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ORIGINAL ARTICLE

Using Health Information Technology to Prevent and Treat Diabetes

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Introduction

This is the fifth volume of the ATTD yearbook, and while much has changed related to health information technology in the past 5 years, much is still the same. There have been extraordinary advances in the ability of mobile and web-based applications and programs to deliver increasingly sophisticated functionalities more conveniently and at an affordable cost. Examples include:

1 Providing timely and accurate data and information so necessary for a clinician to support a patient and for a patient to self-manage his or her diabetes
2 Monitoring and tracking over time: (a) key biometric information (e.g., weight, heart rate, blood pressure, blood glucose); (b) behaviors (e.g., observations of daily living, medication adherence, steps, calories burned, diet, social interaction); (c) attitudes and feelings (e.g., in-the-moment assessments of emotional well-being, sources of anxiety, feelings before a behavior such as smoking or overeating)
3 Making affordable and accessible mobile apps for nearly every individual component of healthcare delivery and patient self-management
4 Providing effective interventions using the range of communications delivery mechanisms to create customizable and personalized programs that meet the needs of specific target populations, including those targeting clinicians and those targeting patients.

Unfortunately, there haven't been concomitant advances in the necessary policies and supports to bring these and other innovations to scale. While changes in the financing and delivery of healthcare are occurring throughout the world, the pace of change is quite slow and is falling far behind the rate of change seen in the technology world. For example, while millions of people are accessing medical information and support via mobile devices and web-based programs, it is extremely rare that the cost of these services is included in the patient's healthcare benefit package from insurance or from the government. What will lead to the policy changes at all levels of healthcare systems to accelerate the acceptance and spread of these innovations? How can the pace be quickened to improve the prevention and treatment of diabetes at a level that impacts the millions of affected individuals? Typically, before there are real and transformative healthcare-related policy changes, the approaches embodied in the policies have been tested and spread to a large enough segment of the population to predict success when at scale. What is needed for innovation to spread beyond the innovators and early adopters? Over the past 60 years, advances in the science of diffusion of innovations has led to some basic principles that are worth applying to health information technology innovations. The key elements of particular innovations that predict the rate of spread include*:

1 Relative advantage
2 Trialability
3 Observability
4 Communication channels
5 Pace of innovation/reinvention
6 Norms, roles, and social networks
7 Opinion leaders
8 Infrastructure

The articles that are included in this chapter document innovations that are ready, or almost ready, to spread. Only time will tell which ones will be successful.

CCHIT ACO HIT Framework

June 6, 2013 © Certification Commission for Health Information Technology

Background

Among the many factors that will contribute to the success of an accountable care organization (ACO) is a focused health

UCLA Schools of Medicine and Public Health, Los Angeles, CA.
Diffusion of Innovation in Health Care; Prepared for California HealthCare Foundation; Prepared by Institute for the Future; Authors: Mary Cain and Robert Mittman; May 2002; ISBN 1-929008-97-X.

information technology (HIT) roadmap that aligns the organization's resources with its goals and objectives for accountable care. The Certification Commission for Health Information Technology (CCHIT) ACO HIT Framework is a guide to developing a technology roadmap that will mitigate some of the risks associated with taking on accountability for costs, quality of care, and patient loyalty.

Methods

CCHIT developed a publicly available ACO HIT Framework. The commission defined seven key processes required to meet the aims of high-quality care, cost efficiency, and customer loyalty; delineated the functions within each process; and identified HIT capabilities to support each function. An advisory panel of healthcare experts was convened to review, modify, and expand upon the initial work of the commission.

Results

A listing of the defined aims, HIT requirements, and key processes needed for comprehensive technology support are seen below. The full article has more details of the 64 processes, which are organized by the 7 key processes.

Aims:

- High-quality care
- Cost efficiency
- Customer loyalty: providers and patients

HIT requirements

- Information sharing
- Data collection and integration
- Patient safety
- Privacy and security

Key processes

- Care coordination
- Cohort management
- Patient and caregiver relationship management
- Clinician engagement
- Financial management
- Reporting
- Knowledge management

Conclusion

The Framework represents a starting point for organizations wishing to build an HIT infrastructure that will support varying levels of financial risk under the rubric of accountable care while reengineering to improve quality, manage cost, change clinician culture, and include patients as partners in care. As the HIT needs of the delivery system are defined and as HIT itself continues to evolve, the Framework will also evolve.

Comment

I selected this publication because it elegantly simplifies the complex issues around health information technology and its use to improve patient care, outcomes, and cost. While written for a specific U.S. approach (called accountable care organizations), it is quite appropriate for any healthcare delivery system and the providers within it. Regardless of the economic and administrative structure, all systems and providers should attempt to address these important aims, requirements, and processes. The challenges to successfully accomplish these ambitious goals are made all the more difficult because, with 64 different processes, the complexity associated with integrating so many disparate technologies and matching them with human processes is enormous. It is almost as if each of the 64 processes is its own line of business with many products and vendors and all-too-often limited ability to work together across business lines. One can feel overwhelmed by the complexity of it all, but the approach should be to acknowledge that the technology needs at each level of the system (e.g., patients, individual clinicians, groups of clinicians, large provider networks, health plans, payors, governments) are analogous to the needs of all the other parts. Accepting this idea—the fractal nature of systems—can go a long way to improve approaches at all levels.

Interactive computer-based interventions for weight loss or weight maintenance in overweight or obese people (The Cochrane Collaborative Review)

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Cochrane Database Syst Rev 2012; Issue 8. Art. No.: CD007675. DOI: 10.1002/14651858.CD007675.pub2.

Background

The standard treatment for overweight and obesity is to help patients change their diet and exercise habits. Over the past decade, web-based interventions have been developed and tested for a range of behaviors and chronic conditions, including weight control. Websites that attract enough users can be provided at no cost to the users and remain profitable when supported by advertising. In addition, web-based programs overcome the time and travel barriers of face-to-face interventions and increasingly include social features similar to the in-person experience. If it were possible to create effective web-based tools that were able to engage individuals for the long-term, the reach of the Internet would give these interventions the ability to have a major public health impact.

