Published in final edited form as:

Health Technol (Berl). 2015 July ; 5(2): 127–133. doi:10.1007/s12553-015-0109-z.

Costs of Development and Maintenance of an Internet Program for Teens with Type 1 Diabetes

Margaret Grey, DrPH, RN, FAAN, Lauren Liberti, MS, and Robin Whittemore, PhD, APRN, FAAN

Yale University School of Nursing, New Haven, Connecticut

Abstract

Many adolescents with type 1 diabetes (T1D) have difficulty completing self-management tasks within the context of their social environments. Group-based approaches to psycho-educational support have been shown to prevent declines in glucose control, but are challenging to implement due to youths' many activities and costs. A novel solution is providing psycho-educational support via the internet. The purpose of this study is to describe the cost of developing and maintaining two internet psycho-educational programs, both of which have been shown to improve health outcomes in adolescents with T1D.

We calculated actual costs of personnel and programming in the development of TEENCOPE™ and Managing Diabetes, two highly interactive programs that were evaluated in a multi-site clinical trial (n=320). Cost calculations were set at U.S. dollars and converted to value for 2013 as expenses were incurred over 6 years.

Development costs over 1.5 years totaled \$324,609, with the majority of costs being for personnel to develop and write content in a creative and engaging format, to get feedback from teens on content and a prototype, and IT programming. Maintenance of the program, including IT support, a part-time moderator to assure safety of the discussion board (0.5–1 hour/week), and yearly update of content was \$43,845/year, or \$137.00 per youth over 4.5 years.

Overall, program and site development were relatively expensive, but the program reach was high, including non-white youth from 4 geographically distinct regions. Once developed, maintenance was minimal. With greater dissemination, cost-per-youth would decrease markedly, beginning to offset the high development expense.

Keywords

Internet intervention; eHealth; Type 1 Diabetes; Cost; Economics

2.0 Introduction

Type 1 diabetes (T1D) is one of the most common chronic illnesses in youth, with approximately 1 in 400 youth affected.[1] Rigorous self-management by youth and their

parents, including frequent monitoring of blood glucose and adjusting insulin doses based on dietary intake and physical activity, is critical if complications are to be avoided.[2] The complex self-management required to maintain health for youth with T1D is challenging as they assume increasing responsibility for their own care. As children transition to adolescence, youth with T1D experience significant stressors. These include stresses associated with relationships with peers and adults as well as a sense of isolation due to navigating concealment or disclosure of their illness to others.[3, 4]

It is widely recommended that youth with T1D receive educational and psychosocial support during the transition through adolescence.[5] Group-based psycho-educational programs have demonstrated efficacy in improving health outcomes and connecting transitioning youth with T1D with their peers.[6] Adolescent groups contend with attrition due to the logistics of finding convenient meeting hours and travel to a common location.[7, 8] While attendance in our in-person Coping Skills Training (CST) groups for youth with T1D was high, our experience has been that scheduling such groups is challenging and labor intensive..[9, 10] Further, nearly 50% of youth who might benefit from our program refused to participate because they were 'too busy' to do so.

Developers of internet-based healthcare interventions cite the benefits of increased convenience for users, reduced cost and resources, and reduced user isolation and stigma as primary factors in the decision to construct their programs.[11, 12] The internet may have additional potential for healthcare interventions in adolescents with chronic illnesses because of their eager adoption of new technology and widespread use of social media.[13]

The delivery of health care via the internet is rapidly evolving, and numerous programs have been developed and evaluated. The efficacy of internet programs has been demonstrated to treat psychological issues in clinical trials in adults, in particular through the use of internet-based cognitive behavior therapy (ICBT).[14] Researchers are also exploring ICBT for youth, but research on efficacy is limited.[15, 16] Other internet programs have been shown to improve outcomes in the management of conditions such as headache, back pain, tinnitus, urinary stress incontinence, smoking cessation, and medication adherence in adults[17–20], and encopresis[21], traumatic brain injury[22], diabetes management[23, 24], eating disorders[25], and prevention of high risk behaviors[26, 27] in youth.

