Management of Chronic Pédriatric Diseases with Interactive Health Games: Theory and Research Findings

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In randomized clinic trials, children and adolescents improve their self-care and reduced their emergency clinical utilization after playing health education and disease management video games. A diabetes game reduced diabetes-related urgent and emergency visits by 77 percent, while diabetic youngsters had the game at home for six months, compared to no reduction in clinical utilization in a control group of diabetic youngsters who looked at an entertainment video game that had no health content. Positive impacts were also found in clinic trials of games for asthma self-management and smoking prevention. Keywords: asthma, child, diabetes, health promotion, video game

Interactive computer and video games are engaging and effective media that can motivate health behavior change. Clinic trials of three interactive games for health education and disease management, which are the focus of this article, have found significantly positive impacts:

- Fewer urgent care and emergency visits related to chronic conditions, with the number of visits dropping as much as 77 percent,
- Improved knowledge about health, awareness of risk factors, and attitudes about prevention,
- Increased confidence and self-efficacy for carrying out self-care behaviors,
- Better daily self-care and self-monitoring for chronic diseases, and
- More discussions about one’s health condition with peers, family, and clinicians—a factor associated with improved social support and health.

Computer and video games have interactive capabilities that lend themselves well to experiential learning and, when created according to established health promotion

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and instructional design principles, offer distinct advantages over conventional methods of health education. Although pamphlets, videos, or health education classes can provide a great deal of didactic content, a compelling interactive game exposes players to essential content thousands of times. It also gives players unlimited opportunities to rehearse new skills and receive personalized feedback on health choices made within the game (Funk & Buchman, 1495). The social components of interactive game play can also enhance players’ motivation to improve health behaviors.

In the United States, most young people and adults from all socioeconomic backgrounds enjoy playing computer and video games. About 60% of all Americans age 6 and older play computer or video games, and those who own computers spend more time playing interactive games, on average, than on any other computer activity in the home. Thirty-nine percent of these interactive game players are age 17 and younger. People of all ages spend an average of 1.2 hours per day playing interactive computer and video games (Interactive Digital Software Association, 2000). The widespread appeal of computer and video game playing among children and adults creates a unique opportunity to deliver health education during leisure time.

This article discusses the psychological theory underlying the design of a series of prevention and disease management games. It then reports clinical trial findings for these games aimed at asthma self-management, diabetes self-management, and smoking prevention. The games are targeted to children and adolescents.

THEORY-BASED GAME DESIGN

The interactive games developed by Click Health, Inc., are side-scrolling action-adventure games with main characters who must manage their own chronic condition (e.g., asthma, diabetes) or who engage in desirable prevention behaviors (e.g., smoking prevention). Young players assume the role of a main character. In the simulated environment, they make all health decisions for their character (e.g., when to take medication, what asthma triggers to avoid, what to eat) and see the resulting health consequences, while also experiencing action-oriented adventures.

The games improve health behavior by providing:

- attractive role-mode characters that demonstrate appropriate self-care, customizable self-care regimens so that the character’s daily self-care routine for a chronic condition can be similar to the player’s,
- constant rehearsal of self-care and prevention skills, with consequences depicted in the game,
- supportive and informative feedback on players’ health choices in the game, cumulative records of the character’s health status, daily activities, and medications taken, similar to the logbooks many caregivers ask patients to use,
- two-player options that foster communication about the health cope with friends, family, and caregivers, and language options so that a player can choose English or Spanish.

The interactive health games were designed to achieve the outcomes that appear in Figure 1. It shows that playing the games is expected to improve self-concepts, self-efficacy, knowledge and skills, and communication and social support, all of which are mediating factors that can, in turn, improve health behaviors and health outcomes. Following is a discussion of these factors.