Behavioral weight control is the sum total of a great number of practices that each influence caloric intake, caloric expenditure, or both. Traditional behavioral weight management programs typically include multiple components from multiple theoretical approaches (e.g., cognitive-behavioral therapy, self-

regulation theory). Participants are taught a number of recommended practices, such as stimulus control, self-monitoring (e.g., food records), and identification of high-risk situations for relapse. As a result, interactive weight management interventions include features that mimic these components that would traditionally be provided in-person, such as online goal setting as opposed to face-to-face goal setting. While face-to-face interventions often include diaries of caloric intake and exercise and a therapist compares these to the recommendations and goals for the patient, this feedback can be computerized and provided online without a therapist involved. Most of what is available, therefore, in interactive interventions has been a computerization of what is available face-to-face. This includes online chat sessions and message boards that are designed to replicate what might happen in a group counseling session.

Methods

To assess the effects of interactive computer-based interventions for weight loss or weight maintenance in overweight or obese people, the authors conducted a comprehensive literature search without limitation to language. Articles selected to be reviewed included randomized controlled trials (RCTs) and quasi-RCTs with durations greater than 4 weeks and in which loss to follow-up was <20%. The primary outcomes were body weight, waist circumference, health-related quality of life, well-being, and patient satisfaction. The secondary outcomes were physical-activity-related outcomes, diet-related cost-effectiveness, and adverse events.

Results

The authors included 14 weight loss studies with a total of 2,537 participants, and four weight maintenance studies with a total of 1,603 participants. The length of treatment ranged from 4 weeks to 30 months. Compared to no intervention or minimal interventions (pamphlets, usual care), interactive computer-based interventions are an effective intervention for weight loss and weight maintenance. At 6 months, computer-based interventions led to greater weight loss than minimal interventions (mean difference −1.5 kg) but less than in-person treatment (mean difference 2.1 kg). At 6 months, computer-based interventions were superior to a minimal control intervention in limiting weight regain (mean difference −0.7 kg), but not superior to infrequent in person treatment (mean difference 0.5 kg). Greater amounts of intervention use, particularly self-monitoring, were typically associated with greater amounts of weight loss, though it was not clear what intervention elements would best encourage greater use or whether encouraging greater use would lead to larger effects. There were not enough articles in which cost and cost-effectiveness were analyzed to allow conclusions to be reached.

Conclusion

The impact of computer-based interventions appears relatively small compared to standard-of-care face-to-face interventions published elsewhere. In-person treatments tend to lead to a loss of 7–10% of body weight in the first 6 months. This is substantially more than the amount of weight lost at 6 months in the computer-based intervention groups included in this review, which raises the question of what role these interventions may play in addressing the epidemic of overweight and obesity. In the studies examined, adherence decreased dramatically in the first few months. Without understanding what level of adherence was clinically significant over the long-term, it will be difficult for clinicians to recommend and monitor the use of these interventions. Also, using a web-based intervention is more complicated than taking a pill, so physicians would need to understand what compliance means to these interventions to be able to use them routinely. This question will become more relevant should interventions be shown, in the future, to lead to greater effect sizes or clinical improvements. A major advantage of computer-based interventions is their ability to reach large numbers of people at a relatively low cost. However, the issue of costs and cost-effectiveness in the area of computer-based interventions is complex. Although cost analyses can be important tools to assist organizations in making decisions, it is increasingly complicated to understand their significance. This is especially true when the costs of obesity are felt in a variety of sectors (healthcare, employer, health plan, etc.). As overweight and obesity are increasingly considered chronic illnesses, interventions will need to examine the cost-effectiveness over time, as the comparator will increasingly be surgery. Interactive technologies change quickly, so it is also quite likely that what is reviewed here will be quite different from the trials reviewed a few years from now.

Comment

This is somewhat encouraging news, though not a ringing endorsement of interactive computer-based interventions for weight loss. As technology improves and more programs are created and tested, I have no doubt we will see better results. This is especially true when the interventions are created from effective programs originally designed to be delivered in-person and then faithfully transformed for a new technology-enabled delivery approach. When these in-person approaches are also cost-effective and/or cost saving, the impact of the derivative approach is even better. The challenge with most in-person programs is that they are often unaffordable (too high of a per-person price) and not scalable (unable to find enough personnel, physical location, time, etc.) to be provided to enough people to make a population-based difference. As technology minimizes the going-to-scale challenges, and if the price of the technology-enabled program is significantly less than the in-person program (e.g., 10–20%), even if the technology-enabled approach is not as effective as the original (e.g., 50% as effective), it will be quite effective at the population level.

School-based Internet obesity prevention programs for adolescents: a systematic literature review

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Yale J Biol Med 2013; ***86****: 49–62*

Background

Prevention is advocated widely as an important strategy to address the rising prevalence of obesity in adolescents, as

once youth become obese, treatment is difficult. School-based Internet obesity prevention programs hold great promise in reaching adolescents at risk for obesity as well as engaging adolescents in learning strategies to improve health behaviors. Adolescents have demonstrated significant improvements in dietary behaviors, physical activity, and body mass index (BMI) after participating in such programs, thus demonstrating the promise of this approach. However, programs have been heterogeneous with respect to type of media used, intervention components, quality, length of program, and outcomes. The purpose of this systematic review is to describe, synthesize, and evaluate the research on school-based Internet obesity prevention programs for adolescents. This includes sample characteristics, geographical location, program framework and content, number of sessions, attendance, attrition, BMI, and behavioral outcomes.

Methods

The authors performed a systematic review on English language, school-based obesity prevention Internet programs for adolescents. Articles were included if they reported an empirical study of a school-based obesity prevention program for adolescents, evaluated BMI, nutrition behavior, or physical activity behavior, and had a comparison group.