As efficacy is demonstrated, an important step towards the implementation of internet health care is the demonstration of cost-effectiveness. Unfortunately, there are few studies providing data. In a 2009 review of cost effectiveness of internet interventions, the authors found only 8 studies that incorporated economic endpoints in their analysis; and they concluded that most of those studies had significant shortcomings making it difficult to determine whether or not the interventions were a good use of health resources.[12] A 2012 review of clinical efficacy and cost-effectiveness of ICBT revealed few studies (total 8 out of 103 trials), with some suggestion that ICBT is cost-effective compared with no treatment or conventional CBT.[14] Since then, there have been several reports of cost and cost effectiveness of various internet interventions.[28–30, 17, 31] Despite an increase in the reporting of costs, there are not enough data to conclude that an effective internet intervention will cost less and improve outcomes compared to usual treatment.

Often neglected in cost-effectiveness analysis, the cost of development and maintenance of psycho-educational programs needs to be considered. The cost of developing internet programs has varied considerably, ranging from approximately 110K for development of an internet physical activity promotion intervention[32] to over 800K for development of an internet intervention for the maintenance of weight loss.[33] While initial costs of internet program development may be high, creators of such programs agree that increased user volume will reduce cost per user over time.[32, 33, 18, 34]

Programs targeting youth with T1D have the potential to reduce healthcare expenditures in the areas of staff resources, service utilization due to adverse events, and the prevention of chronic disease complications.[35] Several internet programs for youth with T1D have been developed and evaluated. These programs vary in focus, targeting such behaviors as adherence to the monitoring of blood glucose and insulin pumps[36], self-management by using problem-solving exercises,[24, 23, 37] CST by using interactive lessons,[23] and expert support by encouraging interaction with providers.[38, 39] Many of these programs take advantage of the internet's capacity to draw peers together for social support.[40, 38, 39, 23] To date, none of these programs have reported on costs of development and maintenance.

The purpose of this manuscript is to describe the costs of developing and maintaining two highly interactive internet programs for youth with T1D – TEENCOPE™ and Managing Diabetes.[41] Provided together these programs have been shown to improve metabolic control, increase quality of life, social acceptance and self-efficacy, and reduce perceived stress and diabetes family conflict in adolescents with T1D.[23]

3.0 Methods

Data for this descriptive analysis were derived from a multi-site clinical trial (n=320) comparing TEENCOPE™ and Managing Diabetes.[10] The TEENCOPE™ program consists of 5 highly interactive lessons adapted from a successful in-person, group-based coping skills training protocol.[9] It uses a graphic novel format and animations to illustrate coping skills content, and houses a moderated discussion board. Managing Diabetes is an internet diabetes education program designed as an active control to TEENCOPE™. It was modeled after an in-person education program for adolescents and consists of 5 interactive lessons with problem-solving components.[41]

In this manuscript, we describe the personnel and programming costs of developing and maintaining the programs. Expenses were incurred over 6 years between 2008 and 2013 and were obtained from monthly expense reports on personnel and technology development. Development and maintenance costs were calculated separately. Personnel costs were estimated from percent effort for development of each program and salaries in 2013 equivalents. All costs calculations were set at US dollars converted to value for the year 2013. Research expenditures, such as site coordination, data collection, and subject follow-up were not included.

4.0 Results

4.1 Program Development and Cost

Programming and personnel choices were based on criteria for the websites' operation and available technology. Both TEENCOPE™ and Managing Diabetes required a safe and secure environment. They also required a highly engaging and interactive interface targeted to adolescents with T1D. Study staff needed the capacity to monitor youth for participation and safety through automated and on-demand reports on website activities (e.g. new discussion board posts and lesson completion). Because both programs required considerable interactivity, a standard content management system was insufficient. Thus, both TEENCOPE™ and Managing Diabetes were programmed using Microsoft Classic asp technology and used VbsScript and Javascript programming languages. Microsoft SQL Server was the database platform, and the sites were hosted on a Microsoft Windows server.

