

# Navigating the Unique Challenges of Automated Insulin Delivery Systems to Facilitate Effective Uptake, Onboarding, and Continued Use

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## Abstract

Advances in diabetes technologies have enabled automated insulin delivery (AID) systems, which have demonstrated benefits to glycemia, psychosocial outcomes, and quality of life for people with type 1 diabetes (T1D). Despite the many demonstrated benefits, AID systems come with their own unique challenges: continued user attention and effort, barriers to equitable access, personal costs vs benefits, and integration of the system into daily life. The purpose of this narrative review is to identify challenges and opportunities for supporting uptake and onboarding of AID systems to ultimately support sustained AID use. Setting realistic expectations, providing comprehensive training, developing willingness to adopt new treatments and workflows, upskilling of diabetes team members, and increasing flexibility of care to tailor care to individual needs, preferences, lifestyle, and personal goals will be most effective in facilitating effective, widespread, person-centered implementation of AID systems.

## Keywords

automated insulin delivery, type 1 diabetes, education, health care delivery, psychosocial

## Introduction

The current landscape of diabetes management includes tools that are unlike anything previously offered, as diabetes technologies become more automated, widespread, and recommended as standard care. Diabetes technologies (insulin pumps or continuous subcutaneous insulin infusion [CSII] and continuous glucose monitoring [CGM]), previously able to be used only in isolation, now utilize advanced features to function as a unit: the automated insulin delivery (AID) system. Automated insulin delivery systems have demonstrated substantial benefits for short- and long-term health outcomes. Randomized controlled trials (RCTs) and real-life observational studies have linked AID system use with a reduction in HbA<sub>1c</sub> levels and a corresponding increase in time in range (TIR) across the lifespan: among infants, children, adolescents, adults, and pregnant individuals with diabetes.<sup>1-7</sup> Automated insulin delivery systems have further demonstrated safety for those at increased risk of hypoglycemia<sup>8</sup> with reductions in severe hypoglycemia and ketoacidosis.<sup>5</sup>

Automated insulin delivery systems have also demonstrated benefits to quality of life.<sup>9</sup> Automated insulin delivery users and parents of children using AID report improved sleep due to reductions in overnight alarms and increased

TIR overnight.<sup>10-12</sup> Positive effects of using an AID system have been observed for several diabetes-related person-reported outcomes (PROs) including diabetes-specific quality of life, treatment satisfaction, treatment self-efficacy, hypoglycemia fear, diabetes distress, and family conflict.<sup>4,9,10,13-16</sup>

Yet, even the most advanced technologies are not without their challenges to access, use, and integrate into one's life. Automated insulin delivery systems are not hands-off. Individuals living with type 1 diabetes (T1D) must still engage in daily self-management and navigate the associated

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diabetes-specific behavioral, emotional, and psychosocial burdens that AID systems do not eliminate from the lived experience of diabetes. Automated insulin delivery systems demand user effort and interaction to be effective, requiring users to maintain and troubleshoot 2 active devices, count and enter carbohydrates, and announce exercise. Management-related challenges evolve for people with T1D as treatment technologies advance. It will be important to develop targeted ways to support people with T1D in these challenges so that more people may experience the benefits that come with uptake and sustained use of advanced technologies. To this end, the goals of this narrative review are to (1) describe emerging challenges to supporting the uptake and onboarding of AID systems; (2) explore existing efforts and recommendations to promote effective uptake and onboarding to support optimal, continued use of AID systems; and (3) to present future directions to support more widespread person-centered AID use in both clinical and research settings.

