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CARDI•OH
Ohio Cardiovascular and Diabetes Health Collaborative

Using Technology to Improve Medication Adherence for Cardiometabolic Disorders

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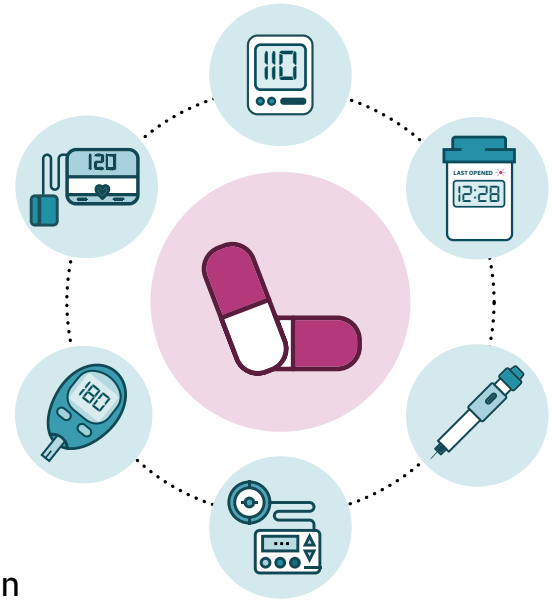


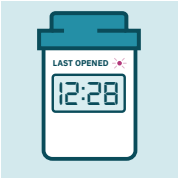
Medication adherence is the extent to which a person's medication-taking behavior corresponds with agreed upon treatment recommendations from a health care provider.[1]

Medication nonadherence has been defined as taking either less than 80% or more than prescribed doses.[2] An estimated 30% to 50% of medications for chronic diseases are not taken as prescribed,[3-5] and this can result in needlessly escalated treatments, potential harm to patients, and increased health care costs.[6] In the treatment of cardiometabolic disorders, nonadherence is a significant problem.[7-9]

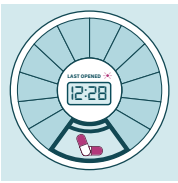
Five dimensions of medication adherence are widely recognized as contributing factors: patient-related, medication-related, condition-related, health care system/health care provider-related, and socioeconomic.[10] Nonadherence is associated with internal and external factors, including regimen complexity, polypharmacy, cognitive and functional decline, cost and access, inadequate social support, and lack of needed assistance in taking medication.[11,12]

It can be difficult for providers to recognize nonadherence, and interventions can be time-intensive with mixed results.[1,13,14] Non-technological behavioral and educational interventions have been shown to improve medication adherence compared with usual care.[11] Digital technologies, such as devices and mobile health applications (apps), can provide medication reminders, track medication use, and increase patients' understanding of how to manage chronic health conditions. When selected and implemented in close collaboration with patients, these technologies have the potential to improve patients' health-related knowledge and medication-taking behaviors, thereby improving adherence.[15]

Types of Tools Available



- **Smart pill bottles**[10,16] track when medications are taken and send reminders to patients when it is time to take the next dose. Some models can send alerts to caregivers or health care providers if medication doses are missed.
  - **Medication Event Monitoring System (MEMS):** uses electronic caps on medication bottles to record date and time when the pill bottle is opened.[17]
  - **Smart blister packaging:** medication packaging, similar to regular adherence packaging but records dates and times when doses are taken.



- **Electronic pill dispensers** dispense medications at specific times and can be programmed to send reminders to patients when it is time to take medications. Features may include recording the date and time when the container was opened, visual/audible alerts[18] alerting a caregiver of missed doses, or custom messaging. Some devices combine the dispenser functions with fall detection alerts and emergency alerts. Caregiver subscription to an online app may be required. Some systems work with pharmacies to fill and track medications.[19-21]

- **Smart Sharps Bins™** use sensors to monitor used syringes and needles being deposited into the sharps container. The bins may include visual/audible reminders or even work online to help track and manage injectable medications.[22] This type of "smart" container may help to monitor patient compliance with self-injection of medication, a critical part of older adult self-care and caregiving.

