

Interactive Computer Technology, Behavioral Science, and Family Practice

Russell E. Glasgow, PhD; H. Garth McKay, PhD; Shawn M. Boles, PhD; and Thomas M. Vogt, MD, MPH
Denver, Colorado; Eugene, Oregon; and Honolulu, Hawaii

In this paper we discuss conceptual and practical uses for interactive computer applications (ICAs) for family practice, with an emphasis on implications for patient self-management, physician-patient relationships, primary care research, and health care systems quality improvement. We discuss recent behavioral science advances in patient self-management and the advantages and potential limitations of ICAs for medicine. We describe the benefits and risks of using ICAs for providing information, coping-skills training, and social support for patients and for improving the consistency and quality of care given by physicians. There are currently many effective ICAs, and they will play a central role in future health care. There is also the risk of inappropriate use of ICAs. We provide a

summary of the empirical literature examining the use of ICAs to aid patients and providers in behavioral change and guidelines adherence efforts. We advise those people researching and applying ICAs in health care to be bold in what they attempt, but cautious in what they claim. Rigorous scientific evaluation and standardized reporting criteria can help quicken this advance, and there are important policy and ethical issues to consider. We conclude with a list of issues for family practices to consider when selecting and using ICAs.

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Family physicians are faced with an ever-increasing array of things they should be doing to deliver quality care. The US Preventive Services Task Force¹ has developed recommendations for clinicians to follow, and Health Plan Employer Data and Information Set (HEDIS) guidelines, critical paths, and other disease management recommendations are proliferating rapidly. These challenges are compounded by 3 additional factors: reduced length of physician-patient interactions, increased prevalence of chronic illnesses, and increasing frequency of comorbid conditions.

Consequently, many preventive services and best practices that most physicians would like to provide are offered at greatly suboptimal frequencies.^{1,2} Acute care concerns and dealing with a patient's current complaints can take the entire duration of the office visit, leaving little or no time for important preventive and illness-management actions. Chronic illness care, which will continue to be provided predominantly by primary care

physicians, involves many behavioral and self-management issues, and is generally not well done.^{3,4} Behavioral science principles, however, when prompted by and delivered through the rapidly developing interactive computer application (ICA) modalities, such as multimedia kiosks, the Internet, laptop computers, or handheld digital devices,^{5,6} can greatly aid family physicians in delivering quality care.^{7,8} By ICAs, we mean computer-based applications that tailor what users receive according to their input.

Our goal is to summarize the literature on recent ICA behavioral science applications and to provide information on current challenges and future directions for using ICAs to assist in patient lifestyle and behavioral change. Some of these applications focus directly on aiding patients with these challenges, while others aid physicians in providing quality care. We discuss technological, evaluation, implementation, and ethical issues from the perspective of the practicing family physician.

Family physicians face resource, information, and logistical barriers that ICAs may help alleviate when delivering quality preventive care and conducting behavioral counseling⁹ (Table 1). Resource barriers include the time and skills required to conduct behavioral counseling, which can be addressed by efficient ICA applications. Information barriers may be overcome by the efficient

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From the AMC Cancer Research Center, Denver (R.E.G.); the Oregon Research Institute, Eugene (H.G.M., S.M.B.); and the Kaiser Permanente Center for Health Research, Honolulu, Hawaii (T.M.V.). Requests for reprints should be addressed to Russell E. Glasgow, PhD, AMC Cancer Research Center, 1600 Pierce Street, Denver, CO 80214. E-mail: glasgowr@amc.org.

TABLE 1

Barriers to Lifestyle Counseling in Family Practice and How ICAs May Help

Barrier	How ICAs May Help
Not enough time	Assessment and counseling largely conducted using ICAs minimizes staff time
Lack of training, skills, or confidence in behavioral counseling	Tailor interventions to individual needs, characteristics, and preferences; deliver evidence-based programs consistently
Inadequate or poorly organized information on patient risks or guidelines status	Organize information as desired; provide prompts and reminders
Lose track of patients who do not come in, difficulty in follow-up	Variety of prompting, follow-up, and support modalities available
Concern about patient reactions	Allow patient choice and preference to determine goals
Cost of intervention	Initial costs can be considerable; ongoing and incremental costs minimal to modest

ICA denotes interactive computer application.

management and display of data, a hallmark of ICAs. Logistic barriers include technical and implementation challenges that can also be addressed by ICAs.