### Challenges in Uptake and Onboarding of Automated Insulin Delivery Systems

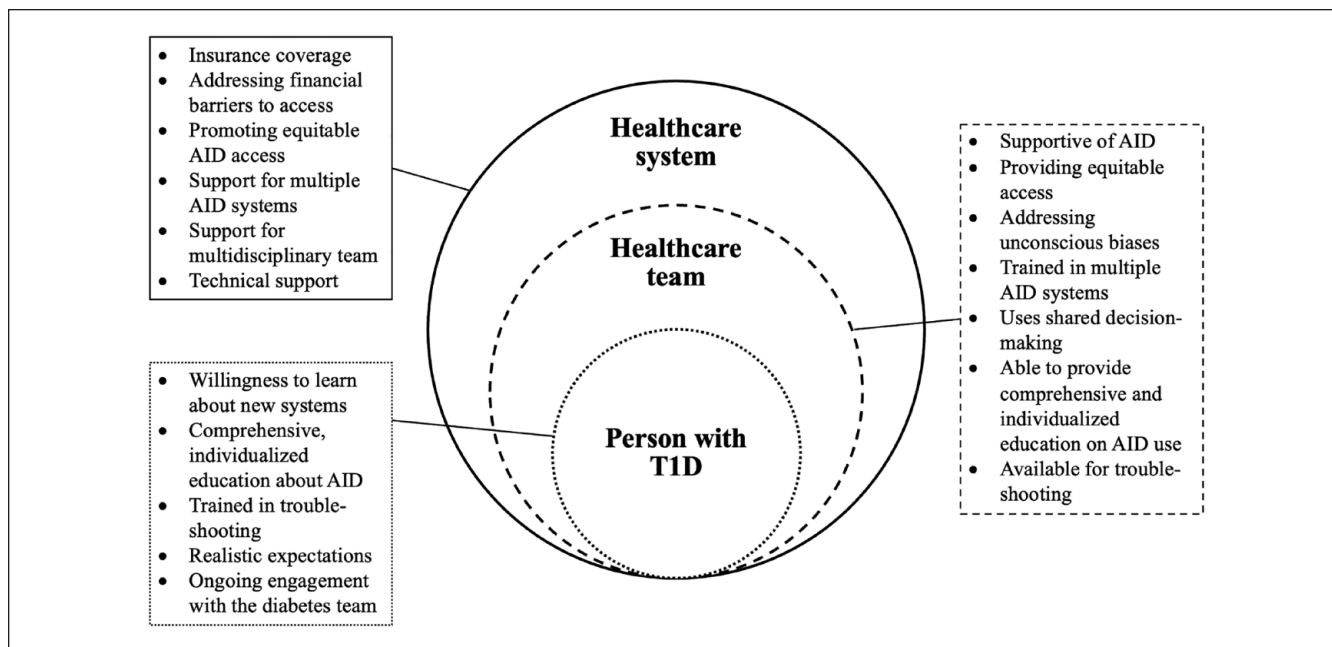
As of 2023, around 1 million people had adopted AID systems, a small fraction of the >530 million with diabetes worldwide.<sup>17</sup> Several factors influence adoption of AID, including those related to the *opportunity and equity*, *accessibility*, and *perceived value*.<sup>18</sup> Although this review will focus on the latter two categories, it is important to acknowledge that AID systems are not readily available to all people with T1D, limiting *opportunity and equity*. Social determinants of health (SDOH), societal factors, and inequity within the health care system impact AID adoption and use. A key challenge in understanding how to best support AID uptake and use is in our ability to serve a more heterogeneous population of people with T1D. Participants in clinical trials have not always been representative of the larger population with T1D.<sup>19</sup> Understanding the unique barriers to AID use for marginalized or underserved groups is necessary to promote widespread, equitable access and sustained use. Furthermore, the structural inequities within the health care system impact AID uptake. For example, insurance coverage and reimbursement are key factors which can influence AID uptake, given that cost and insurance coverage have been cited as the biggest barriers to diabetes technology uptake.<sup>20</sup> The “cost” of opting to use diabetes technology extends beyond finances to include costs to time, society, and relationships as major considerations of technology uptake and continued use.<sup>21</sup>

Outside of systemic barriers, people still face barriers in *accessibility*. Health care providers (HCPs) can serve as gatekeepers to technology access, either intentionally or inadvertently. Health care providers may lack sufficient education and training needed to AID uptake and onboarding and may not offer it to their patients. The recent JDRF

Pathway to Choice survey, which aimed to increase knowledge of and access to T1D technologies, reported a leading barrier to device uptake as: “My clinician/nurse has not recommended it to me.”<sup>22</sup> Furthermore, HCPs may hold attitudes and concerns about diabetes technology and prerequisites for system users that may influence their decision to offer it to people living with diabetes, even when not evidence-based.<sup>23</sup> For example, those who struggle with carbohydrate counting have traditionally not been viewed as “ideal” candidates for AID; however, evidence has demonstrated that simplified bolusing strategies can lead to benefits from AID for these individuals.<sup>24</sup> Similarly, some HCPs may feel that newly diagnosed individuals should learn the basics of diabetes management first before adopting AID; this assumption has been contradicted by RCT evidence of AID benefits for new-onset T1D.<sup>25</sup> Finally, HCP implicit bias regarding race, ethnicity, and/or insurance type (public versus private) has been shown to play a role in decision-making about offering diabetes technology.<sup>26</sup>