- **Smart insulin pens** are reusable insulin pens or devices (e.g., pen caps, buttons) available only by prescription that are connected online to help calculate medication dosage and track times of injections in patients taking multiple daily doses of insulin. Some pens offer dose calculation based on settings (e.g., carbohydrate ratio and correction factor) programmed by the health care provider. Newer smart pens are connected to continuous glucose monitoring systems (CGMs) and reports can be viewed on a phone or electronic device. Health care providers can download reports to help with reprogramming dose adjustments based a patient's glucose patterns.[23] It has been reported that smart pens and pen caps improve medication adherence and improve patient confidence with insulin dosing.[24,25] See Appendix, Table 1 for examples.

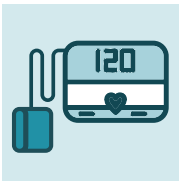
- **Glucose measuring devices** consist of a minimally invasive subcutaneous interstitial glucose sensor connected to a transmitter that is worn on the body.[26,27] The transmitter sends glucose readings to a receiver (a reader or online app), which translates the interstitial glucose to a blood glucose and is viewable by the wearer. These devices (e.g., Dexcom G6 and G7, FreeStyle Libre 2 and 3, Eversense®) show the patient sensor readings every 1 to 5 minutes, 24 hours per day, allowing the patient and provider to evaluate the glucose response to various meals, snacks, physical activity, stress, and illness. CGM use is associated with lower HbA1c, improved percentage of time in range (defined as 70 mg/dL-180 mg/dL), higher

patient satisfaction, and reduced risk of diabetes-related hospitalizations.[28-32] The patient can receive alarms for high and low glucose levels. Glucose reports can be reviewed by the provider online or downloaded by staff in the office and as part of remote monitoring. Finally, mobile apps can be linked to the clinic, so that reports can be reviewed in real time by the provider.

- **Glucometers** can link with a variety of mobile apps that can be helpful in keeping track of blood glucose readings, provide reminders to patients to check blood glucose, and generate reports. Mobile apps (e.g., OneTouch Reveal®, mySugr, BD™ Diabetes Care) can share reports with providers for review. Additionally, there are apps that can collect and combine data from insulin pumps, glucometers, and fitness trackers into one report (e.g., Glooko, Tidepool).

- **Insulin pumps** use artificial intelligence to regulate insulin delivery based on connected CGM data, trends, and insulin delivery histories. The pumps can be paired with mobile apps (e.g., Medtronic MiniMed® Mobile app to professional CareLink™ account, t:connect mobile app to professional t:connect portal [soon to be Tandem Source], Omnipod® 5 app to professional Glooko account) that can stream data to web-based professional accounts and be viewed by providers in the office.

- **Smart blood pressure monitors,**[27] either blood pressure monitors or blood pressure cuffs, may be used at home by individuals with hypertension or other cardiovascular conditions to measure their blood pressure regularly. Evidence supports the use of home blood pressure monitoring to improve antihypertensive medication adherence and improve blood pressure management.[27] Patients who are prescribed home blood pressure monitors may receive coverage or reimbursement from their insurance provider. Some of these devices (e.g., OMRON, Withings, iHealth, QardioArm, Oxiline, A&D Medical) have features such as Bluetooth connectivity to sync data with mobile apps to allow data tracking and analysis.