Results

Of the 12 studies included in this review, 5 compared a school-based Internet obesity prevention program to a no-treatment control group, 3 studies compared an Internet program to traditional classroom education, 2 studies compared an Internet program to a print program, and 2 compared two different Internet programs.

All Internet programs were developed from a theoretical perspective, with six based on the transtheoretical model, four based on social cognitive theory, two with a health promotion model, two based on models of behavior change, and one based on the theory of planned behavior. Content on both nutrition and physical activity was included in six programs; content on physical activity was included in only four programs; and content on nutrition was included in only two.

Overall, school-based Internet obesity prevention programs were effective in improving health behaviors of adolescents in the short-term (< 3–6 months). Across all studies, researchers used self-reporting measures to assess health behaviors. Improvement in dietary behavior and/or physical activity, regardless of theoretical perspective, content, or number of modules, was reported for the majority of programs ($n = 10$). Improvements in adolescents' self-efficacy for healthy eating or being physically active were reported in programs that targeted self-efficacy ($n = 3$). There were four studies in which the program's effect on BMI was evaluated. In only one study, based on models of behavior change, there was a significant decrease in BMI over time. One program resulted in an increase in BMI over time, and in the other two programs that evaluated BMI, no effect on BMI was found.

Conclusion

This review suggests that school-based Internet obesity prevention programs are effective in improving health behaviors in the short-term. They reached diverse adolescents at risk for overweight and obesity and appeared to be superior to standard care and traditional classroom education. School-based Internet obesity prevention programs have been successful in reaching high-risk students and changing behaviors in the short-term, but incomplete reporting, brief duration of follow-up, and a high risk of bias make it difficult to assess the true success of these programs.

Comment

While preventing obesity in adolescents will not have much short-term effect on the incidence or prevalence of type 2 diabetes, it could have a major impact in 20–30 years. School-based approaches that modify the environment and improve student's knowledge, attitudes, and skills, leading to significant and long-lasting changes in behaviors, are critical. It is encouraging to see that technology-enabled intervention shows promise. Given the strong association between child and adolescent obesity and type 2 diabetes later in life, it is essential that we are successful in preventing obesity as early as possible in the life course. Fortunately, the ill health effects of obesity are not felt by most adolescents, but that makes funding for prevention all the more difficult. Put bluntly, there is almost no return on investment from pediatric or adolescent obesity prevention to the healthcare system, so other justifications need to be articulated. Other parts of society (and the schools are good examples) need to be involved if we are to see significant improvement.

Short message service (SMS) text messaging as an intervention medium for weight loss: a literature review

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*Health Informatics J 2012; **18**: 235*

Background

Mobile devices such as mobile phones have emerged as a mode of intervention delivery to help people improve their health, particularly in relation to weight loss. Using mobile phones as a medium to deliver weight loss interventions has distinct advantages in that it reaches across geographic and economic boundaries, can be delivered directly to people, and is easy to use. Furthermore, short message service (SMS), also known as text messaging, has grown in popularity as a way to deliver health information owing to its simplicity, low cost, and ability to serve as a cue to action. SMS is a messaging service of up 160 characters in length to and from fixed-line and mobile phone devices. Thus, the purpose of this review was to answer the following question: What is the relationship between the use of SMS as an intervention medium and weight loss?

Methods

A comprehensive search of the English-language literature was used to find randomized or quasi-experimental intervention trials of participants who used SMS as the primary mode of communication to reduce obesity, overweight, or promoting weight loss. Studies were required to measure the impact of SMS

on a weight-loss-related variable postintervention, including body weight, body–mass index (BMI), waist circumference, physical activity, or diet. In addition, all studies had to be published in a peer-reviewed journal or under a similar peer-reviewed process such as a dissertation.

Results

Fourteen studies were found from 2007 or later. Ten studies used randomization and a comparison control group. Retention was above 80% for 8 of the 14 studies. Three studies conducted a power analysis and recruited the respective required sample sizes. Many of the studies were pilot or feasibility and did not have a power analysis for sample size calculation. All but two studies reported to use validated scales. All 14 studies focused on increasing physical activity, 11 focused on improving dietary habits, 3 measured the effects of SMS on blood pressure (BP) as an outcome from weight loss, and 10 assessed the acceptability or feasibility of SMS as a mode of delivery for weight loss. SMS was found feasible and acceptable in all seven studies in which it was evaluated. One study found it feasible for children to self-report data on eating, exercise, and emotions via SMS for 36 weeks. Additionally, several studies reported that people were positive toward the SMS system. Of the three studies that measured the effects of SMS on self-efficacy, two found no significant change in physical activity self-efficacy. One study showed a statistically significant increase ($p < 0.05$) in dietary self-efficacy in comparison with a control group. One study measured social support, yet found no change from baseline to postbaseline in comparison with a control group. Three out of six studies that measured the frequency or duration of physical activity found a statistically significant increase. Four studies measured the effects of an SMS intervention on dietary habits. One found a positive impact, two found no impact, and one demonstrated weight loss but did not report on dietary habits. Two of three studies that measured the effect on BP from weight loss found SMS statistically and clinically significantly reduced BP ($p < 0.05$). Overall, 11 of the 14 studies had a statistically significant effect ($p < 0.05$) on weight-loss-specific variables (i.e., weight, physical activity or diet). Of the 10 studies that measured BMI or weight as an outcome, 5 (50%) demonstrated a statistically and clinically significant difference in BMI postintervention ($p < 0.05$).

Conclusion

Results from this literature review demonstrate that SMS as an intervention tool for weight loss is still in its infancy, as indicated by the paucity of randomized clinical trials with limited sample sizes. SMS was found to be feasible and acceptable as an intervention medium to transmit and receive diet and exercise messages. Design of the interventions varied significantly. Owing to the inconsistency of timing and delivery, it is difficult to understand how often and when people should receive diet and exercise SMS. The effectiveness of SMS longitudinally for weight loss remains undetermined at present. SMS is often touted as an affordable and low-cost method of delivering intervention to and communication between patient and providers. However, among the studies reviewed, there was limited discussion or evaluation on the cost-effectiveness of SMS.

