REVIEW ARTICLE

WEARABLE DIGITAL HEALTH TECHNOLOGIES IN MEDICINE

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Wearable Digital Health Technologies for Monitoring in Cardiovascular Medicine

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This review article presents a three-part true-life clinical vignette that illustrates how digital health technology can aid providers caring for patients with cardiovascular disease. Specific information that would identify real patients has been removed or altered. Each vignette is followed by a discussion of how these methods were used in the care of the patient.

Vignette, Part 1: Remote Monitoring of Cardiovascular Disease

A 62-year-old woman with long-standing hypertension presents to the emergency department with decompensated heart failure and newly identified atrial fibrillation with rapid ventricular response. She is admitted for further evaluation and treatment and is found to have a left ventricular ejection fraction of 30%, which is thought to be tachycardia mediated from uncontrolled atrial fibrillation. After cardioversion and initiation of anticoagulation, antiarrhythmic drug therapy, and guideline-directed medical therapy for heart failure, she was enrolled in a remote patient monitoring program. Five days after discharge, she received a toolkit by mail that consisted of a blood-pressure cuff, a scale, a pulse oximeter, and a cellular hub that would transmit data to the remote care team.

The clinical presentation described above is a familiar scenario: the patient has long-standing hypertension and is at risk for atrial fibrillation, which affects 1 in 25 adults over 60 years of age and 1 in 10 adults over 80 years of age.[1] Atrial fibrillation may go undetected for long periods of time and may become apparent only when symptoms develop, such as those in the context of prolonged tachycardia leading to pulmonary venous congestion and a decline in ejection fraction or a thromboembolic stroke.[2] Even after a rate-control or rhythm-control strategy is implemented, an ongoing risk for recurrent atrial fibrillation and worsening heart failure may affect quality of life and survival. Ongoing monitoring combined with oral anticoagulation to prevent stroke and maintain sinus rhythm has shown benefits with regard to disease progression, hospitalization, and survival.[3-5]

In a traditional care model, the patient would be scheduled for regular visits to assess her blood pressure, weight, and cardiac rhythm, which would provide single-time-point data to consider in deciding whether to adjust the guideline-directed medical therapy. These visits may be scheduled with clinicians (e.g., primary care providers, cardiologists, or heart-failure specialists) who are matched with patients on the basis of their availability rather than their expertise or resources. Even frequent visits may be mistimed and ineffective for identifying disease progression

and meeting medical therapy goals. Data from a national registry of patients with heart failure showed that less than half of these patients are prescribed guideline-directed medications and even fewer achieve target doses for therapy.[6,7] In the GUIDE-IT trial (Guiding Evidence Based Therapy Using Biomarker Intensified Treatment in Heart Failure), most participants were already receiving guideline-directed medical therapy at baseline, and despite frequent in-person clinic visits over 15 months (12 visits for the intervention group and 10 for the control group), target doses of guideline-directed medical therapy were not reached in the majority of patients, and the outcomes did not differ between the trial groups.[8] Moreover, this care plan may come at a high financial and personal cost to patients who live far from care centers, lack transportation, or require time off work to attend visits, thereby introducing structural inequities in care.

Figure 1 is a timeline showing the experience of the patient with atrial fibrillation and heart failure in the vignette. The patient is unaware that she is in atrial fibrillation until heart-failure symptoms develop. The outpatient and virtual visits occur during periods of stability (and sinus rhythm), whereas the emergency department and hospitalization visits are reactive to symptom progression due to atrial fibrillation leading to progressive heart failure. The gaps between visits contain valuable, actionable clinical information and an opportunity to adjust the patient's therapy.

REMOTE PATIENT MONITORING

The goal of remote patient monitoring is to use remotely collected and transmitted health data to improve outcomes by capturing lifestyle behaviors that patients could change (e.g., sleep, activity),[9] controlling risk factors,[10,11] and detecting clinical deterioration or a change in health status before it worsens.[12,13] Although the uses of remote patient monitoring may be broad and could include management of diabetes and other cardiometabolic conditions,[11,14,15] this review focuses on the three most common cardiovascular conditions for which remote patient monitoring is used: hypertension, heart failure, and atrial fibrillation. Moreover, because this article is part of a series of review articles about wearable digital health technologies (DHTs), our focus is on aspects of remote patient monitoring that meet this standard.[16]

Most clinicians are familiar with remote monitoring of cardiac implantable electronic devices (e.g., pacemakers, defibrillators, and insertable