In particular, TEENCOPE™ required a flexible website architecture that allowed for interactive lessons, tailored computer-generated feedback based upon user responses, video animations, and the ability for users to interact with each other via a discussion board and profile viewing. The diverse Information Technology (IT) team for TEENCOPE consisted of a creative coordinator, IT graphic artist, 2 programmers, and a technician for content transfer. An illustration artist was contracted to draw teenage characters and create animations. Experts familiar with CST in youth with T1D were required for content development. Personnel on the content team consisted of 2 PhD-level registered nurses, 2 clinical psychologists and a family psychotherapist who had delivered group-based, in-person CST in a diabetes clinic. The content team met weekly to develop teenage characters, diabetes-related coping skills scenarios, and to create interactive activities. This team also oversaw pilot testing of the materials with adolescents with T1D. See Table 1 for details about program development of TEENCOPE™.

Managing Diabetes required a logical website architecture that allowed progression through educational lessons as well as interactive, problem-solving content with computer-generated, tailored feedback. The team for Managing Diabetes consisted of a coordinator and a technician who performed content and picture transfer to the web. Content was developed by 2 PhD-level registered nurses, a master's-level registered nurse, and a medical student. The team used an iterative process of determining content based upon clinical protocols and educational materials for youth with T1D. The content was reviewed by other experts and pilot tested in adolescents with T1D. Website graphics consisted of stock photos. See Table 2 for details about program development of Managing Diabetes

The development process took 1.5 years. Costs are shown in Table 3. The bulk of expenses were for staff dedicated to developing content for the TEENCOPE website (~\$198K). IT costs were sizable as well (~\$72K). In total, \$324,609 was spent to develop the two highly interactive internet programs for adolescents with T1D.

4.2 Program Maintenance and Cost

Maintenance costs for the two websites were incurred concurrently during the clinical trial. Maintenance needs for both websites were similar and as such are difficult to separate.

Results of the RCT comparing TEENCOPE™ to Managing Diabetes showed that optimal outcomes were realized when adolescents completed both interventions.[23] Consequently, the maintenance costs reported here are combined. Research costs were not included.

Both programs required a secure server with protocols that met strict HIPAA privacy protection standards. Websites were hosted on a University server and domain names were purchased. Both programs required an administrator to monitor user progress through the interventions, answer questions, and alert the web programmer of any technical difficulties. A web programmer was needed to troubleshoot any issues with the websites rapidly (e.g. problem with automated emails). TEENCOPE™ was unique in requiring a moderator (licensed healthcare professional) to oversee and encourage conversation on the discussion board and to assure the safety of the participants (approximately ½ to 1 hour per week). See Table 4 for details about program maintenance criteria. Maintenance costs are calculated based upon experience with 320 youth over 4.5 years of implementation.

Maintenance for both programs, including administrator oversight, IT support, website hosting, a part-time moderator, and an expert review to update content cost \$43,845 per year (valued for 2013), or \$137.00 per youth over 4.5 years.

5.0 Discussion

In this descriptive study, we analyzed the costs associated with the development and maintenance of two internet programs for youth with T1D. The potential for such an intervention is great as future widespread implementation would improve access to psycho-educational programs for all youth with T1D, regardless of geographical location. Despite T1D being the most common major chronic illness in childhood, the prevalence is such that adolescents are often the only one in their school with a complex chronic illness that requires self-management during school hours. Connecting adolescents with others with T1D and facilitating skill development to complete self-management tasks in common social situations has the potential to promote positive health outcomes and normal growth and development.

More than 93% of youth access the internet regularly, and the ‘digital divide’ is shrinking. In our study, we purposely sampled youth with diabetes from racial and ethnic minorities and with diverse socioeconomic backgrounds to assure that the programs were acceptable. We found that program reach was quite high, as was satisfaction with the programs, in a sample that included non-white youth from four geographically distinct regions.[42]

Our data show that program and website development represent the bulk of total expenses. In our case, development costs were relatively low compared costs for similar programs reported in the literature (\$324,609 for our two programs compared to a range of \$110,000–\$800,000 for one program).[43, 33] Since 2008, new platforms for website development have been released, and our expectation is that use of such platforms would further reduce the technical costs of development.

