Holistic Impact of Closed-Loop Technology on People With Type 1 Diabetes

Journal of Diabetes Science and Technology
2015, Vol. 9(4) 932–933

DOI: 10.1177/1932296815580162
dst.sagepub.com
SAGE

Amanda J. Young, MSc, BSc[1], Hood Thabit, MB BCh, MRCPI, MD[2], Simon R. Heller, BA, MB, BChir, DM, FRCP[3], Mark L. Evans, MD, FRCP[2], Stephanie A. Amiel, BSc, MD, FRCP[4], Roman Hovorka, PhD[2], and Katharine D. Barnard, PhD, CPsychol, AFBPsS[5]

Keywords
artificial pancreas, closed-loop technology, continuous glucose monitor, psychosocial impact, HbA1c

The artificial pancreas (closed-loop insulin delivery) is a potentially exciting technological advance in diabetes. Using a continuous glucose monitor (CGM) and a control algorithm to modulate insulin delivery by a subcutaneous insulin infusion (CSII) pump, preliminary results from non-hospital settings look promising.[1-5] Understanding the biomedical and psychological impact of these systems is crucial if it is to be a viable therapy choice for people with type 1 diabetes (T1DM).

Recent research has explored the holistic impact of closed-loop technology overnight in the home setting.[4,5] Here we report 3 case studies from new research[1] demonstrating the impact, benefits and challenges experienced by adults in a closed-loop trial used overnight at home for 1 month.

For a 33-year-old male, T1DM diagnosis aged 8 (CSII-5 years), HbA1c 8.6% (71 mmol/mol), BMI 30.6 kg/m^2, time spent overnight during closed-loop with normal glucose (3.9 - 8.0 mmol/l) increased by 34% compared to control (real-time CGM combined with CSII) (average glucose level overnight 2.3 mmol/l lower). The experience was "life-changing." The closed-loop system provided a novel sense of security and confidence, and feeling like "a better version of myself." Night-time hypoglycemia, which had been a major concern, was reportedly eliminated. Feeling safe at night on closed-loop, this participant reported a "sense of loss" when it ended. Similar experiences were reported by other participants: cessation of night-time hypoglycemia and improved sleep, leading to improved daytime diabetes control and greater peace of mind.

For a 32-year-old female, T1DM diagnosis aged 15 (CSII-10 years), HbA1c 8.5% (69 mmol/mol), BMI 26.9 kg/m^2, time spent with normal glucose levels overnight increased from 48% to 56% during closed-loop (average glucose level 0.5 mmol/l lower), without increasing time spent hypoglycemic. The participant explained that closed-loop enabled her to better perform at work, provided greater flexibility, and had a positive impact waking up on a "good" number. She described her experience as "the best control I've had for several years," although getting used to the equipment took some time.

For a 30-year-old male, T1DM diagnosis aged 10 (CSII-8 years), HbA1c 7.2% (55 mmol/mol), BMI 27.2 kg/m^2, during closed-loop, time spent euglycemic overnight increased by 12% (average glucose 8.0 vs 9.2 mmol/l). This participant experienced a number of technological difficulties at the beginning, which were described as "intensely irritating," especially the design of the pump. Although once on closed-loop he explained how it "kind of takes some weight off your mind." All participants reported technological challenges such as system portability, frequent alarms, and poor device connectivity.

These data provide unique insight into the experience of participants using closed-loop technology. Closed-loop was associated with improved blood glucose control and psychosocial functioning. Greater control over diabetes was commonly reported, more broadly than blood glucose control. Benefits included "time off" from thinking about diabetes constantly, feelings of "normality," and increased flexibility. The participants had trust in the algorithm during overnight infusion of insulin. However, downsides were commonly reported with hardware (pump and sensor).

[1]National Institute for Health Research, Evaluation, Trials and Studies Coordinating Centre, Southampton, UK
[2]Wellcome Trust/MRC Institute of Metabolic Science, Cambridge, UK
[3]Department of Human Metabolism, Sheffield, UK
[4]King's College London, London, UK
[5]Human Development and Health Academic Unit, Southampton, UK

Corresponding Author:
Amanda Young, MSc, BSc, National Institute for Health Research, Evaluation, Trials and Studies Coordinating Centre (NETSCC), University of Southampton, Alpha House, Enterprise Road, Southampton, SO16 7NS, UK.
Email: A.J.Young@southampton.ac.uk

Next-generation technology may improve participants' experiences and acceptability further.

Abbreviations

BMI, body mass index; CGM, continuous glucose monitor; CSII, continuous subcutaneous insulin; HbA1c, glycosylated hemoglobin; T1DM, type 1 diabetes mellitus.

Acknowledgments

The authors are grateful to the study volunteers for their time and participation.

Declaration of Conflicting Interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: AJY, HT, and SAA declare no conflicts of interest. SRH reports speaker honoraria from Eli Lilly, Novo Nordisk, serving on advisory panels for Eli Lilly, NovoNordisk for which his institution has received remuneration and receiving research support from Medtronic. MLE has received speaker honoraria from Roche, Animas, Ypsomed, Abbott Diabetes Care, Eli Lilly, NovoNordisk; served on advisory panels for Roche, Medtronic, CellNovo; and holds stock options in CellNovo. RH reports having received speaker honoraria from Minimed Medtronic, Lifescan, Eli Lilly, BBraun, and Novo Nordisk, serving on advisory panel for Animas, Minimed Medtronic, and Eli Lilly, receiving license fees from BBraun and Beckton Dickinson, and having served as a consultant to Beckton Dickinson, BBraun, Sanofi-Aventis, and Profil. KDB reports having received speaker honoraria from Roche Diagnostics, Lifescan, Novo Nordisk, and Animas and serving on global advisory board for Roche and as a consultant to Sanofi-Aventis.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: Supported by Diabetes UK (BDA07/0003549), Juvenile Diabetes Research Foundation (#22-2006-1113, #22-2007-1801, #22-2009-801, #22-2009-802), and National Institute for Health Research Cambridge Biomedical Research Centre. Abbott Diabetes Care supplied continuous glucose delivery devices and sensors and modified devices to facilitate real-time connectivity.

References

1. Thabit H, Lubina-Solomon A, Stadler M, et al. Home use of closed loop insulin delivery improves overnight glucose control in adults with type 1 diabetes: a four-week multicentre randomised crossover study. *Lancet Diabetes Endocrinol*. 2014; 2:701-709.
2. Hovorka R, Elleri D, Thabit H, et al. Overnight closed-loop insulin delivery in young people with type 1 diabetes: a free-living, randomized clinical trial. *Diabetes Care*. 2014;37: 1204-1211.
3. Thabit H, Hovorka R. Bringing closed-loop home: recent advances in closed-loop insulin delivery. *Curr Opin Endocrinol Diabetes Obes*. 2014;21(2):95-101.
4. Barnard KD, Wysocki T, Allen JM, et al. Closing the loop overnight at home setting: psychosocial impact for adolescents with type 1 diabetes and their parents. *BMJ Open Diabetes Res Care*. 2014;2:e000025. doi:10.1136/bmjdrc-2014-000025.
5. Barnard KD, Wysocki T, Thabit H, et al. Psychosocial aspects of closed-loop and open-loop delivery: closing the loop in adults with type 1 diabetes in the home setting [published online ahead of print January 23, 2015]. *Diabetes Med*. doi:10.1111/dme.12706.