Continued research is needed on many fronts. Large randomized controlled trials with a significant sample size and longitudinal measurements are needed to understand how to best use and understand the benefits of SMS as an intervention medium. Informative research is required to find out exactly what should be written in a message and to understand the best timing and frequency of message delivery. In addition, it may not be that SMS is the most effective intervention approach, but just one of many that should be used in combination to support and help people change their diet and exercise lifestyle.

Comment

Text messaging as a way to provide education and support to patients certainly has its role. In low-income populations, in developed and underdeveloped countries, SMS can provide a variety of interactions that can be effective, low cost, and accessible to many people without the need for Internet access. For those with access to the range of technologies, it would not surprise me if some prefer the short-and-sweet approach of text messaging to other more time-consuming approaches. The key will be to create text-messaging-based interventions that are specifically designed for a target population, proven to be effective, and able to evolve as wisdom accumulates and technology improves.

Effects of type 2 diabetes behavioural telehealth interventions on glycaemic control and adherence: a systematic review

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*Telemed Telecare 2012; **18**: 447*

Background

Telehealth applications, including telephone counseling, videoconferencing, and educational telephone-based interventions, have been favorably received with good acceptability and uptake by type 2 diabetes patients. Telehealth interventions have also shown efficacy in improving psychosocial, psychological, and clinical outcomes in diabetes. While behavioral interventions and ongoing support are acknowledged as being cornerstones for effective type 2 diabetes self-management, the efficacy of behavioral telehealth interventions specifically aimed at improving glycemic control and diabetes self-care remains uncertain.

Methods

The authors conducted a systemic literature review of the effects of behavioral type 2 diabetes telehealth interventions. Eligible studies were peer-reviewed journal articles published in the English literature that reported evaluating the effects of telehealth interventions on glycemic control and at least one diabetes self-care outcome out of physical activity, diet, blood glucose self-monitoring, and medication adherence. Studies had to be randomized controlled trials and included either a

usual care comparison or an active treatment control (where the telehealth conditions received the same treatment).

Results

The search retrieved 1027 articles, from which 49 were selected based on their title and abstract. Fourteen articles (reporting 13 studies) met the eligibility criteria for inclusion. Four studies reported significant improvements in glycemic control. Five of eight studies on dietary adherence reported significant treatment effects, as did five of eight on physical activity, four of nine on blood glucose self-monitoring, and three of eight on medication adherence. Considerable heterogeneity between study processes and outcomes meant that it was difficult to draw firm conclusions. However, the present review demonstrated that behavioral telehealth interventions can significantly improve both glycemic and diabetes self-care outcomes in type 2 diabetes patients. Of the diabetes self-care outcomes that were examined, physical activity and dietary adherence most commonly demonstrated improvements in response to telehealth.

Conclusion

Overall, behavioral telehealth interventions show promise in improving the diabetes self-care and glycemic control of people with type 2 diabetes. In order to optimize the effect of telehealth for type 2 diabetes, systematic evaluations of different dosages and durations of interventions are also needed, as are studies of specific subgroups of patients (e.g., insulin dependent/nondependent). Research in this field also requires substantial improvements in study methodology, including blind assessment and allocation concealment. Clearer reporting of study processes and outcomes would enable methodological quality to be assessed and more confident conclusions to be drawn from reviews.

Comment

While this review demonstrates the positive impact of telehealth programs on the health of people with type 2 diabetes, it also highlights the lack of high-quality studies. This is not surprising for several reasons: (a) These are very expensive trials and while governments, foundations, industry, and others fund some outcome studies, it is much harder to get adequate funding to perform high-quality, longitudinal research with enough subjects to give results that matter; (b) technology, by its very nature, is constantly evolving, and given the calendar time it takes to plan, implement, and evaluate these kinds of studies, the technology being studied is usually obsolete and 2–3 generations old by the time the study is published. We need a new paradigm that lowers the cost and decreases the time necessary to evaluate technology-enabled behavioral interventions. The need to perform randomized controlled trials severely limits research opportunities. Using statistical methods from economics (which don't require random assignment) could go a long way to solving this problem. In addition, studies should investigate the principles upon which an intervention is based and how the program is implemented in the real world, and less on the specific functionalities of the technology.

Effects of self-management health information technology on glycaemic control for patients with diabetes: a meta-analysis of randomized controlled trials

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*J Telemed Telecare 2013; **19**: 133*

Background

The authors conducted a systematic review and meta-analysis of randomized controlled trials (RCTs) that had evaluated self-management health information technology (SMHIT) for glycemic control in patients with diabetes. SMHIT in this analysis refers to patient-focused, technology-mediated applications that are designed to enable patients with diabetes to engage in self-care activities such as health signs and symptoms monitoring, medication adherence, emotional management, self-education, and information exchange and communication to promote their health and well-being.

The authors hypothesize a number of advantages of SMHIT as a method of healthcare intervention delivery. In addition to its convenience, patients using these technologies can easily monitor their own health signals and transmit the data immediately to their clinicians, supporting better treatment adjustment decisions. They can also consult with the clinicians directly for individual recommendations on better self-management behavior. The benefits of SMHIT could also include the standardization of intervention delivery, access to online disease management resources, flexibility in the time and location of access to healthcare services, a reduction in outpatient visits, a reduction in the stigma of seeing a therapist, the delivery of tailored feedback to patients, and a reduction in hospital care costs. The hope is that the use of SMHITs can facilitate patients' self-management of their diabetes and deliver comprehensive healthcare services in a way that retains healthcare quality.

Methods

A total of 43 RCTs were identified, which reported on 52 control-intervention comparisons. The glycosylated hemoglobin (HbA1c) data were pooled using a random effects meta-analysis method, followed by a meta-regression and subgroup analyses to examine the effects of a set of moderators.

