Computer-Based Learning for ESRD Patient Education: Current Status and Future Directions

Jeanette K. Chambers and Anthony J. Frisby

Computer use in everyday life has expanded human potential in virtually every possible arena. In health care, computer technology affects direct clinical care through diagnostics, treatment, monitoring, and documentation processes. Patient care systems use computer technology to manage billing, scheduling, and multiple other administrative functions. Computer technology for education of health care professionals has been primarily in selected undergraduate, graduate, and professional degree programs. Computer-based continuing education for health care professionals has been available for at least a decade, but computer-based patient education is just now beginning to emerge as a learning option. This article describes examples of patient education programs using different types of hardware and software and explores potential areas for further development of this area for end-stage renal disease patients and families. Computer technology is *not* a replacement for professional involvement in patient education, but rather offers a new arena of media to enhance and expand current teaching and learning resources. Computer-based learning is characterized by features representative of many highly regarded principles of adult education. Further, instructional design concepts used for program development are fundamentally sound for patient education.

Index Words: Patient education; computer-based learning; end-stage renal disease; learning technology; informatics; health education.

In day-to-day living, computer technology enhances communication and comfort, expands work and leisure possibilities, helps to manage information, and extends personal capabilities. Computers are in homes, work, worship, shopping, and learning centers. Although individuals may claim to "not know anything about computers," we work with computers every time we use a telephone, microwave oven, credit card gas pump, handheld calculator, or an anytime banking machine. Children, and sometimes even adults, use computers for education and fun! *Pac Man, Nintendo, Sega Genesis,* and *Karaoke* are examples that have engaged the curiosity of many! Computer technology is part of everyday life.

The purpose of this article is to describe how computers are used for patient education, explore advantages and limitations of computer-based learning (CBL), and consider potential future applications of CBL for the end-stage renal disease (ESRD) patient and family. As nephrology health care professionals who teach ESRD patients and families about self-care for maximal treatment effectiveness and coping, we must begin to prescribe educational interventions that are as carefully considered as prescriptions for hemodialysis or peritoneal dialysis treatments.

Computer Technology and Patient Education

The use of computers for patient education is emerging relatively slowly, but there are increasing reports of significant success. Computer programs for health promotion, health and illness screening, and managing specific health problems are being used increasingly in physicians' offices and clinics, hospitals, libraries, and patients' homes. Medical advisors, pharmaceutical guides, medical dictionaries, and health record keepers are available for home use.[1] Early concerns about the impersonality of computer-based learning and 'computer anxiety' have been set aside by a growing base of literature indicating acceptance and support of computers by patients. Several studies report acceptance by patients of all ages and of all socioeconomic groups, includ-

From the Departments of Medical Nursing and Nursing Education, Development and Research, Riverside Methodist Hospitals, Columbus, OH, and the Office of Academic Computing, Thomas Jefferson University, Philadelphia, PA.

Address correspondence to Jeanette K. Chambers, PhD, RN, CS, 901 Kenmure Ct, Columbus, OH 43220.

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ing those with no previous computer experience.[2-6] These reports are encouraging for all health care professionals who have patient teaching as a component of their responsibilities.

CBL is *not* a replacement for the teaching functions of the health care provider.[7] Rather, CBL expands the range of options that are possible in support of teaching efforts and enhancement of learning outcomes. The nephrology team or individual practitioner necessarily considers when and in what way CBL might help achieve educational objectives.

Computer technology can assist health care professionals with many facets of the educational process. These include assessing learner knowledge and identifying what the learner wants and needs to know, presenting information, demonstrating procedures, and providing vicarious experiences via multimedia, and evaluating learning through test administration, scoring, and record-keeping. In addition, Bell[8] identifies microcomputers for patient education as helpful in achieving consumer demands for information, cost-effective health care, and legal and accreditation mandates.

CBL for ESRD Patient Education

CBL for ESRD patient education offers tremendous potential as there are thousands of patients with chronic renal insufficiency or chronic renal failure with numerous educational needs. In a review of the literature for this article, only three articles describing CBL for patients with ESRD were identified. Wedman[9] developed an interactive videodisc (IVD) on dietary restrictions for hemodialysis patients. Eighteen patients from a hospital-based setting and a physician's dialysis center participated in evaluation of the program. A 10-item pretest was also used for the post-test. Participants improved an average of 82% from pretest to post-test and 9 patients improved from zero correct to 10 correct. In addition, participants were asked to bring a 3-day food diary 1 week after the IVD education program. Wedman reported an 81% improvement in compliance for sodium restriction, fluid modification, and protein serving size reduction based on food diary analysis of pretest versus post-test recordings.