RELEVANCE OF ICAs FOR PRIMARY CARE

The availability of lower-cost personal computers has resulted in exponential growth in Internet accessibility. Use of the Internet has skyrocketed from an estimated 1.1 million users in 1990 to 57 million in 1997, and current estimates project 357 million users by 2000.^{7,10} Among current users of the World Wide Web, there has emerged a group who access the Internet seeking medical information and advice.¹¹ These "HealthMed Retrievers" currently comprise 43% of US Internet users, with a projected rate of 49% by the end of 1998. Similar advances in technology and use have been seen with personal computers.^{6,8} Tomorrow's illiterate citizens will be those who do not know how to use electronic communication.

There are potential advantages and disadvantages of using ICAs in primary care (Table 2). The convenience of accessing reliable health care information on demand from the home or workplace at any time during the day is unique and potentially empowering. Distance learning in isolated rural communities is also becoming possible as they obtain Internet accessibility. Another advantage often cited by Internet chat group users is the ability to give and receive timely emotional support.¹² To be able to do that without the cost, inconvenience, transportation, and scheduling challenges associated with traditional group participation is a new phenomenon ushered in by the Internet.

The anonymity and perceived objectivity of ICAs are also important. Research has found that patients are often more likely to disclose sensitive information to computers

than to human interviewers.¹³ Similarly, perceptions that ICAs are too complicated, too expensive, or beyond the reach of senior citizens are incorrect. Multimedia kiosk applications have made personalized ICAs accessible to those previously underserved and those without previous computer experience. Costs have dropped dramatically, with powerful computers now costing less than \$1000, and \$150 to \$200 Web appliances like WebTV becoming widely available. Senior citizens are becoming active users and have their own national organization, SeniorNet, where they teach their peers about computers.¹⁴

TABLE 2

Potential Advantages and Disadvantages of ICAs

Advantages

- Convenience and ease of use
- Provide emotional support (especially from peers)
- Objectivity and anonymity
- Widespread applicability
- Telemedicine for rural and underserved populations
- Search and personalized display capabilities

Disadvantages

- Cost (especially initial investment)
- Complexity makes them inappropriate for some potential users
- Rapidity of technological change and incompatibility of different applications
- Potential for misinformation
- Loss of confidentiality risks
- Limited breadth of appeal
- Social justice concerns

ICA denotes interactive computer application.

Possibly the most significant aspect of Internet and other networked ICAs is their comprehensive search and retrieval capacity, which can assist patients and physicians with decision making and state-of-the-art care. The capability of ICAs to gather and display personalized information and individually requested results in a variety of modalities provides a large advantage compared with current practice. There are also limitations and concerns about ICAs, which are addressed following a summary of the literature.

STATE OF THE SCIENCE

ICAs have been developed for both patients and medical office staff. We review both patient-focused and physician-or practice-focused ICAs (eg, to aid guidelines adherence, delivery of preventive services, or reduce adverse drug interactions).

PATIENT-FOCUSED LIFESTYLE-CHANGE ICAs

Effective strategies for changing behavior differ according to the patient's readiness for change,^{15,16} comorbidities, and other behavioral characteristics, including health beliefs, feelings of personal control, and social environment.¹⁷⁻¹⁹ There is a relatively consistent literature on the efficacy of primary-care-based ICA applications for lifestyle change that addresses these issues. Several studies had patients complete computer scannable surveys. Those surveys were scored off-site by expert systems that produced personalized reports (including tailored behavioral change strategies) that were later mailed to participants. This strategy has been successful in randomized trials for enhancing smoking cessation,^{20,22} exercise,²³ and dietary fat reduction.^{20,24,25}

Use of ICAs to facilitate behavioral change during medical visits has been studied less often but appears to be effective and has greater potential for integration with office practices. In-office ICA interventions can also take advantage of an in-person message from the physician to enhance credibility, and the availability of staff to answer questions. ICAs that use multimedia kiosks and social-cognitive theory²⁶ have been effective in helping patients with diabetes^{25,27} and heart disease²⁸ change multiple-risk behaviors. Other promising technologies include telephone automated voice messaging and interactive Internet applications. Descriptive data and process reports on Internet support groups for patients with diabetes, HIV or AIDS, and cancer, have recently been published.²⁹⁻³² Such peer interactions are perceived to be very supportive by participants, but outcomes research is needed. Health care professionals can support ICA behavioral changes by reinforcing their importance and by providing follow-up support.³³

Data demonstrate that ICAs facilitate patient lifestyle change. A few studies suggest that ICAs may be highly cost-effective. In coming years, more sophisticated interactive multimedia programs, medical kiosks, and especial-

ly WebTV will provide timely medical advice and support for a broad range of preventive services, lifestyle-change goals, and chronic illnesses.

