Computer-Assisted Instruction for the Chronically Ill Child

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ABSTRACT

A package of four computer-assisted instruction lessons has been developed. These lessons teach elementary principles of nutrition and motivate compliance with those principles for adolescents and pre-adolescents (ages 10 to 16 years) with cystic fibrosis. Nineteen patients at the University of Minnesota Regional Cystic Fibrosis Center used an average of two lessons each. Their self-assessed level of nutrition knowledge before using the lessons was low (slightly less than little knowledge). This self-assessment was not correlated with scores on a nutrition pre-test. On the average, patients reported learning between a medium amount and a good deal from the lessons. However, such learning could not be documented through pre/post-test methodology.

INTRODUCTION

Overview

Children ill with chronic diseases must make many adjustments in lifestyle. For those diseases which require daily medication, therapy, and altered diet, patients' compliance with their therapeutic regimen is very important. However, compliance may be a problem for older children and adolescents. These patients are expected to take increased responsibility for their therapy at the same time they are exposed to peer influence that discourages "different" behavior.

When computer-assisted instruction (CAI) has been used for health education for the general public, it has been well received and users have reported willingness to change health behavior based on such CAI lessons (1,2). CAI for health education of the chronically ill older child and adolescent may be even more appropriate for two reasons: First, patients of these ages are attracted to computers and may be more willing to partake of a computer lesson than one in some other medium. Second, individualized material presented by machine might be better accepted than that presented by the adult physicians or nurses who monitor so much of these patients' activities.

The purpose of this study was to develop and evaluate CAI for education of the chronically ill child. Our population was children with cystic fibrosis (CF). These children demonstrate a variety of problems adapting to their disease.

Problems involving treatment, including nutrition, medications and mist test use, are particularly frequent and difficult for this population to handle, especially for families with an older, less compliant child (3). We thus used nutrition for the adolescent with cystic fibrosis as our subject. Our setting was a CF out-patient clinic.

Hypotheses to be tested included: 1) Subjects' self-assessment of their level of nutrition knowledge is correlated with their scores on the pre-test, and 2) use of the CAI lessons increased the subjects' knowledge of nutrition based on self-reports of learning and on comparison of pre- and post-test scores.

The Subject

Cystic Fibrosis (CF) is a recessive gene defect disease occurring in about 1 in 1000 to 2000 live births. CF is identified as the ninth leading cause of death in children between the ages of 1 and 16 and is the only specific disease in the first 15 causes.

Prognosis for survival is related to complications caused by abnormally thick mucus secretions that obstruct pulmonary and digestive systems. Two major factors influencing weight, pulmonary function, and survival in CF are deficiencies of protein and calories, and deficiencies of essential fatty acids and fat-soluble vitamins. Thus nutrition is of extreme importance to the patient with CF.

The Setting

The University of Minnesota Regional Cystic Fibrosis Center serves the third largest CF population in the nation. There are approximately 400 patients, who visit the Center four times a year. Approximately 27 percent of the Center patients are between the ages of 10 and 16, and the number in this age group is continuing to increase (4).

MATERIALS AND METHODS

Hardware

The computer lessons were developed in Applesoft BASIC on an Apple II microcomputer, with one DOS 3.3 disk drive and a 9-inch black and white monitor. The lessons were evaluated by patients...
on an Apple II+ microcomputer with one DOS 3.3 disk drive and a 12-inch green screen monitor.

Lesson Development

The lessons were developed using a simple BASIC driver framework. It permitted persons with little knowledge of BASIC programming language to display blocks of text, ask multiple choice questions with three possible answers, branch to other blocks of text based on the answer to a question and either reask the question or ask another question. Simple low-resolution monochrome graphics and sound were used where appropriate.

Lessons

The lessons were grouped together into a package entitled "Nutrition Fuels the Fight (In the War Against Mucus)." The outline of a user's interaction with the package is shown in Figure 1.