Luker and Caress[10] developed seven computer-assisted instruction (CAI) programs for patients participating in a continuous ambulatory peritoneal dialysis (CAPD) training center in northwest England. The program topics were as follows: (1) Your kidneys in health and failure; (2) The causes of and treatments for kidney failure; (3) Doing a bag change; (4) Problems; (5) Your CAPD diet; and (6) Fitting CAPD into your life. The seventh program used a simulation/game format that allowed learners to test their knowledge and understanding and practice decision making in a safe environment. Viewing times for the programs ranged from 15 to 25 minutes.

Luker and Caress subsequently reported evaluative data from patient experiences using the CAPD CAI programs.[11] Thirty patients with a mean age of 50.9 years (range 19 to 71 years) with diverse socioeconomic backgrounds and a variety of ESRD etiologies participated. Pre-exposure preferences for the source of information were 1 (3.3%) for books and leaflets only, 1 (3.3%) for computer only, 4 (13.3%) for personal contact, and 23 (76.7%) for a combination of sources; 1 patient did not know. After the study, 3 (10%) preferred books and leaflets only, 7 (23.3%) preferred computer only, 4 (13.3%) preferred personal contact, and 13 (23.3%) preferred a combination; 3 cited no preference. Patients did not have difficulty using the computer and 80% described the experience as "very useful." These findings supported patient acceptance of computers as a method of learning and reinforced the need to use a combination of teaching methods.

CBL and Patient Education

CBL for patient education varies in content, format, educational objective(s), and level of patient interaction. Recently, Kahn[12] cited more than 30 articles describing computer-based patient education and emphasized the importance of computer-based teaching to support patients in making informed decisions. Several examples of CBL are described below.

Suitor and Gardner[13] reported using a computerized questionnaire to obtain information from low-income women about prenatal food frequency. When initially asked about a preference for paper and pencil questionnaire versus computerized questionnaire, 37 of 64 (58%) reported a preference for paper and pencil; the reported post-test preference was 87% for the computer version. A similar question concerning personal interview versus computer-based interview was also asked; computer use was preferred by 45.4% before and 73.5% afterwards.

Tibbles et al[14] used CAI for preoperative and postoperative patient education about joint replacement surgery. CAI programs, referred to as "lessons," included an assessment of knowledge about arthroscopic surgery, preparation for surgery, and decision making about topics such as recognizing infection and what to do. The patients, whose age range was 50 to 80 years, readily accepted CAI as a method of learning.

Sweeney and Guilino[6] reported development of an IVD on breast-feeding options for use with low-income women visiting primary care settings along the United States–Mexico border in West Texas. The touchscreen format was used with minimal assistance. A dual audio track offered the option of English or Spanish versions and video images were representative of cultural diversity. In subsequent studies, mothers reported the interactive videodisc to be easy to use and a good way to learn.[15]

Brennan et al[5] designed ComputerLink, a project using the Cleveland Freenet, in which personal computers with modems were installed in patients' homes to assist persons living with acquired immunodeficiency syndrome (AIDS) and AIDS-related complex (ARC). Information was available from an electronic encyclopedia about AIDS/ARC diagnosis, treatment, symptomatology, lab data, common problems, and terminology. By posting messages to an electronic Bulletin Board, patients received support by communicating with peers, others similarly isolated by disease consequences. In addition, decision-assistance was available from the nurse project director and other health care team members. Fifteen of 19 patients completed a 4-month pilot study. The system was used at least once by all, and over half used the system regularly. Physicians reported that ComputerLink patient users seemed more knowledgeable and asked more questions than did nonusers.

These examples of CBL included CAI using a personal computer (PC),[14] IVD with a touchscreen and PC,[6] and PC with modem.[5] The educational objectives included interview/screening,[13] information presentation to assist with decision-making,[13,14] and electronic social support.[5]

Hardware and Software Options for CBL

CBL can be delivered a number of different ways. The traditional method is by floppy disks.* There are two kinds of floppy disks on the market currently, 5¼ and 3½ inch. The 3½-inch disk is in a hard plastic case and the flexible 5¼-inch disk is in a thin plastic sheet. Other sources for CBL delivery include CD-ROM, videodisc, or magnetic tape. Most CBL will be run from the hard-drive of the computer, because the computer is able to access information from the hard-drive at a much faster rate than from just about any other source. In CBL, speed is important, especially if there are a lot of graphics; users quickly become frustrated by having to wait for images to be displayed if it takes longer than just a few seconds.