Maintenance costs were low and associated mostly with the need for a professional monitor or ‘coach’ to assure that postings to the discussion board were safe for youth. These costs

were calculated according to percent effort (10% of the salary) of a PhD Psychologist or R.N. who oversaw activity of up to 50 youth at the busiest time on the website. More recent iterations of the program have become streamlined and show that a single RN is capable of moderating 60 youth at one time within 2 hours per week. Should volume remain at levels reported in this paper, future maintenance costs are expected to be lower since it is likely to be less expensive to perform updates with newer programming platforms compared with our websites, and professional moderation will be much less costly. Projection of future expenses with dissemination of the program would need to account for an increase in scale, ongoing content updates, marketing, and changes in technology (e.g., programming platforms).

In terms of scale, we estimate that there are 450,000 youth with T1D between the ages of 0 and 18 in the US.[44] Our program is designed for youth age 11–14, reducing the number of total youth eligible for our program at any given time to a broad estimate of 100,000. In our experience, youth who participate in our programs actively visit the websites for the initial 4–6 weeks while completing lessons, and continue to log on to view the discussion board for approximately 6 months. Participation even with most active youth drops off after that time. Should every US youth with T1D in our age range access our programs for 6 months during their adolescence, we can estimate that there would be no more than 10,000 using the website at a time. Our current system is able to accommodate that volume without additional IT resources (e.g. server space or database programming). In terms of website moderation, an increase in scale to 10,000 users may require up to 333 nursing hours per week (or over 8 full-time nurses); although we suspect that hourly requirements are likely not to grow linearly, and therefore cost less.

Based upon our experience, the websites would require an expert content review to ensure recommendations for diabetes care and technology are up-to-date every 2–3 years. In addition, some graphics may be needed to reflect more current styles. Our estimate of \$43,845 per year maintenance includes nearly \$13,000 for updating content. We feel that this is an adequate amount to pay for regular content review and graphical updates going forward.

Dissemination plans for such programs will also require investigation into the most cost-effective strategies to reach the targeted population. Different strategies would be required to reach professionals who may prescribe the program to adolescents with T1D, parents of adolescents with T1D who are struggling with the transfer of responsibility of self-management tasks, and adolescents with T1D who recognize the challenges they face with self-management within their social environment. Future research on optimal dissemination of web-based programs is indicated. However, as we move to widespread dissemination, the maintenance costs will decrease per youth as more avail themselves of the interventions.

There are several limitations of this analysis. While a randomized trial with 320 youth from four clinical sites demonstrated that youth with diabetes benefit from the programs, the number of subjects is not large enough for a formal cost-effectiveness analysis. In addition, we did not measure health utilities in this study, which are usually considered in cost-

effectiveness analyses. Once efficacy has been established, future studies should include measures of health utilities.[45]

Despite these limitations, our results suggest that web-based programs are a potentially cost-efficient means to reach youth with chronic conditions such as T1D. Not only is the potential reach of such programs high, the programs are associated with improved metabolic control and quality of life, as well as feelings of decreased stress and increased self-efficacy. More research on the costs of development, evaluation, and dissemination of such programs is warranted.

Acknowledgments

This study was funded by the National Institutes of Nursing Research (NINR)/National Institutes of Health (NIH) grant #2R01NR004009 to Margaret Grey and Robin Whittemore, PIs. Development of the Internet programs was supported by intramural funds provided to Margaret Grey.