The *perceived value* of AID for the person living with T1D may have a number of valid usability-related concerns about AID that affect uptake and utilization, such as wearability, pain or skin irritation, physical appearance, unwanted social attention, trust, accuracy, and other concerns.<sup>27-31</sup> Using an AID system requires wearing both a CGM and insulin pump on the body, and any challenges with continually wearing or using either device would negatively affect attitudes toward adoption or continued use of AID systems.<sup>28</sup> Pain, skin reactions, site failures, and devices falling off early due to adhesive issues are critical to address and manage for someone to be willing to adopt and continue to use the two devices required for an AID system.<sup>32-35</sup> Furthermore, uptake and onboarding onto a new AID system may demand more time and attention for T1D, at least in the short term, given the potentially time-consuming process of initially obtaining supplies and then learning to use an AID system. Some people with T1D may be reluctant to put their trust in an algorithm to make insulin-dosing decisions due to worries and concerns over CGM inaccuracy and potential negative outcomes. Automated insulin delivery systems are not “plug-and-play”<sup>36</sup>; system users still need to be willing to count carbohydrates, announce physical activity, deliver insulin boluses, address hypo- and hyperglycemia, change infusion sets, carry back-up supplies, and monitor the system to be able to detect issues such as site failures. These burdens may feel costly to those considering adopting AID for their diabetes management. In fact, discontinuation has been documented in past systems due to several factors relating to frustration with operating the system, including burden of alarms and the time-consuming nature of keeping the system working.<sup>37,38</sup>

Finally, given the number of options available today which may differ in functions, wear time, cost, insurance coverage and algorithms, choosing a system may present an



**Figure 1.** Elements for supporting the effective use of AID systems for the person with T1D, the health care team, and the health care system.

added burden; more research is needed around device decision-making given the emerging nature of this barrier. Lack of access to relevant, timely information and education to enable informed decision-making is an additional barrier to uptake for individual users.

### Supporting Automated Insulin Delivery Uptake and Onboarding to Promote Sustained Use

There are a wide variety of barriers to AID use, and people with T1D may experience any combination of these challenges in the present era. By supporting person-centered decision-making in uptake, health care teams may be able to promote sustained and effective use of AID systems going forward. In Figure 1, we present recommendations for the *health care system*, the *health care team*, and the *person with T1D* for effective implementation of AID systems, with a focus on the latter two categories.

#### Promoting Equitable Access Within the Health Care System

In the context of the *health care system*, greater support for insurance coverage and reimbursement for AID systems will be a critical prerequisite to promoting greater uptake and acceptance of this technology.<sup>17</sup> A promising recent development is that in response to the wealth of RCT data and a real-world evaluation of outcomes associated with AID,<sup>38,39</sup> the UK National Institute for Clinical Excellence (NICE)

deemed AID a cost-effective intervention. Furthermore, the American Diabetes Association (ADA) Standards of Care now advise that AID systems “should be offered for diabetes management to youth and adults with type 1 diabetes . . . who are capable of using the device safely (either by themselves or with a caregiver).”<sup>40</sup> The German health care system also now recommends AID system initiation at diagnosis.<sup>41</sup> To ensure that AID access is equitable, more research will be needed to understand the specific challenges for uptake and ongoing use in marginalized groups (eg, those from deprived backgrounds, with language barriers, learning difficulties, with frailty, eating disorders or mental health challenges). This work will be crucial in current and future attempts to embrace AID systems as a tool in overcoming SDOH that have historically negatively impacted diabetes management.