Ganse playing

Computer and video games must be fun if children and adolescents are going to play...
From Interactive Games to Outcomes

Gaine playing -- improved mtadiating factors -- improved outcomes

Figure 1. Intended outcomes of Click Heath video games. Source: Adapted with permission from Debra Lieberman, © 2000.

iherm during leisure time. The success or failure of this kind of health intervention depends in great part on the appeal of the activity itself. To be intriguing and entertaining, an interactive game should encourage the player to participate in the adventure and should respond immediately to the player’s input. In experiments to determine what makes interactive games fun for children, it was found that games should provide challenge to reach a goal, stimulation of curiosity, control over the action, and fantasy themes (Malone & Lepper, 1987). These features have been incorporated into the interactive health game series. Experienced interactive game producers and artists create the games to ensure that the look and feel, game play elements, art and animation, sound track, and other production features are highly appealing to children and adolescents.

Several studies (see Brown et al., 1997; Liebetman, 1997) have found that youngsters rate the health games in this series as highly as they rate other popular commercial video games. They think the games are "cool," and, when they have one of the games at home, they voluntarily play it for an average of 1.5 hours per week consistently over the course of at least 6 months.

Self-concepts

Some children who have a chronic health condition such as asthma or diabetes suffer

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from low self-esteem. They feel different from their peers and stigmatized by having to engage in daily self-care and self-monitoring. The interactive health game series features attractive and efficacious characters who have the chronic condition. They are positive role models who succeed in their adventures while also managing their health, thereby showing that a chronic condition need not be insurmountable.

Social learning theory research (Bandura, 1982, 1990) consistently demonstrates the impact of role models on behavior. Children are highly attentive to characters who are similar to them, and they feel validated when they see those characters represented in media (Johnston & Ettema, 1986; McDermott & Greenberg, 1985). Children also are highly attentive to role models who appear in media genres (such as cartoons and video games) they feel are targeted especially to their age group (Parrot, 1995).

Success in an activity, such as an interactive game, can also boost self-esteem (Clements, 1987; Niemiec & Walberg, 1987). Like most computer and video games, the health game series offers activities that are challenging but achievable, with the difficulty level increasing as each game proceeds. They provide an environment in which players can experiment, fail, develop skills, and ultimately succeed. When players become successful in an interactive health game their self-concepts are bolstered (Lieberman, 1997). Furthermore, when playing games about chronic conditions, peers who do not have the condition are least likely to know what to do in the game—so with admiration they turn to their friend who has the condition for expertise and advice.

Self-efficacy

Self-efficacy is belief about how well one can bring about specific desirable events and avoid undesirable ones (Bandera, 1982, 1990, 1997). People who have high self-efficacy—a strong belief that they are capable in relation to carrying out specific positive health behaviors are more likely to have a healthy lifestyle, to seek and follow medical advice when ill, to avoid life crises, to cope with crises that do occur, and to establish closer social ties so that social support is available to buffer against illness (Lieberman, 1992; Peterson & Stunkard, 1989). Conversely, those with low self-efficacy for carrying out health behaviors are less likely to cope effectively when health problems occur.

Studies of a wide range of health interventions have demonstrated that increasing people's self-efficacy expectations related to specific health behaviors leads to improvements in their health behaviors and outcomes (Anderson, Funnell, Fitzgerald, & Marrero, 2000; Bandura, 1997; Maibach & Cotton, 1995; Stretcher, DeVellis, Becker, & Rosenstock, 1986). Interactive games can improve health self-efficacy when players rehearse specific health behaviors in a simulated environment and then experience successful consequences as a result of their own decisions (see Brown et al., 1997; Lieberman, 1997).

Knowledge and skills

Knowledge gain is the most consistent finding in the literature on computer-based instruction; well-designed interactive media clearly can teach content and skills effectively (see Krendl & Lieberman, 1988; Kulik & Kulik, 1991; McNeil & Nelson, 1991). This is especially true when learners proceed
at their own ability level and pare, receive individualized performance feedback, and review material until they understand it thoroughly (Kozma, 1991). These features are inherent in action-oriented interactive games, which progress from easy to difficult levels of game play, respond immediately to the players input, and offer countless opportunities to rehash and retry.