References

1. Liese AD, D'Agostino RB Jr, Hamman RF, Kilgo PD, Lawrence JM, Liu LL, et al. Search for Diabetes in Youth Study Group. The burden of diabetes mellitus among US youth: prevalence estimates from the SEARCH for Diabetes in Youth Study. *Pediatrics*. 2006; 118(4):1510–8.10.1542/peds.2006-0690 [PubMed: 17015542]
2. Diabetes Control and Complications Trial Research Group. Effect of intensive diabetes treatment on the development and progression of long-term complications in adolescents with insulin-dependent diabetes mellitus: Diabetes Control and Complications Trial. *The Journal of Pediatrics*. 1994; 125(2):177–88. [PubMed: 8040759]
3. Davidson M, Penney ED, Muller B, Grey M. Stressors and self-care challenges faced by adolescents living with type 1 diabetes. *Applied Nursing Research: ANR*. 2004; 17(2):72–80. [PubMed: 15154119]
4. Jaser SS, Faulkner MS, Whittemore R, Jeon S, Murphy K, Delamater A, et al. Coping, self-management, and adaptation in adolescents with type 1 diabetes. *Annals of Behavioral Medicine: a Publication of the Society of Behavioral Medicine*. 2012; 43(3):311–9.10.1007/s12160-012-9343-z [PubMed: 22274724]
5. Chiang JL, Kirkman MS, Laffel LM, Peters AL. Type 1 Diabetes Sourcebook A. Type 1 diabetes through the life span: a position statement of the American Diabetes Association. *Diabetes Care*. 2014; 37(7):2034–54.10.2337/dc14-1140 [PubMed: 24935775]
6. Grey M, Whittemore R, Jaser S, Ambrosino J, Lindemann E, Liberti L, et al. Effects of coping skills training in school-age children with type 1 diabetes. *Research in Nursing & Health*. 2009; 32(4): 405–18.10.1002/nur.20336 [PubMed: 19488997]
7. Hampl S, Demeule M, Eneli I, Frank M, Hawkins MJ, Kirk S, et al. Parent perspectives on attrition from tertiary care pediatric weight management programs. *Clinical Pediatrics*. 2013; 52(6):513–9.10.1177/0009922813482515 [PubMed: 23539682]
8. Sallinen Gaffka BJ, Frank M, Hampl S, Santos M, Rhodes ET. Parents and pediatric weight management attrition: experiences and recommendations. *Childhood Obesity*. 2013; 9(5):409–17.10.1089/chi.2013.0069 [PubMed: 24028563]
9. Grey M, Boland EA, Davidson M, Yu C, Tamborlane WV. Coping skills training for youths with diabetes on intensive therapy. *Applied Nursing Research: ANR*. 1999; 12(1):3–12. [PubMed: 10048236]
10. Grey M, Whittemore R, Liberti L, Delamater A, Murphy K, Faulkner MS. A comparison of two internet programs for adolescents with type 1 diabetes: design and methods. *Contemporary Clinical Trials*. 2012; 33(4):769–76.10.1016/j.cct.2012.03.012 [PubMed: 22484337]