Results

The meta-analysis showed that use of SMHITs was associated with a significant reduction in HbA1c compared with usual care, with a pooled standardized mean difference of 20.30% (95% CI 20.39 to 20.21, p, 0.001). Sample size, age, study setting, type of application, and method of data entry significantly moderated the effects of SMHIT use. The review supports the use of SMHITs as a self-management approach to improve glycemic control.

Conclusion

The present meta-analysis of RCTs shows that the use of SMHIT is associated with improved glycemic control in

patients with diabetes. The analysis indicates that the effect of SMHIT use is significantly greater when the technology is a web-based application, when a mechanism for patients' health data entry is provided (manual or automatic), and when the technology is operated in the home or without location restrictions. Integrating these variables into the design of SMHITs may augment the effectiveness of the interventions.

Comment

While meta-analysis is a flawed but accepted method to see impact across disparate studies, this analysis reinforces the positive outcomes seen from a variety of approaches to helping individuals more efficiently and effectively self-manage their diabetes. While self-management is the professed goal from nearly all clinicians and clinical settings, it is often quite challenging to accomplish given the diversity of people receiving care and varied issues that need to be addressed. Focusing on core knowledge, attitudes, skills, and behaviors that are necessary for a person to succeed can go a long way. Technology has a role to play in ways that will be better defined and redefined in the coming years.

Active assistance technology reduces glycosylated hemoglobin and weight in individuals with type 2 diabetes: results of a theory-based randomized trial

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*Diabetes Technol Ther 2013; **15**: 662–69*

Background

Interactive technology support has been shown to improve glycemic control in individuals with type 2 diabetes, but success in this respect is determined primarily by frequent contact between intervention patients and healthcare personnel. This increases use of healthcare resources and may not be an option for all patients. On the other hand, extensive use of behavioral change techniques via the Internet produces larger effects than interventions with fewer techniques. The rapid evolution of sophisticated information technologies and mobile communication devices in the past decade has made it possible to exploit technology to facilitate healthcare professional and self-management of diabetes. Remote patient reporting of relevant health parameters and linked automated feedback via mobile telephone have potential to strengthen self-management and improve outcomes. Remote patient reporting of blood glucose levels, blood pressure, weight, physical activity, and nutrition can be linked, via mobile telephone, intermittently or in real time, with human healthcare personnel or with automated feedback. Remote patient reporting linked with theory-based health behavior change automated feedback have potential to improve patient outcomes in type 2 diabetes and merit scaled-up research efforts. Given the prevalence and consequences of diabetes and the fact that healthcare professional management and self-management of diabetes are time-, effort-, and cost-intensive, the potential efficiency and effectiveness of automated feedback, articulated to remote patient reports and guided by health behavior change theory, would seem to be considerable. In the clinical diabetes reality, ongoing healthcare provider support for diabetes self-management is not uniformly available. At the same time, however, many, if not most, individuals with diabetes have mobile communication devices that provide potential access to information technology-based interventions, guided by health behavior models, from which they may benefit at minimum cost. This research involved development and evaluation of a mobile telephone-based remote patient reporting and automated telephone feedback system, guided by health behavior change theory, aimed at improving self-management and health status in individuals with type 2 diabetes.

Methods

The study was a randomized controlled trial that involved development and evaluation of a mobile telephone-based remote patient reporting system, linked to automated feedback and guided by the information–motivation–behavioral skills model and evidence-based patient care guidelines. Inclusion criteria were diagnosis of type 2 diabetes, elevated glycosylated hemoglobin (HbA1c) levels (range, 6.5–11%), or use of oral diabetes medication, and 30–70 years of age. Intervention subjects ($n=24$) participated in remote patient reporting of health status parameters and linked health behavior change feedback. Knowledge-based reasoning based on the user's health data was linked in a dynamic process to the delivery of self-management information, motivation, and behavioral skills messages. Control participants ($n=24$) received standard of care including diabetes education and healthcare provider counseling. Patients were followed for approximately 10 months. Assessment of HbA1c, weight, and blood pressure at baseline and follow-up of a 10-month study period, in intervention and control patients, was used to gauge intervention impact on diabetes health-related end points.

Results

Intervention participants achieved, compared with controls and controlling for baseline, a significantly greater mean reduction in HbA1c of -0.40% versus 0.036% ($p<0.03$) and significantly greater weight reduction of -2.1 kg versus 0.4 kg. Nonsignificant trends for greater intervention compared with control improvement in systolic and diastolic blood pressure were observed. Postintervention reports indicated that 100% of intervention participants (24 of 24 who responded to this question) regarded Monica, the mobile telephone application, as "very easy" or "quite easy" to use. More than 90% of respondents (21 of 23 who responded to this question) reported that making health parameter measurements and reporting them was "very useful" or "quite useful," and approximately 82% (18 of 22 who responded to this question) of intervention participants regarded the automatic feedback they received as "very useful" or "quite useful."

Conclusion

This study applied active assistance technology for automated processing of health information from patients in an ongoing interaction with technology. This was achieved with semantic information processing of patient-reported data and delegation of decision making to the automated system, which frees up healthcare personnel resources.

Comment

Although this study was quite small (only 24 subjects), it was quite well thought out and expertly implemented and evaluated. We are seeing the future and the future is now. I fully expect that in the next few years there will be many more of these approaches that will be proven to be effective. I can only hope that the timeframe for adoption of the proven approaches goes much faster than many other medical innovations that often take decades to be adopted. In the case of technology-enabled interventions, the timeframe for innovations secondary to improved technology is in years and, in some cases, months. This will challenge all healthcare providers and healthcare systems to be able to relatively quickly adopt new programs that work while constantly looking for new approaches that need to be investigated and proven effective.