Interactive media have been effective in motivating reluctant learners and in attracting them to subjects they would ordinarily avoid (Lepper & Gurtner, 1989). The motivational appeal of interactive media and games is especially useful in delivering pertinent health information to the young people who do not seek information from other media sources or advice from experts about their own health conditions and health behaviors (Austin, 1995; Deardorff, 1986; Gustafson, Bosworth, Chewning, & Hawkins, 1987).

Communication and social support

For children, computer and video game playing is a popular social activity, as is talking about games (Clements, 1987; Salomon & Gardner, 1986). Youngsters often help each other with game strategies, and they enjoy two-player and multiplayer games (Interactive Digital Software Association, 2000). An advantage of the social nature of interactive game playing is that it can give a child a new role as an expert in the family. Typically, children know much more than their parents do about action-adventure games, and the adults turn to their children for advice and coaching.

An interactive health game has the potential to stimulate discussion about health with friends, family, and clinical caregivers; to give children a starting point for talking about their own condition with others; and to encourage them to seek support and advice. Click Health, Inc.'s interactive health game series facilitates social interaction and discussion about health and self-care even further by providing a two-player option in which players must work cooperatively to keep their characters healthy and thereby to win the game together.

Health behaviors

Knowledge about health and self care is generally not highly correlated with appropriate health behavior (Maibach, Flora, & Nass, 1991; Prochaska & Velicer, 1997); knowing is not the same as doing. For instance, most people with diabetes know they need to limit their intake of certain foods, yet some fail to do this. Adolescents are an especially difficult group to reach with behavior-change messages. They typically feel that they are not personally vulnerable even if they are aware of the health risks of their current behavior (Chaffee & Roser, 1986).

Instead of focusing on the learning of facts, interactive computer and video games can emphasize the acquisition of behaviors via experiential learning. In the interactive health game series, players experience success when they choose appropriate self-care behaviors for their character. In addition to learning through action, factual information is provided in introductory screens and in multiple-choice questions that appear throughout the games, and this provides more detailed information about causes, treatment, social situations, and self-care options related to the health topic.

ASTHMA SELF-MANAGEMENT

DAME

The game "Bronkie the Bronchiasaurus" teaches asthma self-management. The main characters, Bronkie and Trakie, are two dinosaurs who have asthma (see Figure 2).

Game synopsis

The game is set on the prehistoric planet of San Saurian. Years ago meteors struck, filling the air with clouds of dust. The
Inhabitants of San Saurian developed a wind machine to clear the dust from the air, but an evil Tyrannosaurus Rex stole the machine and scattered pieces of it all over San Saurian's cities, lakes, jungles, skies, canyons, and caves. Dust clouds are returning, and Bronkie and Trakie must find and assemble pieces of the wind machine before it's too late. While searching, they must manage their asthma and fend off evil dinosaur thugs who are guarding the machine pieces. Proper asthma management is essential for a player to win the game.

To manage their character's asthma, players must make sure the character takes daily medication; uses an inhaler and spacer correctly; avoids asthma triggers such as dust, smoke, pollen, furry animals, and cold viruses; monitors peak flow (breath strength) with a peak flowmeter; responds to changes in peak flow; uses a sick day plan appropriately; reviews an asthma logbook that has the character's cumulative record of medications taken and highest and lowest peak flow levels each day; and learns about asthma management. Multiple-choice questions cover topics including the respiratory system; basic asthma self-management; identifying and avoiding triggers; recognizing and responding to early warning signs; what to do in asthma emergencies; the purpose of asthma medications; the importance of following a sick day plan; asthma and strenuous exercise; and how to handle common social situations.

Pretest-posttest study

A pretest-posttest study was conducted at Stanford University Medical Center with 50 pediatric outpatients with asthma, ages 6 to 16 (Lieberman, 1995, 1997). A researcher met with each child individually and administered a questionnaire before and after the child played Bronkie for 40 minutes. The
child's parent filled out a paper-and-pencil questionnaire. One month later the child and parent each responded to a delayed posttest telephone interview.