#### Upskilling Health Care Teams

Wide rollout of AID will require buy-in from *health care teams* working with people living with T1D. The recent international consensus statement on AID use recognized the importance of ensuring equitable access through addressing health care professionals’ unconscious biases about individual, family, and psychological attributes required to use AID.<sup>5</sup> Furthermore, qualitative work has identified the need for training, mentorship, expert advice, and access to 24-hour technical support to upskill HCPs with less familiarity with the technology.<sup>42</sup> Furthermore, HCPs need training on multiple AID systems, how to interpret system data, how to adjust and optimize settings, and how to deliver AID-based

T1D care in a standardized way.<sup>42,43</sup> Beyond this, HCPs also need training in navigating finances related to AID use, psychosocial challenges, and more.<sup>44</sup> Given the benefits of AID in pregnancy, HCPs will also need specialized training on the use during the antenatal and postnatal periods. Wider use in pregnancy will need upskilling of providers and staff and timely access to technical support.<sup>45</sup> Importantly, many of the reviewed barriers related to health care teams and people with T1D emphasize psychosocial or behavioral challenges to AID use. Thus, it requires HCPs to participate in psychoeducation around AID use in addition to an information-focused approach. Psychoeducational topics may include psychosocial challenges to effective AID use, efforts to understand the life context of the person with diabetes, the need for balanced patient education, motivational interviewing skills, and effective communication techniques when interpreting data (eg, strengths-based language, avoidance of blame and shame).

### *Individualized Automated Insulin Delivery System Selection for Each Person Living With Type 1 Diabetes*

Increased attention toward individual concerns, preferences, and priorities of the *person living with T1D* is imperative for effective uptake and onboarding which leads to sustained use. Shared decision-making between HCPs and people with T1D will be an important element of promoting effective uptake and ongoing use. Older adults, for example, may have specific concerns related to visual impairment or dexterity, and it is important that individual needs and preferences are addressed when selecting diabetes devices.<sup>46,47</sup> Given the unique features of each AID system, people with T1D may consider other important aspects of the system that would benefit their lives, including size, tubing, insertion process, mobile phone compatibility, comfort, alert sounds, integration into activity routines, and more. These options allow individuals to identify features that not only help them to manage diabetes, but to reduce the bodily, emotional, mental, and social burdens of diabetes. Recent work has suggested a focus on personalized treatment options when considering diabetes technologies, with HCPs assisting people with diabetes in identifying the features, glycemic goals, affordability, preferences, support services, and limitations that would be the best fit for the individual.<sup>48</sup> People with T1D will naturally engage in their own personal cost-benefit analysis prior to and during device use<sup>49</sup>; diabetes management already requires significant effort and attention, and people affected must ensure that new treatment options are beneficial to them. Online resources such as DiabetesWise and DTN-UK have aimed to address this critical gap by providing information about available device options and associated benefits of AID.<sup>50,51</sup> The reduced burden from AID combined with support for

the choice of system to meet individual needs will hopefully support ongoing, long-term use.

### *Balancing Standardized and Tailored Onboarding Education*

International consensus has determined the need for “a rigorous, comprehensive, consistent, and structured education curriculum for all AID systems.”<sup>5</sup> AID onboarding programs should both contain standard elements and be tailored to each individual user, as onboarding needs will differ depending on each person’s T1D management regimen prior to AID initiation, comfort with new technology, and other factors. For example, someone who is already using an insulin pump and CGM may require less training than someone who is newly diagnosed, or is new to CSII and/or CGM.<sup>5</sup>

Automated insulin delivery clinical training programs conducted to date have been delivered over multiple formats (eg, in-person, video conference, phone calls) and provide initial education and ongoing support (eg, for adjustments to insulin dosing).<sup>52,53</sup> Components of onboarding education programs include instruction on how the system works and expectation-setting; benefits of AID; setting up the system; bolusing, hypoglycemia, and correction doses in the context of AID; responding to alerts; and troubleshooting the system.<sup>52,53</sup> Realistic expectations at onboarding and beyond may facilitate ongoing use of the system, as people better understand how it will function in various situations and the degree of effort required from them. Those with unrealistic expectations may experience disappointment, frustration, or discontinuation of AID.<sup>29</sup> Furthermore, new adopters of AID may benefit from guidance on customizing alerts and alarms to fit with their personal priorities and lifestyle and to balance safety considerations while minimizing the potential for developing alarm fatigue.<sup>36</sup> Because physical activity is recommended for people with T1D to benefit cardiovascular and overall health, AID onboarding education ought to incorporate strategies for optimizing the AID system for exercise (both planned and unplanned).<sup>54</sup> Effective AID education may need to be split up into multiple visits, particularly if delivering onboarding support to newly diagnosed individuals.<sup>42</sup>

Finally, there are also circumstances that may require further detailed and unique training. For example, AID use during pregnancy may require specific ongoing education and support to optimize settings as insulin requirements increase with gestation, in an attempt to maintain >70% time in the pregnancy glucose target range.<sup>55,56</sup> More research is needed to develop onboarding and continuing resources for effective AID use leading up to, during, and after pregnancy. Furthermore, more tailored resources may be beneficial and may need further research and development, for AID onboarding support in other specific contexts such as in people who experience fear of hypoglycemia; parents of very young children, and other situations.



