Evaluation of a Web-based Interactive Multimedia Pediatric Asthma Education Program

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Abstract

A web-based interactive multimedia pediatric asthma computer tutorial (IMPACT©) is being tested in a randomized controlled clinical trial. Two hundred and twenty asthmatic children under the age of 18 and their caregivers were randomly assigned to a control group or an intervention group. All children enrolled into the study received printed asthma education materials. In addition, the intervention group used the interactive multimedia asthma education program. Asthma knowledge, quality of life, resource utilization, symptom history and pulmonary function test data were gathered at the baseline visit and on two subsequent visits in the year following the initial visit.

INTRODUCTION

Burden of Asthma

Asthma is a chronic condition affecting 14 to 15 million persons in the United States and is one of the most frequent causes for hospitalization among children and adults. Direct costs for the consumption of health care resources for asthma and additional indirect costs for lost school days and work time have been reported to be billions of dollars.

The burden of disease upon the asthmatic child is enormous. In addition to physical discomfort, asthmatic children experience many psychological and emotional problems due to restricted activity and social isolation. Asthmatic children have been found to suffer significantly more from psychiatric illnesses, anxiety and stress related disorders, learning difficulties, and behavior problems than the non-asthmatic children of the same age. Fowler et al. have found lower school performance among young asthmatics to be related to the severity of disease. School absences among asthmatic children are reported to be three times higher than for non-asthmatics.

Asthma Education

Asthma education programs have been established in major health institutions around the world. Randomized controlled trials and studies based on non-random samples have been conducted to assess the impact of education on patient and caregiver knowledge and disease management skills, and health outcomes. A search of MEDLINE from 1966 to 1999 and of other bibliographic databases produced 25 randomized controlled trials of asthma education interventions among children. A number of individual, small group and large group asthma educational strategies in clinical as well as non-clinical settings were studied to see which of the approaches produce an increase in knowledge and improvement in management skills and health outcomes. Of twelve clinical trials reporting an increase in knowledge, only one reported improvement of health outcomes. One of the studies concluded that patient education needs to be provided on a continued basis due to the “washout” effect of learning. According to Hughes et al., 12 months after the improvement in small airway obstruction, the noted airway improvement had reversed, suggesting that education programs must be sustained for continued benefits.

Asthma is a complex chronic disease that can be life threatening if not managed properly. Asthma management requires a significant effort on the part of children and families to maintain the treatment schedule on a day-to-day basis. Over the years, many programs have been developed that attempt to provide necessary knowledge about asthma and appropriate skills for its management. Patient and caregiver education has been found to increase the knowledge of the disease. Knowledge alone, however, does not necessarily change behavior needed to control and manage asthma. A patient’s or caregiver’s ability to self-regulate, self-discipline and to persevere is critical to success in efforts to control asthma.

Despite an improved understanding of asthma and its treatment, availability of new diagnostic and therapeutic methods, and a number of successful efforts at educating asthma patients and caregivers, incidence of morbidity and mortality due to asthma has consistently shown an upward trend. Identifying
which strategy works best in bringing about behavior change and improved health outcomes in a specific population has been a constant challenge for those involved in health care delivery across the nation.9

**Purpose**

The purpose of this study is to evaluate the effectiveness of a web-based interactive multimedia pediatric asthma education program in increasing knowledge about asthma and its management among children and their caregivers and in improving the health outcomes of asthmatic children. The long-term goals of this project are to decrease morbidity and mortality among asthmatic children so that they and their families might enjoy better quality of life. It also aims at reducing health resource utilization by asthmatic children and thereby easing the financial burden of asthma on the family and society.

**Patient Education and Multimedia Programs**

Growth and affordability of computer technology has facilitated the introduction of computer-based, interactive, multimedia education for use in clinical settings to inform and educate patients and their caregivers. Computer-based, interactive programs have proven successful and effective in several areas of patient education.9 Street et al. used an interactive, multimedia program to educate patients to increase their participation in doctor-patient communication.11 The Internet has broken the barriers of time and distance. CHESS, the Comprehensive Health Enhancement Support System which was developed at the University of Wisconsin is now web-based and allows patients and caregivers access to useful information and support from the comfort of their own homes.