Immediately after playing the video game and one month later, participants experienced significant improvements in asthma knowledge, self-efficacy for asthma self-management, and self-efficacy for talking with friends about asthma. During the month after they played the video game, there was an increase in the children's communication with their parents about asthma, compared to the month preceding the study.

These findings are particularly noteworthy because the participants played Bronkie for only 40 minutes, which is not enough time to progress very far in the game and is certainly not enough time to rehearse asthma self-care behaviors very extensively. However, many improvements appeared immediately after the study participants played the game, and these improvements persisted for at least a month even though the participants had no other opportunities to play the game during that time.

Media comparison study

A randomized experiment was conducted to explore the impact of Bronkie the Bronchiasaurus on children's asthma-related self-efficacy in contrast to an asthma education videotape. Most educators accept video as a motivating, involving, and educationally effective medium for teaching children and adolescents (Kozma, 1991; McDermott & Greenberg, 1985). This study compared the impacts of spending 30 minutes playing Bronkie with watching a professionally produced 30-minute videotape about asthma self-care, targeted to children. The videotape featured a boy who has asthma and who gives the viewer specific advice about basic asthma self-care, self-monitoring, and how to talk with others about asthma. The videotape also contained rock music, special effects, and fart-tut editing designed to attract and hold young people's attention.

At the Pediatric Pulmonary and Cystic Fibrosis Center of California Pacific Medical Center in San Francisco, 14 pediatric asthma patients ages 8 to 13 were randomly assigned to spend 30 minutes either playing the video game or watching the videotape. Self-efficacy was measured on 15 scales asking the children how hard or easy they thought it would be for them to use their inhaler correctly, measure peak flow, avoid asthma triggers, handle emergencies, remember to take daily medications, and so on. Knowledge measures included questions about material covered in both the video game and videotape.

Participants in the video game group reported, on average, a higher level of enjoyment than did those in the videotape group. Asthma knowledge improved equally for both groups, a noteworthy finding since a video game does not explicitly deliver a great deal of factual content in just 30 minutes of play time, while the videotape delivered all its information in 30 minutes. Nevertheless, players learned asthma self-care content in the video game by observing the characters and making self-care decisions for them.

Self-efficacy for asthma self-care activities was the same for both groups at the beginning of the study. After the study, the overall asthma self-efficacy score went up, on average, for the video game group and went down for the videotape group, creating a statistically significant gap in average asthma self-efficacy scores. This suggests that interactive media, which involve active user participation, are better suited to improve self-efficacy than the more one-way, linear presentations in videotape. Indeed, videotape may serve to decrease self-efficacy if it presents an overwhelming amount of "how to" information. Interactive media such as computer and video games, can foster a stronger sense of self-efficacy.
because they offer unlimited chances to practice and eventually succeed.

**Inpatient study**

A study of hospitalized pediatric asthma patients and their peers, family, and clinicians was conducted to observe the effects of Bronkie. It took place at the California Pacific Medical Center Hospital in San Francisco for a 3-month period. Participants included six children ages 5 to 18 who were asthma inpatients at the hospital and 15 nonasthmatic inpatients. The pediatric ward was equipped with two video game stations on rolling carts. Several video games were available to play, including Bronkie. At the end of the study period, nurses and other clinical and support staff responded to questionnaires.

**Use of the video game.** The video game cars were in constant demand at the hospital. Almost every time asthma patients had access to the cars, they played Bronkie, typically for about 2 bouts. It was usually the first video game they chose to play, and it was the one they spent the most time playing. The clinical staff noted that 9 of the 15 patients who did not have asthma also played Bronkie, usually for hours at a time.

**Communication with peers.** The staff concluded that Bronkie enhanced social interactions among the study participants, who talked about the video game when they played it and even when they weren't playing it. They often used the two-player option in Bronkie, and they seemed to enjoy the companionship. Frequently there were bystanders—other children watching two children play—who talked about the video game even though they weren't playing. Often during game play, according to the staff, one child would explain asthma management strategies to another, to help both players win the game together. New friendships developed as children found game buddies who liked to play Bronkie.