Many CBL options exist for patient education. The diversity in both hardware components and software makes buying decisions difficult. Refer to Table 1 for an overview of various hardware and software options. Standardization is increasing, but much more is needed. This section describes some of the current resources to support computer-based learning and comparative comments about ease of use and degree of interactivity.

CAI

CAI programs offer different approaches, depending on the educational objective. The design of the CAI program may offer the learner an opportunity for drill and practice,

*Throughout the article, various spellings of disc and disk appear. These are not typographical errors. Disk (with a k) refers to magnetic media; disc (with a c) refers to optical media, a technical distinction for those interested.[70]

Table 1. Hardware and Software Options for CBL

Item	*Description*	*Advantages*	*Disadvantages*
Operating system	IBM (compatibles)	Large installed base	Limited features, primarily text based
	DOS operating system	Basic systems may be less expensive Difficult for many new users	Expected to be phased out
	IBM (compatibles)	Large installed base	Basic system is usually incomplete requiring expensive add-on boards to provide functionality
	Windows operating system	Basic systems may be less expensive Easier to learn for most new users	
	Macintosh (compatibles)	Usually a complete system from the start	Smaller installed base, company may not have any experience with Macintosh systems
	Macintosh operating system	Frequently the easiest system for new users	Initial expense may be higher, but is often actually less compared with a comparably equipped Windows machine
Modem	Enables communications over phone lines when used with a communications software program	Allows computer to communicate with other computers	May incur increased phone bills depending on area calling
VideoDisc player	Plays back material stored on videodisc	Huge storage potential for slides, full motion video and audio capabilities May provide for interactive learning when paired with a CBL program	Limited number of videodisc titles available Requires purchase of expensive equipment
CD-ROM player	Plays back material stored on CD-ROM	Inexpensive compared to videodisc Very large storage space (though not as large as videodisc) Becoming industry standard method for distributing materials	May be an additional purchase. Some new workstations come with CD-ROM players built-in
Floppy disks	5¼-in magnetic disk for storing information	Inexpensive method for storing information	Not able to hold much information Easily damaged due to soft plastic case Nonstandard size
	3½-in magnetic disk for storing information	Inexpensive method for storing information Hard plastic case is more sturdy than 5¼-in size	Limited storage space
CDi	New format consists of specialized materials and playback devices (software and hardware)	Industry standard size Provides interactive learning environment on inexpensive playback units for home users	Currently not much of an installed base for playback units Software is not currently available to allow play back on existing computers, so requires users to purchase new equipment to use it

learning through a tutorial, game, simulation, discovery/inquiry, or problem solving.

The learner progresses through the program by viewing screens of written text, animations, graphics, or illustrations and responding to choices on the screen. The most successful programs are those in which the learner interacts with the program or becomes part of the action, as opposed to remaining a passive observer. Learner choices may include requesting more information about the topic, looking up terms in the glossary, or self-testing of one's knowledge and understanding by using review questions or problem situations. Some programs have mastery quizzes built into the program, along with the capability of storing responses, rating answers for correctness, calculating scores, and providing feedback to the learner.

CAI hardware requirements/options. CAI programs are run on a PC, which is often referred to as a workstation. PCs or workstations are categorized into two primary computer *platforms* (ie, IBM/IBM-compatible and Macintosh) running on one of three *operating systems.* DOS (Disk Operating System) was the first and has been the most common for the past two decades. DOS runs in IBM and IBM-compatible machines. Many industry experts expect DOS to fade away in the next few years, but there is an extensive base of installed machines currently using DOS and thus DOS is not likely to disappear overnight.

The second operating system (OS) is Windows manufactured by Microsoft. This OS provides a graphical interface to IBM and IBM-compatible machines. The graphical interface is designed to make the computer more user friendly by using pictures (icons) from which to make choices.

The third operating system (OS) is the Macintosh OS, which runs on Apple Macintosh computers. This system was the first graphical interface.