Multimedia programs that educate patients about chronic diseases and preventive care are being developed, but they are not yet in widespread use, and their effectiveness in producing better health outcomes has not yet been established through scientific evidence in randomized controlled trials. No randomized controlled study has been conducted to evaluate a web-based interactive multimedia computer program to educate asthmatic children and their caregivers.

This study will determine whether an interactive, multimedia asthma education program will be more effective than printed asthma education materials alone. The positive evidence of effectiveness will be examined by increase in knowledge and management skills of asthmatic children and their caregivers, improvement in the health outcomes of asthmatic children, and enhanced quality of life for children and their caregivers. The study will evaluate a web-based, multimedia asthma education program designed to teach asthmatic children under 18 years old and their caregivers about the disease and the preventive and therapeutic steps to be taken to manage their own individual health condition.

**STUDY DESIGN AND METHODS**

**IMPACT©**

The web-based IMPACT© program is an interactive multimedia asthma education computer program produced specially for this study by the Advanced Technology Center at the University of Missouri-Columbia. The program consists of 44 vignettes. Each vignette presents one central concept followed by one or more questions for the user. Use of color, audio, video and animation has enhanced the presentation of the content. The target comprehension level of the program is children 6-12 years. Two children, a girl and a boy, along with Mr. O₂ who guides the user through the program in an adult voice, narrate IMPACT©. The program ends with a game to identify asthma triggers in and around one’s home.

The IMPACT© program is password protected. Each child in the intervention group has been issued an identification number and a password. They are also provided the instructions to use the program from home if they have a computer and Internet access. Each time a child or a caregiver logs back on, the program informs the user that it will pick-up from wherever the user left off last time. Before the program presents the new material, it first presents the concepts missed during the previous session. To handle the problem of “washout” the tutorial has been programmed to present again any vignette completed longer than 6 months previously.

The IMPACT© program is interactive and provides immediate feedback to the user about whether a question was answered correctly or incorrectly. A unique feature of the program is its ability to monitor the progress made by the user of the program. It keeps track of what percent of concepts the user has mastered. At the end of a session it generates a report that shows the percent of concepts mastered, severity of asthma symptoms, and medicines being used by the child.

**Printed Asthma Education Material**

The printed asthma education handouts were developed to provide information to all first-time patients who are given a diagnosis of asthma at the Pediatric Pulmonary and Allergy Clinic. The
information in these leaflets is based on the asthma expert guidelines and covers disease-specific information about asthma such as the pathophysiology of disease, asthma prevention and control measures, triggers, medicines and various devices used for inhaling the medications. The leaflets have been designed by a graphic artist and use over 80 sketches and drawings to present the material in an interesting and easy-to-understand format. The materials have been reviewed and approved by an interdisciplinary team of professionals from pediatric pulmonary, respiratory therapy, pharmacy, nursing, child life and educational media.

Eligibility and Exclusion Criteria

Patients and their caregivers were selected for the study if a child was given a confirmed diagnosis of asthma with severity of asthma from mild to severe, was under 18 years old and was expected to have reversibility of airways to be equal to or greater than 15 percent for children capable of performing spirometry. Patients who have had other disease complications along with asthma were not included in the study. If a parent had two asthmatic children coming for treatment, only one child was enrolled into the study. Participants who have been exposed to a formal asthma education program were excluded from the study.

Instruments

The biomedical literature was searched for the selection of standardized instruments but instruments suitable to our needs could not be found for knowledge and resource utilization. Two standardized quality of life instruments were selected to measure asthma related quality of life in children and the caregivers. All other instruments were developed locally. The following instruments have been used in this study.

Quality of life questionnaires

The self-administered versions of two validated instruments, the Pediatric Asthma Quality of Life Questionnaire (PAQLQ)\(^1\) and the Pediatric Asthma Caregivers’ Quality of Life Questionnaire (PACQLQ)\(^1\) were obtained from EF Juniper. These instruments have been developed and validated by Juniper and colleagues at the Department of Clinical Epidemiology and Biostatistics, McMaster University, Canada. The instruments are available in several languages and have been widely used in pediatric asthma research both in Canada and the United States.