Internet psycho-education programs improve outcomes in youth with type 1 diabetes

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*Diabetes Care 2013; **36**: 2475–82*

Background

Considerable evidence indicates that in-person psychoeducational interventions, such as coping skills training (CST), improve metabolic control of type 1 diabetes as well as psychosocial adjustment and quality of life (QOL) in youth. However, implementing these evidence-based programs in clinical care is challenging because of provider and organizational barriers, such as lack of time, resources, and expertise. Rapid advances in technology and access to the Internet have made it not only a viable mode for the delivery of psychoeducational interventions but also a platform that can be widely disseminated and implemented. Psychoeducational interventions delivered via the Internet have demonstrated efficacy in improving symptoms and health behaviors in youth of different ages and illness experiences.

Methods

The purpose of this multisite randomized clinical trial was to compare the efficacy of two Internet-based programs on the primary outcomes of HbA1c and QOL and on the secondary outcomes of stress, coping, self-efficacy, self-management, social competence, and family conflict at 12 months. At the 12-month follow-up, youth were invited to participate in the alternate program, allowing the authors to explore the effect of participating in two programs compared with participating in only one.

TeenCope, a new Internet-based version of CST, was developed by the authors. It is based on social cognitive theory and posits that improving coping skills will lead to improved self-efficacy and self-management of diabetes that result in better outcomes, as has been demonstrated in studies of CST delivered in a group-based in-person format. Managing Diabetes was developed to serve as the control condition and was a diabetes education and problem-solving program.

Each program consisted of five sessions with content tailored to transitioning adolescents with type 1 diabetes that were released once per week for 5 weeks. TeenCope used a cast of ethnically diverse characters with type 1 diabetes and a graphic novel video format to model common problematic social situations (i.e., parent conflict) and different coping skills to solve the problems. The content of CST was based on our previous studies and included communication skills, social problem solving, stress management, positive self-talk, and conflict resolution.

The study was a multisite clinical trial of 320 youth (age 11–14 years; 37% minority; 55% female) randomized to one of two Internet-based interventions: TeenCope or Managing Diabetes. Primary outcomes were HbA1c and QOL. Secondary outcomes included coping, self-efficacy, social competence, self-management, and family conflict. Data were collected at baseline and after 3, 6, and 12 months online. Youth were invited to cross over to the other program after 12 months, and follow-up data were collected at 18 months. Analyses were based on mixed models using intent-to-treat and per protocol procedures.

Results

Youth in both groups had stable QOL and minimal increases in HbA1c levels over 12 months, but there were no significant differences between the groups in primary outcomes. After 18 months, youth who completed both programs had lower HbA1c ($p=0.04$); higher QOL ($p=0.02$), social acceptance ($p=0.01$), and self-efficacy ($p=0.03$); and lower perceived stress ($p=0.02$) and diabetes family conflict ($p=0.02$) compared with those who completed only one program.

Conclusion

Internet interventions for youth with type 1 diabetes transitioning to adolescence result in improved outcomes, but completion of both programs was better than only one, suggesting that these youth need both diabetes management education and behavioral interventions. Delivering these programs via the Internet represents an efficient way to reach youth and improve outcomes.

Internet interventions allow for standardization of program content, can be targeted to specific ages and developmental phases, allow for social interaction, and can be easily updated. Access to the Internet is increasingly available nationwide and has risen to its highest level ever, with 93% of youth using the Internet regularly for school assignments, hobbies, or special interests, entertainment, and connection

with others. The Internet, therefore, represents an efficient way to deliver psychoeducational interventions to youth with type 1 diabetes.

Internet-based interventions that can reach large numbers of youth with diabetes have the potential to result in significant improvements in long-term health as well as reductions in the costs of care for diabetes-related complications. They also have the potential to improve access for diverse youth with type 1 diabetes.

Comment

This elegantly designed, implemented, and evaluated study is just what the doctor ordered. I am not surprised that it didn't demonstrate superiority of one approach over the other and only modest improvement when the youth decided to take both programs. It may be that considerably more needed to be provided to help an adolescent actually do what was in his or her best interest. Go figure. It is hard for any of us to change our behaviors, and this is all the more true for adolescents. It was encouraging, and again not surprising, that adolescents enjoyed receiving education and support via technology. Since most young people with diabetes are using a lot of technology already to manage their condition, adding this approach would be quite natural. After all, technology is how they are experiencing nearly everything else in their lives, so why not this?

Mobile health applications to assist patients with diabetes: lessons learned and design implications

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Background

Self-management is critical to achieving diabetes treatment goals. Personal health applications (PHAs) developed for use on mobile information and communication technology (ICT) platforms offer potential to address this need. While there are increasing numbers of mobile PHAs for diabetes self-management support, their effectiveness is still being determined. This study describes opportunities for developing and leveraging mobile health (mHealth) interventions in diabetes treatment and self-management based on various feature sets. Lessons learned and design implications are discussed.

Methods

A mHealth research platform—the Few Touch Application (FTA) was used to assess the impact of a variety of mobile applications. The FTA consists of a mobile phone–based diabetes diary, which can be updated both manually from user input and automatically by wireless data transfer, and which provides personalized decision support for the achievement of personal health goals. Studies and applications (apps) based on FTAs have included (a) automatic transfer of blood glucose (BG) data; (b) short message service (SMS)–based education for type 1 diabetes mellitus (T1DM); (c) a diabetes diary for type 2 diabetes mellitus (T2DM); (d) integrating a patient diabetes diary with healthcare (HC) providers; (e) a diabetes diary for T1DM; (f) a food picture diary for T1DM; (g) physical activity monitoring for T2DM; (h) nutrition information for T2DM; (i) context sensitivity in mobile self-help tools; and (j) modeling of BG using mobile phones. The authors analyzed the performance of these 10 FTA-based apps to identify lessons for designing the most effective mHealth apps. The authors used user-centered methods that incorporate focus groups, interviews, usability testing, questionnaires, paper prototyping, functional software and hardware prototyping, and iterative design and development cycles.