Currently, almost every commercial software provider makes applications for both machines. Some programs such as Microsoft Word or Excel can be used on either platform and file transfers are accomplished without too much difficulty. For example, the authors of this article work on two different platforms (IBM and Macintosh), yet transferred this document back and forth during its creation.

The actual PC or workstation consists of at least three components, a monitor, a CPU (central processing unit—the brain of the computer), and some input device (eg, keyboard, mouse, touchscreen). Additional hardware may be installed to add functionality and storage space. These include (1) a hard-drive, which will allows storage of programs and files and faster access than via a floppy disk; (2) a CD-ROM drive, which allows clip art, programs, or files to be read from a CD-ROM; (3) a videodisc (another alternative storage medium, usually for visual images); (4) an image scanner to obtain images from photos or slides, or scanning in text); (5) a sound board and speakers to reproduce sounds and music; and many others.

PC with Modem

Attaching a modem to a computer transforms it from an isolated workstation to an interactive information research tool. Communications with PC and modem permit access to the Internet. The Internet is comprised of networks of computers that are hooked together for the purpose of communication. The use of a modem permits anyone to connect to one of many community-based 'freenets', a library, a school or work place, and from there to anywhere in the world. On-line computer services for which one pays a fee permit similar world-wide communications. One may access the National Library of Medicine, the National Institutes of Health, the Library of Congress, or the Louvre in France! A modern, fast machine with extra memory and a good color display permits the user to get the "most" out of all of these resources. These items continue to come down in price making them more affordable.

Community bulletin boards have developed in many areas allowing government organizations, community groups, and individual citizens to share information with each other. Students can communicate with teachers about homework problems and patients can contact their doctors with questions. This global system offers endless possibilities for communication.

Modem and communications hardware/software. A modem is an electronic device that converts computer data (digital data) into common voice signals (analog data) so that they can be sent over the telephone lines. Modem is short for *mo*dulating *dem*odulating, because it always takes two modems, a sender and a receiver, for the process to work.

A modem is either internal or external. The internal model sits inside the CPU and uses the CPU power source. The external model resides outside the CPU, requires a cable to the CPU and a separate electrical supply into any standard wall outlet. Access to a standard modular phone jack is required for either the internal or external modem.

Communications software is also necessary to allow the computer and modem to work together. When purchasing a new modem, it is often already packaged with a communications application. If the modem does not contain communication software, one needs to get a free copy or to purchase a copy. Free software, sometimes called 'Freeware' is available from libraries and schools, as well as local electronic bulletin boards and file transfer protocol (FTP) sites on the Internet.

IVD

IVD programs offer very specific educational experiences, combining a variety of media that are stored on the videodisc. As with many of the educational objectives of CAI, IVD is interactive and permits tutorials, drill and practice, and simulations. Yet, IVD offers more learning experiences, as full-motion video from stored videotape or motion picture is readily accessible for viewing. The content for each frame of the 54,000 frames on the videodisc is numbered and described. Therefore, the teacher or learner can immediately select the frames wanted for a particular learning activity. Access and response of the frames is nearly immediate and quite superior to the search mode of videotape, or the forward/reverse mode of film. For example, a hemodialysis nurse might decide that a patient needed to review care of an arteriovenous fistula. In a prepared videotape, the external site care demonstration may only be a small section of the videotape. Finding the desired section of videotape would be time-consuming and difficult. By storing this section of videotape on the interactive videodisc, the desired frames could be selected for immediate patient viewing.

IVD hardware/software requirements/options. IVD is the use of a videodisc along with a videodisc player, either alone or combined with a computer. The videodisc is a 12-inch metallic silver disk much like a long-playing record (for those familiar with vinyl LPs).

Each side of the videodisc is capable of storing 54,000 frames. This can be either single images, such as photographs, slides, or drawings, or a series of images as with full-motion video. Although videodiscs used with computers will look the same as those used in the home movie industry, the formats of the disk are different. When used alone, the IVD requires use of a remote control to access the images. The remote can be a simple one like those used with VCRs or it can be a bar code reader wand.