An example. In our diabetes self-management program, participants complete a touch-screen ICA assessment of eating patterns and recommended self-care practices while in the waiting room. The computer immediately scores this information and presents the patient with an individualized choice of behavioral change goals on the basis of personal behavior patterns and perceived barriers to change. The patient then chooses a specific goal and receives a 1-page printout summarizing this information. This sequence takes approximately 10 to 15 minutes, after which the patient is seen by the physician, who has received a related 1-page summary (Figure). The physician then stresses the importance of the goal the patient has selected and of meeting with an educator to design strategies for achieving it. The messages and informa-

FIGURE

A sample of a printout for the physician.

**McKenzie Health/Oregon
Research Institute Personalized
Diabetes Assessments
Summary Form**

Patient Name: Sally Sample Date: 3/11/98
Age: 54 Visit Number: 1

Most Recent Risk Factor and Lab Results

Weight: 162	Height: 63	
Percent of Ideal Weight: 127	Total Cholesterol	199 3/11/98
Smoking Status: Nonsmoker	LDL	93 3/11/98
Exercise Status: Inactive	HDL	27 3/11/98
	Triglycerides	394 3/11/98
	HbA _{1c}	8.5 3/11/98

Primary Nutrition Goal for Next Few Months:

Reduce the amount of meat products you eat (for example, eat leaner meat or trim the fat).

Key Obstacle Patient Has for Managing Diet:

Few healthful food choices when shopping or eating out

Key Message for Patient:

Following a healthy low-fat eating pattern is one of the most important things you can do for your health.

tion in the printouts can be tailored to the content and style preferred by the physician. This brief counseling session takes approximately 15 minutes and is guided by a more detailed educator printout. In our initial randomized study²⁵ that found this strategy to be a cost-effective way to reduce dietary fat intake and reduce serum cholesterol levels, the educator saw patients immediately in the office. More recently, we have worked with a variety of primary care settings and had patients come to a centralized location.

Community resources. ICAs can also facilitate the use of community resources to help achieve the objectives of community-based medicine.³⁴⁻³⁶ In our Internet-based diabetes support intervention,³² we provide information about low-cost and free community activities and act as a clearinghouse for information about various community support resources. ICAs have several advantages compared with more traditional print-based compendia of community resources, including ease and low cost of updating, ability to provide different amounts and levels of information depending on user interest, and potential for registering users for activities online. ICAs can also reach those who have mobility limitations or live in outlying areas. Other community-based interfaces are also available, such as ICA kiosks or terminals in work sites, libraries, and other settings.

PHYSICIAN- OR PRACTICE-FOCUSED ICAs

Medical care guidelines. ICAs can improve the access physicians and patients have to evidence-based health care guidelines (provided on the Web at www.ncqa.org and www.ahcpr.gov)^{1,37} and assist them in following these best practices. ICAs can be used to provide timely, individualized prompts and reminders to both patients and staff.³⁸ If integrated with electronic medical records, ICAs can provide summaries of past and needed preventive services. Such approaches are more consistent and less time consuming than manual chart reviews or patient interviews.

Customized visual or graphic feedback and displays can be provided across all patients, for a single patient, or by various subgroups, and can compare current levels of service delivery with baseline levels, goals, or peers.

ICAs include hand-held or touch-screen computers in waiting rooms used to collect information from patients that can be uploaded immediately to medical records. Physician-prompting systems can integrate information on risk, morbidity, medication use, laboratory data, and needed preventive services arranged by priority. ICAs can assist in developing prioritized, patient-centered goals and strategies for accomplishing prevention or clinical care objectives.²⁷ A summary of these integrated plans can be provided to the patient and all members of the health care team through their preferred media (eg, print, electronic).