Figure 1 - Diagram of Patient-Computer Interaction

The lessons in this package cover four important subject matter areas related to nutritional problems encountered by CF patients. **Nutrients** is an elementary introduction to the three energy-yielding nutrients protein, fat, and carbohydrate. This lesson describes the most important functions of each of these nutrients in the body and lists foods which are good sources of each. **Energy Storage** emphasizes how energy is obtained from protein, fat and carbohydrate and why and when supplementary enzymes and vitamins are needed by CF patients. **Energy Balance** introduces the concept of balancing the energy received from food with physical activity. The need for such activity, which is essential to build strength, is emphasized along with the accompanying need for increased food, and thus energy, intake. **Energy Reserves** covers why CF patients must eat enough food to store extra energy for use in illness or other stress.

Both **Energy Balance** and **Energy Reserves** estimate recommended calorie intake, based on age, sex and weight and (for Reserves) height and level of activity. CF patients may need up to 150 percent of the usual Recommended Daily Allowance (RDA) for energy for their age and sex (5). However, the average intake of children seen at the Center is about 80 percent, and many patients are anorexic (K. Schiessel, personal communication). Thus 100 percent of the RDA was used as a realistic goal, with the warning that this was a very rough estimate.

A fifth lesson, **Explain Computer**, introduces the computer and its keyboard but does not teach nutrition. This lesson was not used in this evaluative phase of the project, because lesson use was always under supervision. If and when the package is in routine, unsupervised use in the Clinic, such a lesson can reassure the timid or unsure patient.

The package also contains a **Menu** of lessons that permits the patient to obtain a description of each lesson. After each description, the user is asked "Do you want to try this part? (Yes or No)." If the user answers "Yes," then he or she is asked an evaluation question prior to the start of the lesson, and a second question at the end of the lesson (Table I). In this evaluative phase, the Menu section also requests a numeric identification code before a lesson can be selected to permit tracking of patients between lessons. The numeric code and coded answers to the two evaluation questions are the only information stored for each lesson use.

Evaluation

These lessons were evaluated in several ways. The reading grade level for each lesson was determined using the method of Gunning, as implemented by Carlson in an Apple II+ computer program (6). In a preliminary pilot study, all ambulatory CF Center patients between the ages of 10 to 16 were offered the opportunity to use the lessons on two different days. Refusals were noted, as well as the reasons for any refusals.

Knowledge and learning were externally validated using the pre/post-test methodology reported by Asp (7). The pre- and post-tests were developed from a pencil-and-paper 70-item multiple-choice test on the principles of nutrition that was given at the Center to a second group of 15 ambulatory clinic patients between 9 and 17 years old. The subjects were asked to record their age and sex, but no other identifying information. Item difficulty and validity were calculated for each test question, and 40 appropriate questions were used in the pre- and post-tests.
The 20-question pre- and post-tests were developed to cover the same subject matter as the computer lessons using Bloom's Taxonomy of Educational Objectives, Cognitive Domain (8) and a system described by Gronlund (9). The questions for each test, which covered a wide range of difficulty levels from easy to very hard, were randomly selected without replacement from the pool of 40 questions. Thus each pre- and post-test contained a different combination of questions for each subject. The statistical analysis used for the test scores was a special test that determined the probability of a subject not having "learned" during the time interval between the pre- and post-test (7).

User-perceived knowledge of the subjects was recorded through the evaluation question asked prior to the start of each lesson (Table Ia). Self-perceived learning was recorded through the evaluation question asked at the end of every lesson (Table Ib).

The sequence in the final evaluation was: First, the pre-test was given to a patient. After completing the test, the patient was offered the opportunity to use the computer lessons. Before and after each lesson the patient answered an evaluation question (Table I). After completion of one or more computer lessons, the patient was given the post-test.

## Results and Discussion

### Lesson Evaluation

The lessons were written for 10-to-16 year old children with cystic fibrosis. The reading grade level of the lessons was 4.2 (Nutrients), 6.1 (Energy Storage), 6.8 (Energy Balance), and 9.1 (Energy Reserves). The reading level of the Nutrients, Energy Balance and Energy Storage lessons was appropriate for the younger of the target group of ages, yet not particularly low for the older members of the group. Energy Reserves may be less appropriate for 10 and 11 year olds.