Information on the videodisc is usually organized into chapters, like a book. The controller permits access of any chapter and the images within them, by using a touchscreen, mouse, bar code reader, or keyboard. Internal or external speakers distribute the audio portion of the program; headsets are also available. When used with a computer, the IVD is a tremendous visual storage medium. Fifty-four thousand images would take up an enormous amount of disk space and explains why the IVD made such an impact on the CBL market. CBL developers could store thousands of visual, sound, and full-motion video segments on a videodisc and not have to worry about storage space or display rates. A decade ago, IVD was necessary because most machines could not display full-color images at all. Even though modern machines are capable of displaying full-color images and storage space has become significantly cheaper, IVD is still popular because of its speed. IVD is able to access and display any image on the videodisc in less than 3 seconds and the fastest computers today are not likely to match that speed. When the user needs to look at a great many images, as in CBL, the display rate is a critical factor in user satisfaction.

CD-ROM

Compact Disc–Read Only Memory represents an encyclopedia of stored information from multiple media formats, such as videotape, film, slides, or photographs. CD-ROMs may only be read by the user. Thus, the user cannot store data onto the compact disc; user interactions or data entry may be stored onto the hard drive or a floppy disc.

CD-ROM hardware/software requirements. The CD-ROM disc resembles its' popular music culture counterpart. The CD is placed into a CD-ROM drive of the computer, in a special compact disc player drive, which is either internal or external to the CPU. The CD-ROM can contain any combination of images, text files, programs, music, or movies. Each CD-ROM holds from 65 to 74 minutes of continuous playing music, or 650 Megabytes (650 megabytes is equal to more than 450 high-density diskettes)!

Because the price of CD-ROMs has dropped significantly in recent years, many software providers are beginning to distribute material on CD-ROMs as an alternative to floppy disks. CD-ROMs are more durable than diskettes. They cannot be accidentally erased by airport security gates nor can their files be accidently written over.

Compact Disc interactive (CDi)

CDi † uses a specially designed CDi player and a CD-ROM disc. As such, it provides more interaction with the program of the CD, while not using a computer. The CDi is an optical storage medium, like the CD-ROM, and thus offers the advantage of massive storage. Patient education has been identified as one of the potential uses of CDi because it allows access to audio and video, interactivity, and is played on a standard television.[16] Only a few CDi program applications for patient education are available, but several new titles include Self Breast Examination produced in cooperation with the American Cancer Society, a back care education program, and a program on diabetes.[17] The CDi *About Your Diabetes* was developed by the US Pharmacopeial Convention and the American Diabetes Association and is an integrated program providing an individualized presentation based on information the patient provides about type of diabetes, use of insulin, and self-monitoring methods. At the completion of the program, a report is shown on the screen describing additional learning needs.

†Compact disc interactive is described in the literature as both CDi and CD-I and exemplifies lack of industry standards. The authors prefer the use of both upper case (CD) and lower case (i) to describe compact disc interactive. The decision is based on an intent is to eliminate confusion that might occur from using an upper case I, which could be erroneously be interpreted as 'Roman numeral one.'

Benefits and Limitations of CBL

Computer technology and CBL have benefits and limitations as options for patient education. As with any new educational medium, the teacher must know how to use the potential medium and when to select it. Wild[18] reported the use of computers and programs to support CAPD training to be fun and simple, but in earlier reports[19] of the same project, it was noted that nurses had concerns about appearing uninformed about how to use the computer or that they might lose their jobs.

Learners need to be willing to try the new method and studies indicate support of CBL.[2-6,10-11,13-14,18,20] Nearly one third of households in the United States have a PC[21] and public school systems throughout the United States (K-12) have increasingly incorporated computer-related teaching and learning activities into curricular expectations.

Numerous advantages of CBL have been described[22-25] and these are representative of adult learning principles[26] and instructional design theory.[27] With CBL, there is active involvement by the learner who is in control of the learning experience by selecting the content, controlling the pace and amount of content, and selecting repetition and feedback options. With CBL, the learner experiences privacy. Learning that actively involves the learner as a participant is widely acknowledged to contribute to retention, mastery, and enjoyment in adults and children.[28-29] Nephrology educators have emphasized the importance of patient involvement and participation for enhanced outcomes.[30-32]

CBL provides instructional consistency, while at the same time offering some flexibility.[33] The content and mode of presentation may be the same for each learner, or changed depending on learner needs. ESRD patient educators have also reported the need for repetition, reinforcement, and multiple language versions of various educational materials.[34] The computer has infinite patience and does not get interrupted with pager or telephone calls.