Optimizing preventive services. The effectiveness of widely accepted primary and secondary preventive services differs depending on who receives the services and when they are received.^{39,40} The cost-effectiveness of saving 1 year of life with cervical cancer screening, for example, may vary 80-fold depending on the frequency of screening and the risk status of those screened.⁴⁰⁻⁴²

Simple approaches to screening were essential when information was recorded by hand on paper. It was not possible to be cognizant of multiple risk states for each person and to instantaneously calculate optimal services for every individual. Computers, however, can do these things quickly and easily. It is not sufficient, however, to simply have an electronic record; that record must interface with current guidelines for care.

Reducing adverse drug interactions. Systems exist in many hospitals and pharmacies that identify potential drug interactions. If these systems were integrated with patient-input systems that assess risk and with clinical information systems that contain all drugs and morbidities for each patient, the occurrence of drug reactions and iatrogenic morbidity could decline markedly.⁴³

ICAs have been used in a variety of ways. The potential

TABLE 3

What ICAs Can Provide for Patients and Physicians

For Patients

- Summaries of preventive actions, ranked by risk reduction potential and personal preference
- Information to aid in decision making tailored to a patient's key concerns and the level of information desired
- Lists of prescriptions and how to use them available 24 hours
- Peer and health care team support and sharing of personal coping strategies available on demand

For Physicians

- Prioritized summaries of patient health risks and health care problems for individual patients or for all subgroups of patients
- Convenient, customized summaries of guidelines and recommended preventive services relevant for a given patient; feedback reports on level of preventive services delivered across all patients; prompts for individual patients on needed services
- Lists of drugs prescribed and potentially relevant, and interactions
- Remote consultations with colleagues and patients

ICA denotes interactive computer application.

use of ICAs to assist both patients and physicians is considerable (Table 3).

FUTURE DIRECTIONS

ICA-based telemedicine allows highly skilled experts to provide input and advice to less experienced colleagues at remote locations.⁴⁴ The complexities of prevention, diagnosis, and treatment will increase exponentially over the coming decades. For example, within a decade there will be hundreds of genetic marker tests. Distilling this mass of information into a rational provision of cost-effective health services that do not cause unnecessary anxiety will require algorithms that assure that risk is approached optimally. Remote provision of care and the integration of new tests into treatment plans will require ICAs that are dynamic and interactive and present information in ways that allow consumers and clinicians to make collaborative, informed decisions.⁴⁵

TECHNOLOGY

Improvements in multimedia ICAs⁴⁶ will help inform patients on a greater variety of medical conditions and treatments and the relative risk of procedures, and in the future, ICAs will become more integrated with medical office practice. Increased ownership of low-cost home computers and the low replication cost of CD-ROMs provides the opportunity for patients to receive customized health messages for home use. Future ICAs will enable patients to link to online group support and updated health care information much more easily, and to become more involved in their care.

In the near future far more people will have access to Web appliances that will make patient-physician E-mail⁴⁷ commonplace. Patients will access the Web through their televisions at low cost and in a user-friendly manner. Other ICA applications, such as portable, hand-held, personal digital assistants, will soon allow access to the Internet. This will lead to mobile communication with physicians and database tracking that can be uploaded for review.

Web-based TV is the most obvious example of convergence technologies (in which emerging telecommunication technologies merge with more well-established communication platforms). Computers are converging with the telephone systems in what is called "telephony," which enables telephones to interact with computers to manage E-mail, voice mail, and the Web.^{47,52} With increased access to information comes a growing need to manage the overload of information coming to the user. We will soon see more sophisticated "personal agents," which will serve as our proxies and representatives in many telecommunications transactions.

LIMITATIONS

Among concerns that have been raised about the use of ICAs are cost, incompatibility of computer systems,

threats to confidentiality,^{8,53} potential for misinformation,⁵⁴ and lack of access.⁵⁵ Although sometimes daunting, it is possible to design information systems that substantially mitigate these problems.

There is a growing concern about the privacy and confidentiality of medical information.^{8,47,56} We have the technological means to provide any desirable balance between accessibility of patient medical information and protecting confidential information.⁵ To the extent that an organization can specify confidentiality requirements (eg, patient consent, patient representative permission, who in the organization will be permitted access, safeguards to prevent others from gaining access), ICAs can be designed to meet them. However, these issues are complex and have not all been worked out.^{53,54} Failing to protect privacy and confidentiality can seriously undermine the physician-patient relationship.⁵⁷

A final concern relates to the inequitable distribution of access to ICAs. Although ownership of personal computers and use of ICAs are related to socioeconomic status,⁴⁷ the gap between more and less affluent users is diminishing. Historically, no communications technology (including the telephone) has been adopted as rapidly as the Internet.⁵⁸ One of the most exciting opportunities for ICAs is the ability to reach the underserved, including those in rural areas. Current applications include telephone interventions and resources, such as the Cancer Information Service.^{49,51} There are also successful examples of proactive and personally tailored uses of ICA resources, such as computer-based telephonic interventions.^{48,50,52} Some of these applications can overcome issues of low literacy and lack of English comprehension. However, far more work needs to be done on these topics and on documenting the impact of ICAs on various underserved, minority, and low-literate populations.