Results

The authors concluded that (a) automatic BG data transfer is easy to use and provides reassurance; (b) SMS-based education facilitates parent–child communication in T1DM; (c) the T2DM mobile phone diary encourages reflection; (d) the mobile phone diary enhances discussion between patients and HC professionals; (e) the T1DM mobile phone diary is useful and motivational; (f) the T1DM mobile phone picture diary is useful in identifying treatment obstacles; (g) the step counter with automatic data transfer promotes motivation and increases physical activity in T2DM; (h) food information on a phone for T2DM should not be at a detailed level; (i) context sensitivity has good prospects and is possible to implement on today's phones; and (j) BG modeling on mobile phones is promising for motivated T1DM users.

Conclusion

The authors expect that the following elements will be important in future FTA designs: (a) automatic data transfer when possible; (b) motivational and visual user interfaces; (c) apps with considerable health benefits in relation to the effort required; (d) dynamic usage, for example, both personal and together with healthcare personnel, long-/short-term perspective; and (e) inclusion of context sensitivity in apps. They conclude that mHealth apps will empower patients to take a more active role in managing their own health.

Mobile applications for diabetes self-management: status and potential

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*J Diabetes Sci Technol 2013; **7**: 247–62*

Background

Advancements in smartphone technology, coupled with the proliferation of data connectivity, have resulted in increased interest and unprecedented growth in mobile applications for diabetes self-management. The objective of this article is to determine, in a systematic review, whether diabetes applications have been helping patients with type 1 or type 2 diabetes self-manage their condition and to identify issues necessary for large-scale adoption of such interventions.

Methods

The review covers peer-reviewed articles about commercial applications available on the Apple App Store (as a representative of commercially available applications) and articles published in relevant databases from January 1995 to August 2012. The review included all applications supporting any diabetes self-management task in which the patient is the primary actor.

Results

The studied applications support self-management tasks such as physical exercise, insulin dosage or medication, blood glucose testing, and diet. Other support tasks included decision support, notification/alert, tagging of input data, and integration with social media. Fifteen out of 16 articles reviewed experimentally tested their application. Two studies found no added benefit provided by the use of the application, whereas the remaining articles reported some type of added benefit. Overall, the review indicates that mobile applications can be viable tools for diabetes self-management. Mobile applications are generally preferred to web- or computer-based systems when it comes to usability. Regimen adherence can be managed through the use of mobile applications, which affects self-efficacy and other enabling factors. The review also seems to point out that diabetes self-management applications are useful to patients as well as providers. Limitations of the applications include lack of personalized feedback; usability issues, particularly the ease of data entry; and integration with patients and electronic health records.

Conclusion

This review attests to the value and potential for mobile applications to improve diabetes self-management. It is important to note that mobile application–based self-management is not a "silver bullet," and it is critical to understand that its effect is based on strong behavioral change theory. Such interventions may not be suitable for all patients with diabetes. Some patients abandon use because of technical problems, and others cannot afford the cost (phone and associated data plans). Research into the adoption and use of user-centered and sociotechnical design principles is needed to improve usability, perceived usefulness, and, ultimately, adoption of the technology. Proliferation and efficacy of interventions involving mobile applications will benefit from a holistic approach that takes into account patients' expectations and providers' needs.

Comment

These articles add to the literature that indicates that mobile delivery of education and support can help patients improve outcomes. They also demonstrate the evolving utility of single, focused mobile applications that help patients self-manage their diabetes. As these approaches become even more refined, they will no doubt be able to better help support patients as they learn to live and thrive with diabetes. The best of them will be linked to clinicians who can help interpret unclear findings or observations and to interventions that help the patient overcome barriers to be ready and able to benefit from the data and information these apps provide.

Video games for diabetes self-management: examples and design strategies

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*J Diabetes Sci Technol 2012; **6**: 802–6*

Background

Video games offer great promise for the delivery of diabetes self-management interventions because they provide new and unique ways to motivate and support health behavior change. Serious games are entertainment video games that have been designed to accomplish a beneficial purpose, such as influencing learning, civic engagement, or health behavior change. The field of health games is an active and innovative segment of the serious games field, with games that address topics ranging from healthy lifestyle improvement to prevention to self-care to disease self-management, and for healthcare providers, there are games that teach and rehearse clinical skills and assist with diagnosis and delivery of treatments.

Methods

This article briefly describes diabetes self-management video games and, when available, cites research findings on their effectiveness. The games were found by searching the Health Games Research online searchable database, three bibliographic databases (ACM Digital Library, PubMed, and Social Sciences Databases of CSA Illumina), and the Google search engine, using the search terms "diabetes" and "game." Games were selected if they addressed diabetes self-management skills.

Results

The 14 diabetes self-management games described in this article use a variety of game play genres, and the games typically involve players in problem solving and decision making in simulations of diabetes self-management, usually by asking players to balance food and insulin to keep a game character's blood glucose within a normal range. This format requires players to rehearse skills repeatedly until they win the game, so these games provide practice and show cause and effect, while also providing basic information about diabetes self-management. For example, this approach was

tested in a randomized controlled trial of the *Packy & Marlon* game, which found improvements in diabetes-related knowledge, self-efficacy, communication with family and friends, self-care behaviors, and clinical utilization.

Conclusion

New ideas and theoretical models are emerging in the field of diabetes self-management video games. These advances are providing a strong evidence-based foundation of behavioral health principles that could be integrated into the design of future games to more successfully engage and motivate players, improve and support their diabetes self-management, and lead to better health outcomes.

Comment

Video games are not just for kids, and the newer ones will no doubt have more content, even better graphics, and more impact. The challenge, not surprisingly, is the high cost of creating a game when such a small number of people will likely use them. This relegates their creation to a limited number of well-funded organizations or charities that have a mission to improve health outcomes. Without a natural market for these games, the ability of health-related games to reach large numbers of individuals is severely limited.