11. Griffiths F, Lindenmeyer A, Powell J, Lowe P, Thorogood M. Why are health care interventions delivered over the internet? A systematic review of the published literature. *Journal of Medical Internet Research*. 2006; 8(2):e10.10.2196/jmir.8.2.e10 [PubMed: 16867965]
12. Tate DF, Finkelstein EA, Khavjou O, Gustafson A. Cost effectiveness of internet interventions: review and recommendations. *Annals of Behavioral Medicine: a Publication of the Society of Behavioral Medicine*. 2009; 38(1):40–5.10.1007/s12160-009-9131-6 [PubMed: 19834778]
13. Madden M, Lenhart A, Duggan M, Cortesi S, Gasser U. *Teens and Technology 2013*. Pew Research Internet Project. 2013
14. Hedman E, Ljotsson B, Lindefors N. Cognitive behavior therapy via the Internet: a systematic review of applications, clinical efficacy and cost-effectiveness. *Expert Review of Pharmacoeconomics & Outcomes Research*. 2012; 12(6):745–64.10.1586/erp.12.67 [PubMed: 23252357]
15. van der Zanden R, Kramer J, Gerrits R, Cuijpers P. Effectiveness of an online group course for depression in adolescents and young adults: a randomized trial. *Journal of Medical Internet Research*. 2012; 14(3):e86.10.2196/jmir.2033 [PubMed: 22677437]
16. Richardson T, Stallard P, Velleman S. Computerised cognitive behavioural therapy for the prevention and treatment of depression and anxiety in children and adolescents: a systematic review. *Clinical Child and Family Psychology Review*. 2010; 13(3):275–90.10.1007/s10567-010-0069-9 [PubMed: 20532980]
17. Sjostrom M, Umefjord G, Lindholm L, Samuelsson E. Cost-effectiveness of an Internet-based treatment program for stress urinary incontinence. *Neurourology and Urodynamics*. 2013;10.1002/nau.22540
18. Page TF, Horvath KJ, Danilenko GP, Williams M. A cost analysis of an Internet-based medication adherence intervention for people living with HIV. *Journal of Acquired Immune Deficiency Syndromes*. 2012; 60(1):1–4.10.1097/QAI.0b013e318250f011 [PubMed: 22362156]
19. Ritterband LM, Andersson G, Christensen HM, Carlbring P, Cuijpers P. Directions for the International Society for Research on Internet Interventions (ISRII). *Journal of Medical Internet Research*. 2006; 8(3):e23.10.2196/jmir.8.3.e23 [PubMed: 17032639]
20. Murray E. Web-based interventions for behavior change and self-management: potential, pitfalls, and progress. *Medicine*. 2012; 1(2):e3.10.2196/med20.1741
21. Ritterband LM, Thorndike FP, Lord HR, Borowitz S, Walker LS, Ingersoll KS, et al. An RCT of an Internet Intervention for Pediatric Encopresis with One Year Follow-Up. *Clinical Practice in Pediatric Psychology*. 2013; 1(1):68–80.10.1037/cpp0000007 [PubMed: 24040581]
22. Kurowski BG, Wade SL, Kirkwood MW, Brown TM, Stancin T, Taylor HG. Long-term benefits of an early online problem-solving intervention for executive dysfunction after traumatic brain injury in children: a randomized clinical trial. *JAMA Pediatrics*. 2014; 168(6):523–31.10.1001/jamapediatrics.2013.5070 [PubMed: 24781374]
23. Grey M, Whittemore R, Jeon S, Murphy K, Faulkner MS, Delamater A, et al. Internet psycho-education programs improve outcomes in youth with type 1 diabetes. *Diabetes Care*. 2013; 36(9):2475–82.10.2337/dc12-2199 [PubMed: 23579179]
24. Mulvaney SA, Rothman RL, Wallston KA, Lybarger C, Dietrich MS. An internet-based program to improve self-management in adolescents with type 1 diabetes. *Diabetes Care*. 2010; 33(3):602–4.10.2337/dc09-1881 [PubMed: 20032275]
25. Jones M, Taylor Lynch K, Kass AE, Burrows A, Williams J, Wilfley DE, et al. Healthy weight regulation and eating disorder prevention in high school students: a universal and targeted Web-based intervention. *Journal of Medical Internet Research*. 2014; 16(2):e57.10.2196/jmir.2995 [PubMed: 24583683]
26. Newton NC, Andrews G, Champion KE, Teesson M. Universal Internet-based prevention for alcohol and cannabis use reduces truancy, psychological distress and moral disengagement: a cluster randomised controlled trial. *Preventive Medicine*. 2014; 65:109–15.10.1016/j.ypmed.2014.05.003 [PubMed: 24823906]
27. Park, E.; Drake, E. *Journal of nursing scholarship: an official publication of Sigma Theta Tau. International Honor Society of Nursing/Sigma Theta Tau*; 2014. Systematic Review: Internet-Based Program for Youth Smoking Prevention and Cessation.

