and impact of a computer-based support system for people living with AIDS and HIV infection. J Am Med Informatics Assoc 1994; 1:604-8.
30. Schneider SJ, Schwartz M, Fast J. Computerized, telephone-based management program. In: Safran C, ed. Proceedings of the Seventeenth Annual Symposium on Computer Applications in Medical Care, 1993 Oct 30 - Nov 3, Washington, DC. New York, NY: McGraw-Hill, 1994: 37-40.
31. Turnin MC, Beddok RH, Clottes JP, Martini PF, Adadie RG, et al. Telematic expert system Diabeto: new tool for diet self-monitoring for diabetic patients. Diabetes Care 1992; 2:204-12.
32. Kassirer JP. The next transformation in the delivery of health care [editorial]. N Engl J Med 1995; 332:52-4.
33. Whitestone R. Health sites are reaching epidemic proportions. Inter@ctive Week 1996; 15:16.
34. Arron DJ, Sekikawa A, Libman IM, Iochida L, Barinas-Mitchell E, et al. Telepreventive medicine. MD Comput 1996; 4:335-8.