Asthma knowledge questionnaire

The knowledge questionnaire is designed to assess the knowledge and management skills of children and caregivers. The questionnaire consists of objective multiple-choice questions that are based on pre-established objectives designed to assess both the asthma knowledge and management skills of children and their caregivers. The main categories are the physiology of asthma, asthma symptoms, control and quick relief medicines, inhalers, what to do and where to get help in case of an asthma attack, and scenarios to teach about preventive measures. A fifth grade teacher wrote the questions from the need-to-know information in the printed material and the multimedia computer program.

Asthma symptoms history questionnaire

This questionnaire is designed to monitor changes in asthma symptoms and to assess the trends in morbidity. The items of the instrument are based on the most commonly used symptom history and resource utilization variables in other asthma controlled studies found in scientific literature. The first four items on this questionnaire concern asthma symptoms, the next 5 items concern the resource utilization and the last four enquire about the control and quick relief medicines used by the child.

Data Collection and Measurement

Two hundred and twenty asthmatic children and their caregivers meeting the eligibility criteria were selected from children and their caregivers who come for treatment at the Pediatric Pulmonary and Allergy Clinics at the University of Missouri-Hospital Columbia. The population of children from which the subjects for this study were selected resides in a 26 county area, served by the Pediatric Asthma Clinic. This is largely rural population, with a total of 244,026 children under the age of 18 years in the service area of 26 counties. Caregivers consisted of parents, grandparents, foster parents or siblings.

Subjects were enrolled into the study from February 1999 through October 1999 during their scheduled visit to the Pediatric Pulmonary Clinic and were randomly assigned to a control group, the printed asthma education materials group or an intervention group, the web-based interactive multimedia asthma education group. In addition to receiving the printed materials, the study group went through the computer-based multimedia education program.
The two pulmonologists were not informed about which children were participating in the study or what their group assignments were. Children in the intervention group were asked not to share their identification number and the password to use the computer program with any other asthmatic children coming to this clinic.

The caregiver that was more likely to accompany the child for the second and third visits was asked to participate in the study and fill out the knowledge and management skills and quality of life assessments. For children who were under 7 years old, only the primary caregivers completed the asthma study questionnaires, whereas for children between 7-17 years, both the children and their caregivers filled out the questionnaires.

During the initial visit, after obtaining consent to participate in the study, baseline demographic data were collected for both the child and the caregiver. At this time basic knowledge of asthma and its management skills among patients and caregivers was assessed through the asthma knowledge questionnaire. To assess the quality of life affected by asthma the Juniper’s Pediatric Asthma Quality of Life Questionnaire (PAQLQ) for children and the Pediatric Asthma Caregiver's Quality of Life Questionnaire (PACQLQ) for their caregivers were administered. Both intervention and control children in 7-17 years age group completed the knowledge, Pediatric Asthma Quality of Life Questionnaire and symptom history questionnaires along with their caregivers who completed the knowledge and Pediatric Asthma Caregiver’s Quality of Life Questionnaire. For children in 0-6 years old group, the caregivers completed the knowledge, symptom history and caregiver’s quality of life questionnaires.

All children capable of performing spirometry, usually 5 years old and above, did the pulmonary function test before and after the use of a bronchodilator. Health care utilization was assessed through the Symptom History questionnaire by collecting data on self-reported emergency room visits, unscheduled physician consultation visits, number of hospitalizations, length of hospital stay, and lost school days since the previous clinic visit. During the return visits all questionnaires were repeated. The follow-up visits were normally scheduled at the interval of every three or four months at the discretion of the pulmonologist.

Preliminary Findings

All children in the study were of the age range between 1 month and 16.5 years. Sixty six percent of children were male and 34% were female. Eighty seven percent children were white, 9% African American, and the rest 4% belonged of other ethnic origins. Of the patients in 7-17 group, 85% said that they used a computer more than once a week and 41% reported to have Internet access from home. Eighty eight percent of all caregivers were females. Sixty percent of caregivers reported using computer more than once a week and 55% reported having Internet access from home.

Tables 1, 2 and 3 summarize the preliminary data for asthma knowledge, overall quality of life, and resource utilization. As noted in Table 1, there is no difference in mean knowledge scores of caregivers in control and intervention groups but the intervention group with 7-17 years old patients shows a greater increase in mean knowledge scores than the children of the same age in the control group.