## Support for Continuous Use of Automated Insulin Delivery Systems

For many users, a challenge of sustained diabetes technology use is identifying ongoing benefit during different points in their life. As technology options and capabilities advance, user expectations may expand beyond solely glycemic benefits to include psychosocial or person-specific benefits. The AID users will benefit from continued, flexible, and adaptable support from their HCPs in the face of changing life demands and new technological developments.

Challenges with engaging in AID require validation and exploration from HCPs. In some cases, further education and support may be necessary throughout the duration of technology use. For example, additional AID-specific support may be needed during key developmental transitions such as when adolescents take over diabetes management responsibilities from parents. A qualitative analysis identified five psychological constructs to include in positive psychology interventions to help adolescents adjust to AID systems: knowledge and education, identity and sense of responsibility, positive affect and gratitude, social support, and trust in the system.<sup>57</sup> The involvement of a multidisciplinary team and, in particular, behavioral health providers with expertise in diabetes, is particularly valuable for both AID support and overall diabetes care. Others may encounter challenges with age or new life demands where their prior AID routine no longer works for them. The HCPs need to discuss these issues in detail and assist in problem-solving these situations, to help the individual once again utilize AID in a way that is perceived as more beneficial than burdensome. Ongoing access to support and education around troubleshooting system issues is necessary,<sup>58</sup> as this may reduce burden and empower people with diabetes to feel they can manage their AID system, thus avoiding burnout around system use. The HCPs may be able to better identify and address AID challenges through repeated, holistic assessment of needs in managing diabetes, adapting recommendations over the lifespan, offering support for gaps in care, and working with the person with T1D to provide specific skills or knowledge needed to better engage in management.<sup>46</sup> Challenges with AID use may not always be reflective of the AID system itself, but rather, of an individual's own preferences, priorities, and stressors at that point in their lives.

Finally, although AID systems offer both glycemic and psychosocial benefit for many, we cannot assume they are the right "fit" for everyone at any point in time. A recent review of the psychological implications of AID systems identified a variety of reasons for discontinued use, including device-specific frustrations (eg, wear or accuracy issues), supply issues, discouragement with the system, greater workload than anticipated, life intrusions, and other life stressors.<sup>59</sup> If AID challenges cannot be resolved with education, support, and problem-solving, it is imperative that HCPs respect the individual's decision to take a break from

their AID system. The HCPs ought to support a range of diabetes treatment options and to privilege the perspective and preferences of the person living with T1D who knows their health, barriers, and resources best. For some, a break from devices may serve as a needed respite before they restart. For others, discontinuation may feel like the best option until they can resolve the other challenges or demands getting in the way of use.

## Conclusion

Current AID systems are a major milestone in the pathway to improving health outcomes and quality of life for people with T1D. However, barriers to uptake, onboarding, and sustained use remain. A multisystemic approach that addresses the gaps in the health care system and health care team and provides individualized support to the person with T1D is likely the most effective way to promote widespread, equitable, effective, and sustained use of AID systems. Efforts to facilitate a positive experience with uptake and onboarding will likely support continued use; more research is needed to develop high-quality, evidence-based programs to support AID uptake, onboarding, and continued use that can be tailored to individual needs. Comprehensive, balanced education, realistic expectations, a teamwork approach between the person with T1D and their HCP, and adaptive, ongoing support are needed for both HCPs and people with T1D. The individual experiences and needs of people who take responsibility for their diabetes 24/7/365 should be the focus of a holistic approach to diabetes care with AID systems.

## Abbreviations

AID, automated insulin delivery; CGM, continuous glucose monitoring; CSII, continuous subcutaneous insulin infusion; HbA<sub>1c</sub>, glycated hemoglobin A1c; HCP, health care provider; PRO, person-reported outcomes; RCT, randomized controlled trial; TIR, time in range; T1D, type 1 diabetes

## Declaration of Conflicting Interests



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