Local health department use of Twitter to disseminate diabetes information, United States

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Background

Educating and informing the public about health problems is a service provided by local health departments (LHDs). The objective of this study was to examine how LHDs are using social media to educate and inform the public about diabetes.

Methods

In June 2012 we used NVivo 10 to collect all tweets ever posted from every LHD with a Twitter account and identified tweets about diabetes. We used a 2010 National Association of County and City Health Officials survey to compare characteristics of LHDs that tweeted about diabetes with those that did not. Content analysis was used to classify each tweet topic.

Results

Of 217 LHDs with Twitter accounts, 126 had ever tweeted about diabetes, with 3 diabetes tweets being the median since adopting Twitter. LHDs tweeting about diabetes were in jurisdictions with larger populations and had more staff and higher spending than LHDs not tweeting about diabetes. They were significantly more likely to employ a public information specialist and provide programs in diabetes-related areas. There was also a weak positive association between jurisdiction diabetes rate and the percentage of all tweets that were about diabetes ($r = 0.16$; $p = 0.049$).

Conclusion

Health departments have a unique opportunity to use social media to provide this essential service, meeting several of the standards required for accreditation and, potentially, aiding in improving public health in their jurisdiction and nationwide. LHDs are beginning to use social media to educate and inform their constituents about diabetes. An understanding of the reach and effectiveness of social media could enable public health practitioners to use them more effectively. Future research is needed to better understand how best to use social media as a tool for dissemination of health information to constituents and as a way to engage people living with and managing chronic disease.

Comment

I chose this article not because it demonstrates good outcomes (no outcomes were presented) or that its conclusions are very profound—which they aren't. I chose it to demonstrate the limited research available about tweeting as a method to improve the health of large numbers of individuals. It takes time to develop a literature base that can demonstrate effects of new technologies. That is why it is essential for researchers to determine the principles under which effective communication technology can be used to positively impact patient outcomes. With these principles understood, effective interventions can be developed that increase the likelihood that a new technology—in this case, a new communication channel—can make a significant difference.

Improving prompt effectiveness in diabetes care: an intervention study

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*Am J Med Qual 2012; **27**: 406–10*

Background

A proposed advantage of electronic medical records (EMRs) over paper charts is the ability to track patients with complex and/or chronic disease such as diabetes and "prompt" providers to order monitoring tests within the periodicity recommended by clinical practice guidelines. EMR-generated prompts may be more likely to increase ordering of recommended monitoring tests when clinic workflow, staff training, and medical culture are incorporated into the prompt delivery. However, early experience with prompts has had mixed results for improving the rate and timeliness of test ordering. Prompt effectiveness may be improved when implemented with an understanding of the clinical workflow that recognizes the roles of all healthcare team members. For example, targeting a test-ordering prompt to medical staff, rather than to a physician, has been shown to be effective in diabetes management and colon cancer screening.

Methods

The authors performed a nested, time-series, quasi-experimental design of EMR prompting in the internal medicine and family medicine clinics at the University of California, San Diego Medical Group (UCSDMG). The study was conducted within the context of a medical-group-wide quality improvement initiative to increase appropriate diabetes monitoring test ordering rates. The primary outcome of the study was the missed opportunity rate (MOR).

Results

The authors analyzed 16,511 visits performed on 3730 patients. The rate of ordering all indicated that tests at the time of the visit increased from 29% with no prompts to 49% ($p < 0.001$) with appropriately designed prompts and training support. There was a 20% absolute decrease in missed opportunities to order all appropriate diabetes monitoring tests for which an individual patient was eligible. An unintended but reassuring finding of the study was the strong influence of a visit with the primary care provider (PCP) on the adherence to prompts. The absolute change in MOR for PCPs was 24%; the change was 12.8% for non-PCPs. More than half of the MOR reduction occurred when test ordering switched to the medical staff, and the physician simply "approved" the order. This shift in workflow relies on medical staff to help facilitate test ordering and may be more contextually appropriate to their role in healthcare delivery.

Conclusion

Although the physician is still ultimately responsible for finalizing the test orders, this intervention should allow the physician more time to focus on data analysis and implementation of a care plan rather than spending visit time negotiating the indicated test-ordering process. In summary, workflow-compatible, simplified prompts that accommodate clinic workflow and team members' scope of work can improve ordering rates of indicated diabetes tests.

Comment

This study is about a very specific technological support for patient care, the use of EMR-driven prompts to increase notification adherence with expected tests and appointments. It is encouraging that a relatively simple intervention can help improve the quality of care provided. It is not surprising that when medical staff takes over a specific task that is best done by them that they get better results than a busy clinician. I was only surprised that the medical staff was not already providing reminders that labs were needed for a specific visit. That is what good teamwork is all about.

Summary

The articles reviewed in this chapter summarize advances in technology that are making a real difference in the lives of people with, or at risk for, diabetes. Many of the reviews point the way to a consensus on what works, and the original research articles provide targeted wisdom about a more focused element of the solution. While none of the articles will by themselves lead to a time when technology can provide help and support to all those who need it, it is hoped that these and other publications can lead to a deeper understanding of what works and why and for which people. This knowledge and wisdom will go a long way to the goal of preventing diabetes and improving the health of those affected by the disease.

Significant and lasting progress will happen when we have a true partnership between academics, providers, and the technology industry: Academics to continue pushing the envelope and creating approaches that work in the lab; healthcare providers who experiment with programs in real-world settings to evaluate their effectiveness; and technology companies able to not only create something that works technically, but also provide what patients and clinicians actually need to improve outcomes. We will know that the health information technology industry has fully arrived when more of the companies are able to provide answers to what their customers and patients need and want and not only what the company is able to produce. Now, wouldn't that be nice?

Author Disclosure Statement

N.K. has no conflict of interest with any of the reviewed articles. He is the founder and co-owner of DPS Health, a software development company based in Los Angeles, CA. DPS Health creates and distributes web and cell phone based weight management services.