28. Smit ES, Evers SM, de Vries H, Hoving C. Cost-effectiveness and cost-utility of Internet-based computer tailoring for smoking cessation. *Journal of Medical Internet Research*. 2013; 15(3):e57.10.2196/jmir.2059 [PubMed: 23491820]
29. Krukowski RA, Tilford JM, Harvey-Berino J, West DS. Comparing behavioral weight loss modalities: incremental cost-effectiveness of an internet-based versus an in-person condition. *Obesity*. 2011; 19(8):1629–35.10.1038/oby.2010.341 [PubMed: 21253001]
30. Schulz DN, Smit ES, Stanczyk NE, Kremers SP, de Vries H, Evers SM. Economic evaluation of a web-based tailored lifestyle intervention for adults: findings regarding cost-effectiveness and cost-utility from a randomized controlled trial. *Journal of Medical Internet Research*. 2014; 16(3):e91.10.2196/jmir.3159 [PubMed: 24650860]
31. Blankers M, Nabitz U, Smit F, Koeter MW, Schippers GM. Economic evaluation of internet-based interventions for harmful alcohol use alongside a pragmatic randomized controlled trial. *Journal of Medical Internet Research*. 2012; 14(5):e134.10.2196/jmir.2052 [PubMed: 23103771]
32. Lewis BA, Williams DM, Neighbors CJ, Jakicic JM, Marcus BH. Cost Analysis of Internet vs. Print Interventions for Physical Activity Promotion. *Psychology of Sport and Exercise*. 2010; 11(3):246–9.10.1016/j.psychsport.2009.10.002 [PubMed: 20401164]
33. Meenan RT, Stevens VJ, Funk K, Bauck A, Jerome GJ, Lien LF, et al. Development and implementation cost analysis of telephone- and Internet-based interventions for the maintenance of weight loss. *International Journal of Technology Assessment in Health Care*. 2009; 25(3):400–10.10.1017/S0266462309990018 [PubMed: 19619360]
34. Rasu RS, Hunter CM, Peterson AL, Maruska HM, Foreyt JP. Economic evaluation of an Internet-based weight management program. *The American Journal of Managed Care*. 2010; 16(4):e98–104. [PubMed: 20370312]
35. Gage H, Hampson S, Skinner TC, Hart J, Storey L, Foxcroft D, et al. Educational and psychosocial programmes for adolescents with diabetes: approaches, outcomes and cost-effectiveness. *Patient Education and Counseling*. 2004; 53(3):333–46.10.1016/j.pec.2003.06.003 [PubMed: 15186872]
36. Levine BA, Turner JW, Robinson JD, Angelus P, Hu TM. Communication plays a critical role in web-based monitoring. *Journal of Diabetes Science and Technology*. 2009; 3(3):461–7. [PubMed: 20144283]
37. Newton KT, Ashley A. Pilot study of a web-based intervention for adolescents with type 1 diabetes. *Journal of Telemedicine and Telecare*. 2013; 19(8):443–9.10.1177/1357633X13512069 [PubMed: 24197399]
38. Nordqvist C, Hanberger L, Timpka T, Nordfeldt S. Health professionals' attitudes towards using a Web 2.0 portal for child and adolescent diabetes care: qualitative study. *Journal of Medical Internet Research*. 2009; 11(2):e12.10.2196/jmir.1152 [PubMed: 19403464]
39. Boogerd EA, Noordam C, Verhaak CM. The Sugarsquare study: protocol of a multicenter randomized controlled trial concerning a web-based patient portal for parents of a child with type 1 diabetes. *BMC Pediatrics*. 2014; 14:24.10.1186/1471-2431-14-24 [PubMed: 24472527]
40. Ekberg J, Ericson L, Timpka T, Eriksson H, Nordfeldt S, Hanberger L, et al. Web 2.0 systems supporting childhood chronic disease management: design guidelines based on information behaviour and social learning theories. *Journal of Medical Systems*. 2010; 34(2):107–17. [PubMed: 20433049]
41. Whittemore R, Grey M, Lindemann E, Ambrosino J, Jaser S. Development of an Internet coping skills training program for teenagers with type 1 diabetes. *Computers, Informatics, Nursing: CIN*. 2010; 28(2):103–11.10.1097/NCN.0b013e3181cd8199
42. Whittemore R, Jaser SS, Faulkner MS, Murphy K, Delamater A, Grey M, et al. Type 1 diabetes eHealth psychoeducation: youth recruitment, participation, and satisfaction. *Journal of Medical Internet Research*. 2013; 15(1):e15.10.2196/jmir.2170 [PubMed: 23360729]
43. Lewis ML, Hobday JV, Hepburn KW. Internet-based program for dementia caregivers. *American Journal of Alzheimer's Disease and other Dementias*. 2010; 25(8):674–9.10.1177/1533317510385812
44. JDRF. Statistics: JDRF and Diabetes. 2012

