COMMENTARY

Technology Use for Problem Solving in Adolescent Type 1 Diabetes

Ling Hinshaw, MD, PhD, and Ananda Basu, MD, FRCP

DIABETES SELF-MANAGEMENT with active involvement of family members is a well-accepted, necessary, and integral part of diabetes therapy in adults^{1,2} and is also an important and emerging concept in adolescent patients with type 1 diabetes (T1D). Effective self-management has been shown to be positively associated with clinical outcomes in this group of patients.¹ However, self-management could be difficult because of the natural and evolving age-appropriate attitudes and biological factors in adolescent T1D patients. Studies have shown lack of self-discipline and management resulting in higher hemoglobin A1c (HbA1c), despite intensive assistance and guidance from their parents.^{2,3}

Technology, telemedicine, and social media use in diabetes care for adolescents includes the Internet, cell phone applications, and software such as Skype, Facebook, etc., involving data management and active feedback. A recent report⁴ applying social media has demonstrated improvement in glucose control (measured with HbA1c) within 6 months with sustained improvement at the end of a year in a group of adolescent children and young adults with T1D. The rapid expansion of these technologies for the treatment of diabetes is swiftly shifting the approach to patient care in adolescent T1D. These technologies provide them with effective and practical tools to solve therapeutic problems and improve their quality of care and life.⁵

To the best of our knowledge, however, there are no available robust statistics for the use of telemedicine approaches in adolescent T1D. In general, adolescents use 7 h 38 min of social media daily,⁶ 95% of American adolescents use the Internet, 74% of adolescents have their own computers, and 77% have mobile phones, with most of them texting every day.⁷ With this ready availability and use of the Internet and electronic tools, the field is ripe for exploitation of these tools for improving management of chronic diseases like T1D, especially in the adolescent population. Reports have demonstrated technology-related self-management, such as smartphone glucose applications,⁸ a computer-based consulting system,⁹ and sensor-augmented insulin pump therapy,¹⁰ to be an integral part of self-management of adolescent T1D.

Whether technology-based self-management improves hard diabetes-related outcomes such as HbA1c is controversial. In a randomized prospective study, Chase et al.¹¹ tested the hypothesis whether use of modern technologies improve clinical

outcomes in adolescent patients with T1D. In total, 70 subjects were randomized into control and modern technology intervention groups. The control group had standard care with quarterly clinic visits; the intervention group transmitted their blood glucose data every 2 weeks to clinics instead of visiting quarterly. After 6 months, both groups had similar blood glucose control, but costs were lower in the intervention group.¹¹ Several retrospective studies have demonstrated improvement of HbA1c using Internet-based interventions.^{12–14}

Nevertheless, there are two sides to the coin. If used excessively, technology tools may distract and detract from effective self-management. A few studies have shown that children who do not practice good self-control behaviors may need more guidance from parents and medical professionals.^{15,16} As reported in the current issue of *Diabetes Technology & Therapeutics*, Kumah-Crystal et al.¹⁶ examined the role of technology use for problem solving in adolescents with T1D and its relationship to HbA1c in 112 patients at a large tertiary-care medical center using mobile applications, social technologies, and glucose software with a new Technology Use for Problem Solving (TUPS) scale. Hierarchical regression methods were applied to determine the relationship of technology to diabetes control.

The primary aim of this study was to assess the use of modern technologies while identifying the relationship between frequency of use of these applications and glycemic control. The logical hypothesis tested was that the HbA1c level would be negatively correlated with technology use. However, the authors concluded that their results indicate a “counterintuitive relationship” between higher use of technologies for problem solving and higher HbA1c level, thus implying that an adolescent with poorer glycemic control may use technologies in a “reactive” rather than a proactive or preventive manner. The sample size was adequate, and subjects were representative. Problem-solving skills, a surrogate of self-management of diabetes, were scored by a new TUPS scale, so that self-management could be quantitated reliably. This was confirmed based on Cronbach’s α reliability index of 0.78. When the relationship between each technology used and glycemic control was explored, none of the applications was significantly related to HbA1c. Furthermore, the final model R^2 was only 0.23 for modeling HbA1c. Although statistically significant ($P < 0.001$), only

23% variance of HbA1c was explained by the socioeconomic status, Diabetes Adolescent Problem Solving Questionnaire, and TUPS, with the former two variables negatively correlated, whereas TUPS positively correlated, with HbA1c.

This study raises several important issues that include but are not limited to the following: First, technology can only achieve so much and cannot replace the fundamental and *individual* will, motivation, and effort to improve glucose control. Second, adolescents who already practice excellent self-management may not need technical tools. Third, in contrast, those with poor glucose control may not be invested enough in their diabetes management, hence using these tools reactively rather than proactively. Additional significant limiting factors that are mentioned in the article include the cross-sectional nature of the study and the use of a single HbA1c value at a point in time closest to the survey completion. The cross-sectional design of the study precluded comparison between adolescents with Internet access and those without Internet access. As a consequence, the conclusion drawn that unguided use of available tools had a negative relationship with glycemic control needs to be further evaluated. Evidence-based studies that are focused on association between improvement in outcomes such as HbA1c and use of technology-related diabetes self-management are lacking.¹⁷ Future prospective, randomized, and controlled studies are needed to evaluate the association of technology use and clinical outcomes in adolescents with T1D. Furthermore, it might be more reasonable that stratification of subjects into groups with high, medium, and low technology would facilitate the problem-solving use score for detailed regression analysis.