Many on the clinical staff found that "Bronkie" enhanced clinicians' communication with young patients.

**Communication with clinical staff.** Many on the clinical staff found that Bronkie enhanced clinicians' communication with young patients. They could talk about the video game and how far the patient had progressed in it. This was an icebreaker and then became an ongoing topic of discussion, as children were proud to report their progress.

**Learning about asthma.** Several clinical staff members observed that children were learning about asthma care by playing Bronkie. The quality and depth of children's questions about their own care indicated that they were learning from the game.

**Age appropriateness.** Patients as young as 5 and as old as 18 were avid Bronkie players. The youngest children asked visiting relatives to read the text on the screen while they played. The 18-year-olds found the video game to be challenging and fun, even though the artwork and characters were designed for younger children.

**Clinicians' assessments of the video game.** The pediatric ward's doctors, nurses, and child life specialists were enthusiastic about Bronkie as a form of entertainment and education for their patients. They said it boosted children's spirits, raised self-esteem, encouraged learning about asthma, and improved clinician-patient relationships. Clinical staff sometimes played Bronkie with study participants. One child life specialist said it was particularly gratifying to see the child in the role of expert, with the adults faring much worse in an activity that clearly belongs to young people.

**Parents' assessments of the video game.** According to several staff members, parents were extremely positive about Bronkie. They were delighted that their children could play
a video game dealing with their chronic condition, and that it demonstrated daily self-care. They were also glad that the game served as a bridge between their child and other children who did not have asthma, and for that reason they were eager to obtain the game for use at home.

DIABETES SELF-MANAGEMENT GAME

"Packy & Marlori" is an interactive diabetes self-care and disease management game (see Figure 3). It models game challenges after diabetes challenges. Children with diabetes, like the protagonists in the game, must avoid certain threats to their well-being and must engage in self-care activities and self-monitoring on a daily basis.

Game synopsis

The main characters, played by one or two players, are two adolescent elephant friends who have diabetes and are on their way to a diabetes summer camp. Players help their character gather up food and diabetes supplies, which marauding rats and mire have scattered throughout the camp. Players must also help their character monitor blood glucose, take appropriate amounts of insulin, review a diabetes logbook, and eat foods containing a good balance of food exchanges (bread, fruit, meat, milk, vegetables, and fat) for three meals and three snacks a day, during four simulated days. Players learn about self-care and typical social situations related to diabetes by answering multiple-choice questions posed by camp counselors who appear occasionally during the game. By selecting appropriate food exchanges and choosing

Figure 3. Packy & Marlon. Source: Reprinted with permission from Click Health, Inc., © 2000.
proper doses of insulin, a player can keep the character’s blood glucose in the normal range: when imbalances in food or insulin occur, blood glucose can go too high or too low and the character is not in optimal condition to win the game. Players can use a food exchange database in the game to look up the exchanges in all foods available at camp, such as an apple, a bowl of cereal, or a tuna sandwich.

Controlled clinical trial

A 6-month randomized, controlled clinical trial assessed the effects of Packy & Marion when youngsters had access to it at home. (See Brown et al., 1997, for a complete description of the study and its findings.) Study participants were young people with diabetes, ages 8 to 16, who were patients of pediatric endocrinologists at Stanford University Medical Center and at Kaiser Permanente clinic in San Jose, California. Ali 59 participants were given a video game system to take home and were randomly assigned to take home either Packy & Marion (treatment group) or an entertainment pinball video game with no health content (control group). They were told they could play their game at home, or anywhere else, as much or as little as they wished. They were also instructed to follow any rules in their household regarding when or for how long video game playing could occur.

Participants responded to interview questions and their parents filled out questionnaires at the start of the study and 3 and 6 months later. At the end of the study, children in the treatment group reported enjoying Packy & Marion as highly as the control group reported enjoying the pinball game. On average, treatment group participants said they played Packy & Marion for 34 hours during the 6 months of the study; they averaged 18 hours during the first 3 months and 16 hours during the second 3 months. These was no statistical difference between the treatment and central groups in their average amount of time spent playing their game.