45. Lee JM, Rhee K, O'Grady MJ, Basu A, Winn A, John P, et al. Health utilities for children and adults with type 1 diabetes. *Medical Care*. 2011; 49(10):924–31.10.1097/MLR.0b013e318216592c [PubMed: 21544001]

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Ethical Statement

Neither the entire paper nor any of its content has been submitted, published, or accepted by another journal. The paper will not be submitted elsewhere if accepted for publication in *Health and Technology*. No data have been fabricated, manipulated or plagiarized. All co-authors have contributed sufficiently to this work. They and responsible authorities at Yale University consent to the submission of this manuscript.

Table 1

TeenCope Development

Criteria for TEENCOPE	Fulfillment	Rationale
Flexible website architecture	Microsoft Classic asp programmed using VbScript and Javascript. Microsoft SQL Server database. Website hosted on Microsoft Windows server. (2008) Personnel: Coordinator, graphic artist, web programmers, and technician for content transfer.	Creative user interface, lessons, interactive content including video animations, tailored feedback, and ability for users to interact with one another.
Five lessons: self-talk, stress, social problem solving, communication, conflict resolution	Content experts: 2 RN's with PhD, 2 clinical psychologists, and a family psychotherapist who had delivered group-based, in-person coping skills training. Pilot test: adolescents with T1D.	Weekly meetings to write content, develop characters, develop scenarios, create interactive activities.
Teen-centric graphic novel format	Illustration artist.	Content presented in a format appealing to adolescents.

Table 2

Managing Diabetes Development

Criteria for Managing Diabetes	Fulfillment	Rationale
Logical website architecture	Microsoft Classic asp programmed using VbScript and Javascript. Microsoft SQL Server database. Website hosted on Microsoft Windows server. (2008) Personnel: Coordinator and technician for content/picture transfer.	Progression through lessons, interactive content, and ability for users to get tailored feedback.
Five interactive lessons on glucose control, nutrition, exercise, sick days, and new technology	Content experts: 2 RN's with PhD, one RN, MSN, and one medical student. Content reviewers: other experts and adolescents with T1D.	Iterative process of writing content using clinic protocols and educational websites for youth with T1D.
Teen-centric program	Stock photos.	Content presented in a format appealing to adolescents.

Table 3

Development Costs

Category	Costs
Content experts	
Planning/writing TEENCOPE	\$197,995
Planning/writing Managing Diabetes	\$15,318
Content reviewers	\$30,196
Information Technology charges (e.g., website development, programming, inserting content and images)	\$71,980
Artwork	\$9,120
Total	\$324,609

Table 4

Program Maintenance Criteria

Criteria for TEENCOPE and Managing Diabetes	Fulfillment	Rationale
Security	Secure server with protection that met Yale University's stringent standards. Moderator (TEENCOPE).	HIPAA and study subject privacy protection. Assure safety of participants and accuracy of information shared.
Automated systems	Administrator monitored process and alerted web programmer of any problems.	Monitored lesson release, lesson completion, discussion board posts, and other pertinent information.
Rapid IT response to troubleshoot	Web programmer available to address problems.	Rapid troubleshooting of any technical issues with websites.
Domain name	Purchase of domain name.	Ownership of website address.