In summary, incorporation of modern technologies into self-management in adolescent T1D, as well as its relationship to both short-term (such as HbA1c) and long-term (diabetic complications) outcome variables, needs to be assessed. When technologies are applied in this cohort of patients, the practice of self-management, the nature of the technology itself, and the availability of guidance from parents and family members and support from medical staff such as youth camps for appropriate patient education also need to be assessed. Perhaps the most important lesson from this study is the inference that technology use may have to be individualized for a given patient, and hence be focused and need-based. One should not apply a “shot-gun” all-encompassing approach, as far as technology use is concerned, to any individual patient with T1D, perhaps even more so in the adolescent age group.

Acknowledgments

Funding was obtained from grants DK 085516 and DK 094331 from the National Institutes of Health.

Author Disclosure Statement

No competing financial interests exist.

References

1. Lombardo F, Salzano G, Messina MF, et al.: How self management therapy can improve quality of life for diabetic patients. *Acta Biomed* 2003;74(Suppl 1):26–28.
2. Markowitz JT, Garvey KC, Laffel LM: Developmental changes in the roles of patients and families in type 1 diabetes management. *Curr Diabetes Rev* 2015 April 21 [Epub ahead of print].
3. Helgeson VS, Snyder PR, Seltman H, et al.: Brief report: trajectories of glycemic control over early to middle adolescence. *J Pediatr Psychol* 2010;35:1161–1167.
4. Petrovski G, Zivkovic M, Stratova SS: Social media and diabetes: can Facebook and Skype improve glucose control in patients with type 1 diabetes on pump therapy? One-year experience. *Diabetes Care* 2015;38:e51–e52.
5. Vanelli M, Corchia M, Iovane B, et al.: Outside-hospital assistance for children and adolescents with type 1 diabetes mellitus. *Acta Biomed* 2006;77:163–167.
6. Rideout JV, Foehr UG, Roberts DF: Generation M2: Media in the Lives of 8- to 18-Year-Olds. 2010. <http://kff.org/other/poll-finding/report-generation-m2-media-in-the-lives/> (accessed May 21, 2015).
7. Dougherty JP, Lipman TH, Hyams S, et al.: Telemedicine for adolescents with type 1 diabetes. *West J Nurs Res* 2014; 36:1199–1221.
8. Carroll AE, DiMeglio LA, Stein S, et al.: Using a cell phone-based glucose monitoring system for adolescent diabetes management. *Diabetes Educ* 2011;37:59–66.
9. Becker A, Herzberg D, Marsden N, et al.: A new computer-based counselling system for the promotion of physical activity in patients with chronic diseases—results from a pilot study. *Patient Educ Counsel* 2011;83:195–202.
10. Cemeroglu AP, Stone R, Kleis L, et al.: Use of a real-time continuous glucose monitoring system in children and young adults on insulin pump therapy: patients’ and caregivers’ perception of benefit. *Pediatr Diabetes* 2010;11:182–187.
11. Chase HP, Pearson JA, Wightman C, et al.: Modem transmission of glucose values reduces the costs and need for clinic visits. *Diabetes Care* 2003;26:1475–1479.
12. Ng SM, Finnigan L, Connellan L, et al.: Improving paediatric diabetes care with the use of an integrated paediatric electronic diabetes information management system and routine uploading of blood glucose meters and insulin pumps in outpatient clinics. *Arch Dis Child* 2014;99:1059.
13. Harris MA, Hood KK, Mulvaney SA: Pumpers, skypers, surfers and texters: technology to improve the management of diabetes in teenagers. *Diabetes Obes Metab* 2012;14:967–972.
14. d’Annunzio G, Bellazzi R, Larizza C, et al. Telemedicine in the management of young patients with type 1 diabetes mellitus: a follow-up study. *Acta Biomed* 2003;74(Suppl 1):49–55.
15. Belanger RE, Akre C, Berchtold A, et al.: A U-shaped association between intensity of Internet use and adolescent health. *Pediatrics* 2011;127:e330–e335.
16. Kumah-Crystal YA, Hood KK, Ho Y-X, et al.: Technology use for diabetes problem solving in adolescents with type 1 diabetes: relationship to glycemic control. *Diabetes Technol Ther* 2015;17:449–454.
17. Sheehy S, Cohen G, Owen KR: Self-management of diabetes in children and young adults using technology and smartphone applications. *Curr Diabetes Rev* 2014;10:298–301.

Address correspondence to:

Ananda Basu, MD, FRCP

5-194 Joseph

Endocrine Research Unit

Division of Endocrinology and Metabolism

Mayo College of Medicine

Rochester, MN 55905

E-mail: basu.ananda@mayo.edu