By the end of the 6-month trial period, the treatment group experienced a 77 percent drop in diabetes-related urgent care and emergency medical visits, an annualized decrease of two urgent visits per patient per year. The control group experienced no decline and remained at an average of 2.4 urgent visits per year.

The clinical trial also found improvements for the treatment group only in diabetes-related self-efficacy, in communication with parents about diabetes, and in daily diabetes self-care.

SMOKING PREVENTION GAME

"Rex Ronan" is a video game that graphically portrays the physiological effects of smoking. It is intended to strengthen preadolescents’ (ages 10 to 12) antismoking attitudes and their intentions not to start smoking. These intentions, although widely held, notoriously weaken in many youngsters when they reach 13 or 14, the age when many people begin smoking.

Game synopsis

In the video game, Dr. Rex Ronan shrinks to near-microscopic size and enters the body of a smoker who has a multitude of tobacco-related illnesses. Using his powerful laser scalpel, Dr. Ronan attempts to blast away masses of smoking-induced phlegm, tar, debris, plaque deposits, and precancerous cells. At the end of the game he must conquer another mighty enemy: nicotine addiction. The player maneuvers Dr. Ronan through the mouth, trachea, lungs, blood vessels, and other realistically rendered internal organs and controls the laser scalpel. The main messages of Rex Ronan are conveyed through an attractive role model main character who...
holds strong antismoking attitudes, through graphic portrayals of the physical harm smoking can cause, and through true-false questions about the impacts of tobacco on the body.

I'm test-posttest study

In a study at the Medical College of Georgia (Tingen, Grimaling, Bennett, Gibson, & Renew, 1997), children ages 10 and 11 took Rex Ronan home for a week. As is typical for preadolescents, they came to the study with an intention not to smoke but their reasons were very abstract (e.g., "Smoking is bad for you"). After playing Rex Ronan whenever they wished during leisure time over the course of a week, they gained a better understanding of specific physiological effects of smoking on the body (e.g., "It will give you blood clots." "I didn't know it caused all these diseases. . . and cancer." and "In the artery stuff looked like cheese. That was plaque"). Thus, to explain their intentions not to smoke, they became able to use concrete and graphic examples about the detrimental effects of smoking on the body. As a result, their resolve not to smoke was intensified. Other studies (see Lieberman, 1997) have shown that Rex Ronan is highly appealing to children ages 10 to 16, and when it is available at home they play it often.

DISCUSSION

Interactive health games, designed with a strong foundation in psychological and instructional theory, can significantly improve players' health. Clinical trials and other evaluation studies of the interactive games developed by Click Health, Inc. consistently find that the games are appealing, engaging, and effective in promoting better health behaviors and outcomes. They are a valuable addition to disease management programs because they increase patient involvement in health, they improve adhesion to an ongoing self-care and self-monitoring regimen, and they lead to better communication with those who can offer social support and clinical care.

As interactive computer and video game technology becomes more powerful, it will be possible to design self-care and disease-management games that assess individual preferences, abilities, health status, and learning styles, and that more closely tailor the content to individual characteristics. This kind of targeting and personalization should make the games even more effective at improving compliance and self-care behavior.

Several advantages are unique to computer and video games, in comparison with traditional health education and disease management methods. The player's inherent involvement in the game deepens his or her involvement in managing the character's chronic condition. Rehearsal of self-care and prevention strategies in the game makes it easier to enact those behaviors in one's own life. Properly designed interactive health games improve self-care behavior without exhortations and directives; instead, better self-care is a natural consequence of the game experience. Game playing occurs in a social context, and it stimulates discussion of game topics, which in this case are health topics. Discussion and social support are strong predictors of improved health outcomes. Another important aspect of this approach is that people enjoy interactive game playing and they seek it out during leisure time. Therefore, leisure-time health games can supplement formal health education programs and clinic-based disease management interventions and not supplant them. Research on today's health games provides clear evidence that this popular medium can improve health behaviors and in so doing can significantly improve health.
REFERENCES


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