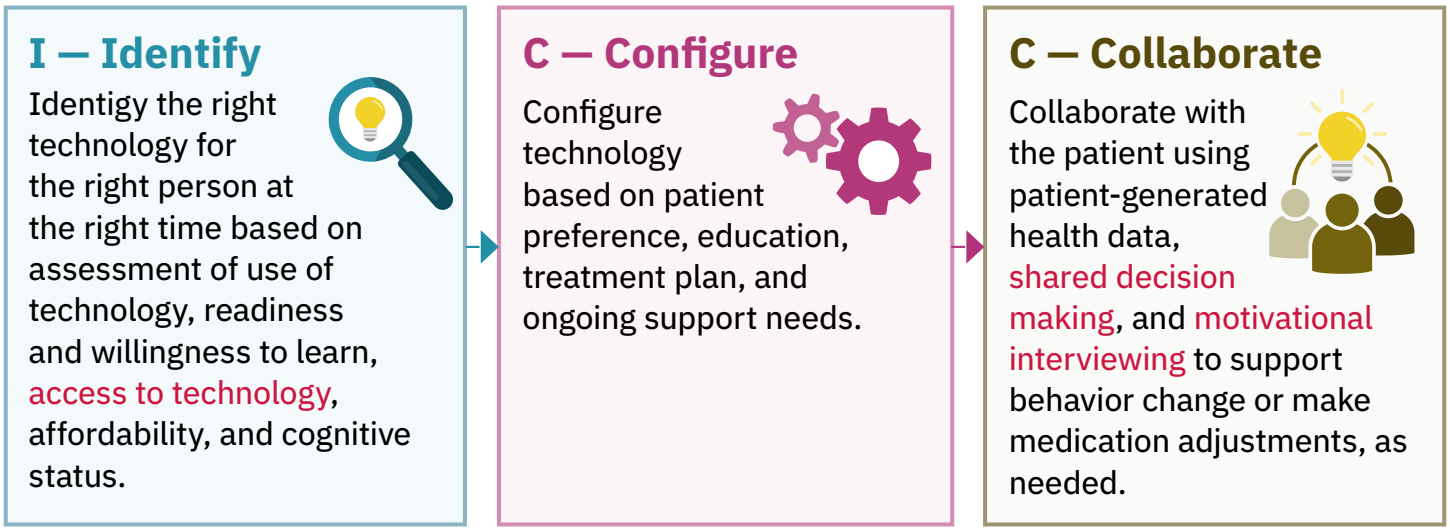
- **Mobile Apps**[33]
  - **Medisafe Medication** allows users to track their medications and set reminders to take them. It also provides information about possible drug interactions and side effects. Users can import prescriptions from major chain pharmacies and add over the counter medications manually, keep track of refills, get coupons, and access resources on medical conditions.
  - **MyTherapy** offers a medication tracker and reminder feature, as well as a symptom tracker and a health journal. It also provides patients with medication information and allows them to share their medication history with healthcare professionals.
  - **MyMedSchedule** helps patients create a personalized medication schedule and set reminders to take their medications. It also provides educational resources about different medications.
  - **Round Health** allows patients to create a visual list of their medications and set reminders to take them. It also provides information about potential drug interactions and side effects.

Implementation of Technology to Improve Medication Adherence

The Identify, Configure, Collaborate (ICC) Framework:[34]

The ICC Framework offers health care providers a standardized approach to helping patients choose, use, and benefit from the use of technologies. When implemented in collaboration with patients, this approach may help to improve adoption rates of adherence-enhancing digital technologies.

Figure 1. Identify, Configure, Collaborate (ICC) Framework[5]



Adapted from *A Framework for Optimizing Technology-Enabled Diabetes and Cardiometabolic Care and Education: The Role of the Diabetes Care and Education Specialist.*

Considerations for Prescribing Technology to Improve Medication Adherence

There is minimal evidence demonstrating specific improvement in adherence with the technology examples listed above. Also, due to their recent emergence, some technologies have not yet been compared with existing approaches to improving adherence or utilized across a range of populations.

Even considering the potential of improved medication adherence, patient-specific factors should be considered before recommending new devices. These factors include insurance coverage, out-of-pocket costs, support networks, usability, complexity, internet access, additionally required technology (e.g., smart phone), and time.[22] Also, certain populations, such as older adults, those with financial barriers or low health literacy, or those with limited access to health care, may be less likely to use health information technology.[35,36] For example, literacy-related disparities in technology access and use are widespread. Instructions may be complex and require comprehensive education prior to use.[25] Although providers and patient's often view barriers differently,[37] providers can mitigate patient concerns by assessing the user's digital skills and literacy level, providing plainly worded instructions (augmented with illustrations), providing direct assistance with set up, and ensuring that ongoing support networks will be available.[38] Other techniques, such as shared decision making and motivational interviewing may also help.