ICAs have great potential to help, but also potential for harm, if systems are not carefully constructed and monitored. In addition, community outreach efforts should be initiated to ensure that ICAs and other information technologies help to decrease rather than widen disparities between "haves" and "have-nots."

RESEARCH NEEDS

Research on ICAs has identified efficacious, and in some instances cost-effective, interventions that have the potential to improve the quality, consistency, and reach of health care.^{5,46,59} ICAs also present a socioeconomic paradox. Although many current users of the World Wide Web are educated and affluent, ICAs' greatest potential may lie in extending quality services to underserved and disenfranchised populations. Therefore, it is especially important to document the reach of ICA programs, the representativeness of participants, and patient and setting characteristics associated with outcomes. These and other criteria for evaluating population-based effects on public health impact have been discussed elsewhere.⁵⁹⁻⁶¹

TABLE 4

Recommendations for Selecting and Reporting on ICAs

Has the application been evaluated with populations similar to yours? Are the outcomes similar to those you are concerned about?

What has been the reaction of patients to the application? Do they find it understandable and easy to use?

Does the application tailor strategies and output to the individual? If so, on what basis?

Does the user (and provider) receive a printout or other take-home materials to enhance maintenance?

Are there appropriate safeguards built in to ensure and protect accuracy of data entered and confidentiality of data and results?

Will the application interface with other programs you have? To what extent can it be customized to meet your needs?

Will you have to purchase new hardware to run the application? Are there additional fees for maintenance, upgrades, and so forth, and if so, how much?

Key issues to be addressed by future research on ICAs¹² include: (1) how broadly applicable the ICAs studied are and the characteristics of patients who try the program, complete treatment, and benefit; (2) the long-term outcomes—positive and negative—and cost-effectiveness of ICAs;^{27,62} (3) under what conditions ICA applications can be effective when used in a stand-alone fashion, or whether they are always best used as supplements to face-to-face care; (4) how critical personalization or tailoring for particular applications and populations is, and what the key dimensions on which to tailor (eg, sociodemographic or psychological variables, medical history, environmental context) are; and (5) reporting on a *standard* set of evaluation criteria, such as those developed by the Science Panel on Interactive Communication and Health,⁶³ so clinicians and consumers have a common metric by which to evaluate products.

RECOMMENDATIONS FOR DEVELOPING, SELECTING, AND EVALUATING PROGRAMS

At present, selecting ICAs can be a risky business. We hope that before long developers of systems will report on a standard set of criteria (Table 4).⁶³ In the meantime, family physicians are advised to ask how a system will fit into their practice.⁶⁴ By considering how many barriers potential ICAs can address and how many questions can be answered positively, a practice should make more informed choices (especially if the decision to buy is made following trial use of the program).

The questions in Table 4 fall into 4 general categories: evidence-based, ease of use, degree of customization and changes possible, and safeguards against technology

changes (including compatibility with other software and cross-platform compatibility). All are important—along with program cost and reputation of the developer and marketer—but which deserves the highest priority will vary, depending on the purchaser's degree of computer sophistication.

CONCLUSIONS

Like medical technology, evidence-based guidelines, and genetic markers, ICAs have great potential to improve the quality of health care and patient quality of life. Also like these other innovations, however, ICAs are not a panacea or magic solution. Thoughtful applications of ICAs, with attention to the clinical and social context, could potentially improve the quality and reduce the costs of medical care.

Interactive technology is sweeping through society and is changing how we relate, how we do business, our standards of privacy, and the nature of debate over censorship and freedom of speech.^{5,6,8,44,48} ICAs offer incredible opportunities for discovering and implementing better ways to improve health.⁶⁴ Careful, creative development and evaluation efforts are critical now to assure that our implementation of ICAs will be both positive and productive.

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