When the lessons were offered to 10 CF patients between 10 and 16 years of age in the waiting room of the Center's ambulatory clinic, there were no refusals to take at least one lesson. Two 9-year-olds also used the lessons at that time; they needed parental assistance with some of the lesson vocabulary. Thus the lessons are probably correctly targeted for children and adolescents 10 years and older.

The final pre/post-test evaluation was offered to patients in the appropriate age groups while they were in the waiting area of the CF clinic over the course of three months in early 1983. Of these, 19 (10 boys and 9 girls) completed the pre-test, one or more computer lesson(s), and the post-test.

To determine each patient's exposure to the lessons, patients were credited with completing a lesson if they completed both the first and the second evaluation question for that lesson. They were given credit for half of a lesson if they completed the first evaluation question but terminated the lesson at any point prior to the second evaluation question (see Figure 1).

The 19 patients answered the first evaluation question 43 times and the second evaluation question 36 times, and were exposed to an average of 2.1 ± 1 lessons.

Over 86% (37/43) of the answers to the first evaluation question reported little or no knowledge of the lesson subject matter prior to the start of the lesson. And 78% (28/36) of the answers to the second question reported learning at least a medium amount after completing a lesson.

Each individual's responses to the evaluation questions was averaged to give an average self-report of pre-knowledge and an average self-report of learning, and the overall average was calculated (Table II). These patients self-report slightly less than a little knowledge of a subject prior to taking a lesson, and between a medium amount and a good deal of learning from a lesson.

The results of the pre- and post-tests and the probability of the patients not having learned something from the lessons are given in Table II. Though over 86% of the lesson uses were by patients who claimed little or no knowledge of the lesson subject matter, scores on the pre-test varied from 50 to 90%. There was no significant correlation between self-reported pre-knowledge and score on the pre-test (rho = 0.19).

Though 78% of the lesson users claimed they learned at least a medium amount from the lesson, post-test scores covered a wider range (30-95%) than pre-test scores (50-90%). The mean score was higher for the pre- than for the post-test though this difference in means is not statistically significant.

These results might be explained by the variable number of lessons each patient was exposed to; there was a slight correlation between post-test scores and number of lessons (rho = 0.29). Patients also tended to be rushed towards the end of this
Table II - Final Evaluation Results

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*May have learned something.

**Average answers to evaluation questions listed in Table I.

The probability of the patients having learned something was not significant for these patients. Three of the patients had probabilities of not learning only slightly larger than P = 0.10, indicating a trend towards learning. The remaining probabilities, however, were much larger than these. Perhaps each of these patients had completed all of the lessons before taking the post-test, more patients would have learned, but this was impossible under the time constraints of their clinic visits.

CONCLUSIONS

Computer-assisted instruction in health topics can be accepted by chronically ill older children and adolescents. All patients in this study self-report at least some learning, and the majority self-report learning a medium amount or a good deal. External documentation of this learning using pre- and post-tests was not possible in most cases. Further studies are needed to determine the effectiveness of computer-assisted health instruction.

ACKNOWLEDGEMENTS

The project would not have been possible without the cooperation of the patients and staff of the University of Minnesota Regional Cystic Fibrosis Center, including its director, Dr. Warren J. Warwick, its nurse patient educator, Mary Jo McCracken, and its pulmonary scientist, Dr. Jeffrey R. Budd. Contact Dr. Budd at Box 184 Mayo Building, University of Minnesota, Minneapolis, MN 55455, for information on the availability of the lesson package.

We are grateful for the assistance of several students: Jan Easches and Debra Cahn developed much of the text of the lessons, Jean Hassett Nelson and Pat Anderson assisted in the pre- and post-test evaluation, and Mary Werner and Amy Schneider helped to a lesser extent. Karen Lachner, psychometrician, performed the latter phases of the final evaluation.

REFERENCES