With all their potential, innovations designed to improve medication adherence are evolving, and products may be made available despite limited evidence to support their effectiveness. Technological interventions vary in the aspects of adherence they address, so tailored combinations of technological and non-technological interventions may be indicated. Ultimately, technology holds promise for the improvement of medication adherence, but it's use is more likely to help when providers 1) assess patient need, 2) review usability, and 3) consider technology as one component of a plan to improve medication taking.[34]

Access Cardi-OH's Expanded Resources

- **Addressing Common Barriers to Insulin Initiation and Use**
  cardi-oh.org/resources/addressing-common-barriers-to-insulin-initiation-and-use
- **Medication Adherence: The Key to Positive Patient Outcomes**
  cardi-oh.org/resources/medication-adherence-the-key-to-positive-patient-outcomes
- **One Simple Step to Improve Medication Adherence for Blood Pressure Control (Capsule 1)**
  cardi-oh.org/resources/capsule-1--one-simple-step-to-improve-medication-adherence-for-blood-pressure-control
- **Ohio Department of Medicaid: Checking Your Blood Pressure at Home**
  cardi-oh.org/resources/ohio-department-of-medicaid-checking-your-blood-pressure-at-home
- **Optimizing the Telehealth Diabetes Visit: Glucose Monitoring Data**
  cardi-oh.org/resources/optimizing-the-telehealth-diabetes-visit-glucose-monitoring-data
- **Overcoming the Digital Divide**
  cardi-oh.org/resources/overcoming-the-digital-divide
- **Simplified Prescription of Diabetes Technology and Medications (Capsule 25)**
  cardi-oh.org/resources/capsule-25--simplified-prescription-of-diabetes-technology-and-medications

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Appendix

Table 1. Smart Pens and Pen Caps

Device	pen/ cap/ button	CGMs/BGM Compatibility	Compatible Insulin	Cartridge (Yes/No)	Dose Calculation	Associated Apps	Other features	More information
Bigfoot Unity®	cap	Freestyle Libre (CGM)	**Rapid acting insulin**	No	Able	Bigfoot Unity Mobile app	White cap for rapid insulin; black cap for long-acting insulin; works with prefilled pen	bigfootbiomedical.com/bigfoot-unity
		Bigfoot Glucose Monitor (BGM)	Humalog Kwikpen (U-100, U-200)					
			Lyumjev Kwikpen (U-100, U-200)					
			Insulin lispro Kwikpen					
			Apidra Solostar					
			Admelog Solostar					
			Novolog Flexpen					
			Fiasp Flexpen					
			Relion Novolog Flexpen					
			Insulin aspart Flexpen					
			Long acting insulin					
			Basaglar Kwikpen					
			Lantus Solostar					
			Toujeo Solostar (U-300)					
			Tresiba Flextouch (U100, U200)					
In Pen®	pen	Dexcom (CGM)	Humalog	Yes	Able	In Pen app	Reusable pen; insulin dosing in 0.5 unit increments, max dose per injection 30 units	medtronicdiabetes.com/products/inpen-smart-insulin-pen-system
		Guardian Connect (CGM)	Novolog					
			Fiasp					
Novo Pen Echo®	pen	Not available in US	Novolog	Yes	Unable	None	Reusable pen; memory capacity; insulin dosing 0.5 unit increments; max dose per injection 30 units	novonordisk.com/our-products/pens-and-needles/novopen-echo.html
			Fiasp					
Tempo® pen	pen	Dexcom (CGM)	**Rapid acting insulin**	No	Unable	Tempo Smart app	Pre-filled pen; re-usable button; button lasts 8 months; same button can be used for both basal and bolus insulin	lillytempo.com
		Tempo (BGM)	Humalog					
		Accu-Chek Aviva (BGM)	Lyumjev					
		Accu-Chek Guide (BGM)	**Long acting insulin**					
		Accu-Chek Instant (BGM)	Basaglar					
		One Touch Verio Reflect (BGM)						
		One Touch Verio Flex (BGM)						
		True Metrix Air (BGM)						

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