Table 1: Mean knowledge scores

<table>
<thead>
<tr>
<th>Group</th>
<th>Knowledge Scores V1</th>
<th>Knowledge Scores V2</th>
<th>Knowledge Scores V3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caregivers (all chil)</td>
<td>C 48.57</td>
<td>51.61</td>
<td>51.89</td>
</tr>
<tr>
<td>Caregivers (all chil)</td>
<td>I 48.87</td>
<td>50.64</td>
<td>51.58</td>
</tr>
<tr>
<td>Patients (7-17 yrs.)</td>
<td>C 44.02</td>
<td>46.58</td>
<td>47.07</td>
</tr>
<tr>
<td>Patients (7-17 yrs.)</td>
<td>I 43.33</td>
<td>48.53</td>
<td>50.67</td>
</tr>
</tbody>
</table>

C = Controls  I = Intervention

Table 2: Mean overall quality of life scores

<table>
<thead>
<tr>
<th>Group</th>
<th>QOL Scores V1</th>
<th>QOL Scores V2</th>
<th>QOL Scores V3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caregivers (all chil)</td>
<td>C 5.21</td>
<td>5.62</td>
<td>5.54</td>
</tr>
<tr>
<td>Caregivers (all chil)</td>
<td>I 5.28</td>
<td>5.70</td>
<td>5.29</td>
</tr>
<tr>
<td>Patients (7-17 yrs.)</td>
<td>C 5.25</td>
<td>5.67</td>
<td>5.40</td>
</tr>
<tr>
<td>Patients (7-17 yrs.)</td>
<td>I 5.11</td>
<td>5.85</td>
<td>4.54</td>
</tr>
</tbody>
</table>

C = Controls  I = Intervention

Table 3: Mean resource utilization

<table>
<thead>
<tr>
<th>Group</th>
<th>Visit1</th>
<th>Visit2</th>
<th>Visit3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean # of doctor visits</td>
<td>C 1.16</td>
<td>3.89</td>
<td>0.58</td>
</tr>
<tr>
<td></td>
<td>I 1.44</td>
<td>0.43</td>
<td>0.67</td>
</tr>
<tr>
<td>Mean # of ER visits</td>
<td>C 0.21</td>
<td>0.16</td>
<td>0.44</td>
</tr>
<tr>
<td></td>
<td>I 0.49</td>
<td>0.17</td>
<td>0.17</td>
</tr>
<tr>
<td>Mean # of hospitalizations</td>
<td>C 0.10</td>
<td>0.01</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td>I 0.35</td>
<td>0.01</td>
<td>0.00</td>
</tr>
<tr>
<td>Mean days of hospital stay</td>
<td>C 0.42</td>
<td>0.04</td>
<td>0.33</td>
</tr>
<tr>
<td></td>
<td>I 0.68</td>
<td>0.06</td>
<td>0.00</td>
</tr>
<tr>
<td>Mean # of school days missed</td>
<td>C 1.71</td>
<td>0.95</td>
<td>5.18</td>
</tr>
<tr>
<td></td>
<td>I 2.09</td>
<td>0.85</td>
<td>0.33</td>
</tr>
</tbody>
</table>

C = Controls  I = Intervention
Overall quality of life data for both caregivers and patients have been presented in Table 2. A score of 7 means high and a score of 1 means low overall quality of life. Mean quality of life scores for both caregivers and patients show a greater increase in the intervention group than in the control group for visit two. Visit three quality of life scores are lower for both groups although this decrease is greater for 7-17 intervention group patients. Table 3 summarizes the mean number of physician visits, emergency room visits, hospitalizations, length of hospital stay and number of school days lost since last visit. Control and intervention groups differ in each of these resource utilization measures but those in the intervention group show a reduction in the mean scores on four of the five variables at visit three.

DISCUSSION

The focus today in providing health care is not just treating the disease but affecting the quality of health over the long term. Many asthma education programs have been developed and used to improve the health of asthmatics, however this is the first randomized controlled clinical trial examining evidence that interactive multimedia and Internet-enable communication have converged to try to improve the health of potentially millions of children.

The study findings from the clinical trial to evaluate a web-based interactive multimedia asthma education program reported here, although preliminary, are very encouraging. Since a longer follow-up period is in progress, we expect to see changes in the data presented here with the progression of the trial. Moreover, this study was conducted in the real clinical environment instead of in an “ideal” clinical environment. Although it often created challenging situations, it does increase the generalizability of the findings.

Acknowledgements

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References