Computer learning allows one to set the pace of learning. The learner controls when to move on and when to repeat. Repetition that the learner controls is done in private. Therefore, the learner does not have to acknowledge to others that the information was not understood or remembered, and thus may be repeated on personal request as many times as necessary.[11] Patients can also ask for information from a computer that they might be too embarrassed to ask a caregiver,[5,35] or they can give information to the computer that might not be shared with a health care professional.[36] In a study of 272 potential blood donors, the computer-based interview of risk factors for human immunodeficiency virus (HIV) infection identified 12 persons whose behavior put them at risk for acquiring HIV, or who had symptoms of AIDS that were not identified via face-to-face interviews or written questionnaires.[36]

Self-pacing can increase efficiency, reduce learning time, and improve mastery of content. Patient educators do not always detect when the patient 'turns off' listening to the important information being conveyed. Yet, health care providers have all had experiences when we know we gave the patient or family necessary required information or explanations only to be told subsequently that they never got the information. This is true: the message was sent, but it was never received.

CBL also offers variety in the modes of instruction.[37] With a computer-based tutorial, content may be primary, or supplemental to other sources. The feedback feature of many programs provides on-going assessment and evaluation of the learner's mastery and retention. Simulations allow safe practice of new concepts and skills before attempting real-world practice, which may be costly or have personal risk. Problem-solving programs assist learners to analyze information and make decisions in an emotionally neutral environment. Compliance, or noncompliance, often engenders emotionally charged responses in the patient or health care provider. Defensiveness, frustration, anger, denial, and blaming are only a few of the emotions experienced by the patient and health care provider when compliance or noncompliance is an issue. Facts without emotions, such as delivered by CBL, enhance analysis and understanding.

CBL offers readily available reinforcement to promote retention. In addition, learner access to information is expanded, as learning opportunities are available on demand 24 hours a day, 7 days a week, including holidays.[5,35] With the Internet or with a home PC using CAI or CD-ROM, the computer is readily available when the patient decides there is a need. Learning by computer is enjoyable.[18] High-quality programs compare favorably with television and the movies, thus maintaining learner attention by meeting the societal standards and expectations of the entertainment media.

Limitations associated with CBL include a lack of widespread availability and access to computer hardware. In addition, there are very few programs that have been developed specifically for patient education and even fewer for ESRD patient education. Hardware acquisition and software development is expensive. Deficiencies in industry production standards, which are being addressed, have resulted in on-going concerns about compatibility among and between hardware and software. High financial requirements for start-up hardware when there is uncertainty about long-term payoffs further limit demand for CBL media. Reduced costs are possible with large numbers of users, but the transition to high numbers of patients using CBL will require time. Consumer requests to have computers available for learning seem slow when compared with the rapid integration of videotapes and VCR players into the patient education arena.

Potential Computer Applications for ESRD Patient Education

Computer technology offers some hope for addressing the multiple and diverse patient education challenges in the ESRD community. Patients with ESRD or progressive chronic renal insufficiency need to know about ESRD, pharmacological and dietary interventions, and the range of therapeutic options for renal replacement. Most ESRD and pre-ESRD patients need and want information to help them make informed decisions and choices about future therapy,[38-42] as well as information about what to expect with treatment.[32,43] Spouses and family members also need information to establish realistic expectations and cope effectively with ESRD in a loved one.[44,45] There are consistent reports that ESRD patients want more information about medications, their disease, and treatment.[46] ESRD patients are increasingly older[47] and limitations in vision, hearing, and speaking present significant challenges for patient education.[48]

Descriptions of the challenges and frustrations of noncompliance with fluids, medications, diet, and other aspects of ESRD treatment and related requirements are abundant and a frequent topic of discussion in professional meetings. Fewer professional staff and higher patient to clinician ratios, along with escalating costs despite constancy in reimbursement, further complicate and challenge the goal of quality care.[49] Staff have traditionally been responsible for providing education during the patient's treatment. For hemodialysis patients, the effectiveness of using treatment time for patient education has been questioned by findings suggestive of decreased cognitive function during the time of treatment and enhanced concentration and information processing on nondialysis days.[50] A recent study reported a successful educational intervention 1 hour before the hemodialysis treatment in a one-to-one session and concluded that nurses needed to offer repeated educational sessions, provide reinforcement, and have regularly scheduled sessions.[30] In another educational intervention study, education and counseling was offered in a 1.5-hour session after the dialysis treatment with the recommendation that opportunities to enhance patient control through access to information were needed.[31] Although more studies are necessary to clearly establish that educational interventions during hemodialysis are not effective, hemodialysis patients consistently report that they feel, think, and function better on nondialysis days. From a practical standpoint, the likelihood of having a large number of hemodialysis patients arrive an hour early for a treatment, or stay an hour and a half after a treatment seems quite unlikely.

Computer programs could assess patient knowledge of various subjects and report scores about areas of knowledge or knowledge deficits. Computer programs could deliver information about almost any content area, such as preoperative and postoperative care for vascular access, fluid management, or treatment of anemia. Educational games could be developed for use on computers. The benefits of gaming to provide reinforcement and feedback in ESRD patients have been reported.[51-53] Computer programs could also be developed for patients to analyze problems common to day-to-day living to identify 'what might have happened' to cause undesired outcomes such as hypervolemia or hyperkalemia. These problem-solving programs would actively engage patients (learners) in exploring relationships, understanding concepts, and assist in transferring understanding to personal behavior and choices. The capability of having a specific patient analyze his or her own data to assess and monitor trends in fluid, potassium, or phosphorus status, or other topics, exists with computer technology. Successful examples of patient education and personal health monitoring using computers have been reported for asthmatics[54] and diabetics.[55,56]

An encyclopedia of ESRD-related lessons and content stored on a videodisc or CD-ROM would offer a tremendous resource to nephrology practitioners with patient education responsibilities. The CD-ROM or IVD could be used to supplement discussions about treatment options, for remediation to enhance recall and promote behavioral change, or for other learning activities.

Offering patients and families the opportunity to visit a dialysis unit or talk with other patients about treatment experiences before making a decision about a choice of therapy is reported to be very useful by many patients and nephrology clinicians.[57-62] Yet, the logistics of getting all the right people together at a time when the unit is calm, the staff is available to provide a unit tour, patients are willing and available to share their experiences, and the learner is physiologically and psychosocially ready and able is extremely challenging and may be less than completely effective. Many of these experiences could be realized more easily with the support of computer technology.

Computer technology has proven successful with a variety of patient populations by assessing existing knowledge about a chronic health problem and its management before delivering an educational program. Assessment of existing knowledge, as well as what it is that the patient wants to know, is a fundamental step in planning an educational intervention. For ESRD and pre-ESRD patients, recent developments of reliable and valid instruments for assessment of knowledge about kidney disease[63] and knowledge about kidney function, causes and effects of kidney failure, and treatment options have been reported.[64-65] Programming of these instruments for administration and scoring via computer would assist nephrology practitioners to assess learner needs and learning outcomes. Printouts of educational deficiencies (needs) and reports about existing knowledge would be informative for initial or follow-up educational planning.

Some initial success in preserving renal function and thus delaying the need for renal replacement therapy in adults with decreased kidney function has been reported to be associated with enhanced patient education.[66] For the patient with progressive renal insufficiency, knowledge about diagnostic procedures, interpretation of laboratory tests, use of medications, the importance of protein restriction, and blood pressure control are all important to preserving renal function and optimizing health maintenance. CBL and opportunities for personal health monitoring via computer technology offer tremendous potential to delay the onset of ESRD.

ESRD patient education is significantly limited by lack of appropriate software. The authors are aware of two efforts to develop software to assist ESRD patients understand about modality choices[67] and PD treatment components.[68] Both of these programs are being tested but neither is available for distribution at this time. The lack of hardware availability is the other significant challenge to promoting CBL for ESRD patient education. Creative partnerships between dialysis facilities and businesses to recycle outdated equipment, or fund-raising by patient advocacy organizations such as the National Kidney Foundation, are considerations for increasing hardware availability.

Summary

The educational needs of ESRD patients and families have never been greater or more complex. The Standards of Clinical Practice for Nephrology Nursing lists over 70 patient outcome statements requiring some patient education activity for conservative management (pre-ESRD), hemodialysis, PD, and transplantation patients.[69] And while this article has focused on the educational uses of computers, the potential for using computer technology to improve the quality of life of persons with ESRD by enhancing abilities and capabilities also exists. Assisting ESRD patients to attain the most optimal health and well-being possible requires new initiatives and strategies; this primary goal has never been more important or more difficult. Opportunities for ESRD patient education to support attainment of maximal treatment effectiveness and improved quality of life exists with the as yet untapped potential of computer technology and CBL.

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