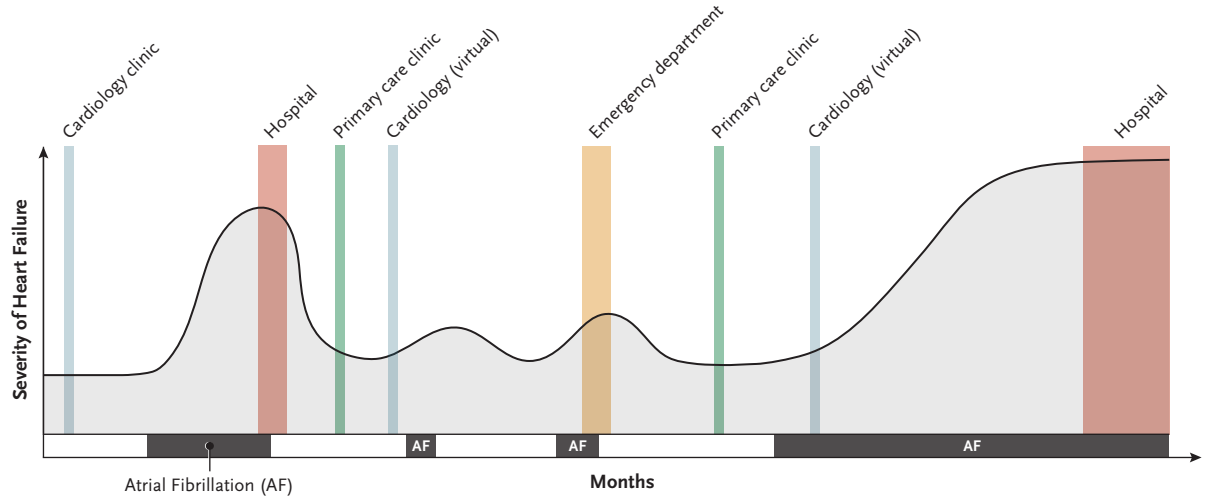


Figure 1. Gaps in Care of a Patient with Paroxysmal Atrial Fibrillation and Heart Failure in a Traditional Episodic Care Model.

This graph of atrial fibrillation burden and heart-failure severity over time shows how disease progression leading to hospitalization may occur despite frequent face-to-face or telehealth (virtual) visits. The patient may be in sinus rhythm during visits, and asymptomatic atrial fibrillation and progressive heart failure may develop during visit-free intervals. Even when a patient is in atrial fibrillation, episodic visits prevent ongoing disease management with adjustment of medical therapy for atrial fibrillation or heart failure.

cardiac monitors), which have been in place for decades on a variety of connectivity and software platforms. These systems not only detect arrhythmias but also alert clinicians to the need for changes in therapies (e.g., changes in the pacing burden or after a defibrillator shock) and provide early-warning systems for lead failure or battery depletion. Some implantable defibrillators can identify changes in heart-failure status using thoracic impedance, activity, and respiratory rate. Volume status can also be monitored with an implantable sensor that measures pulmonary artery pressure as a surrogate for left ventricular filling pressures, which enables the heart-failure team to detect early worsening of heart failure and to change the therapy with the goal of preventing an exacerbation or hospitalization.[17,18]

VIGNETTE, PART 2: CONTINUOUS MONITORING WITH WEARABLE TECHNOLOGIES

In the second week of monitoring after discharge, the patient's weight increased by 2.3 kg (5 lb). The remote-monitoring nurse called the patient, who reported increased dyspnea on exertion and occasional palpitations. The patient was able to assess herself for edema in the lower legs and noticed pitting. Blood pressure was elevated, averaging 152/84 mm Hg; resting pulse oximetry was unchanged. She reported no adverse effects with the use of the angiotensin receptor–neprilysin inhibitor, beta-blocker, sodium–glucose cotransporter 2 inhibitor, and direct oral anticoagulant, which had been prescribed at discharge. To achieve better blood-pressure and volume control, the nurse increased the dose of the beta-blocker, added a mineralocorticoid receptor antagonist, and doubled the dose of the diuretic for 3 days. A follow-up basic metabolic panel and measurement of the pro–B-type natriuretic peptide level were ordered. An ambulatory electrocardiography (ECG) monitor to evaluate the cause of palpitations and to assess the atrial fibrillation burden was also prescribed and shipped to the patient.

WEARABLE TECHNOLOGIES

DHT refers to software (e.g., mobile health apps and predictive analytics), hardware (e.g., sensors, monitors, and wearables), and telehealth platforms that are increasingly being integrated in a range of contexts in cardiovascular medicine to support patient care, clinician interactions, interpretation of imaging, and clinical workflows.[19] DHTs capture patients' physiological data, which can be transmitted to and used by care teams to manage cardiovascular risk factors and disease (Fig. 2). Blood-pressure cuffs and scales are nonwearable DHTs that capture data episodically with patient initiation. Wearable DHTs, the focus of this review, can capture continuous or semicontinuous data measurements that can often be captured without patient initiation (e.g., pulse rate, oxygen saturation as measured by pulse oximetry, respiratory rate, heart rate, and cardiac rhythm). Common cardiovascular wearable DHTs include smartwatches and other wrist-worn devices, skin-surface patches, and wearable ECG devices that use leads and electrodes. The patient in the vignette is given a combination of nonwearable DHTs (a blood-pressure cuff, a scale, and a pulse oximeter for the finger) and a wearable DHT (an ambulatory ECG monitor).

ECG RECORDING

For atrial fibrillation, critical variables to measure include cardiac rhythm and heart rate. Atrial fibrillation and other cardiac rhythms can be directly ascertained by a host of consumer-facing and clinical ECG devices (Fig. 3). Most consumer-facing devices can produce a 30-second rhythm strip using a lead I vector from the left arm to the right arm. Smartwatches measure the electric impulse from the wrist to the contralateral finger that touches the watch crown. Some handheld devices function as lead I ECGs when held by the left and right hands. Newer smartphone-connected devices that have an electrode on the underside of the device for the leg can generate six ECG lead vectors. Whereas some of these devices may provide the user with a provisional, automated interpretation of sinus rhythm or atrial fibrillation, the consumer-facing devices typically have regulatory clearance as over-the-counter prediagnostics and require clinician interpretation before they can be used for medical decision making.[20]

Clinicians should be aware that signal quality varies across different systems, even within categories of wrist-worn devices.[21,22] In one study comparing the diagnostic accuracy of proprietary algorithms to detect atrial fibrillation among three commercially available single-lead devices,

the sensitivity ranged from 78 to 88% and the specificity ranged from 80 to 86%.[22] These numbers improved when unclassified ECGs were excluded and when cardiac electrophysiologists interpreted the results. Noise or artifacts can also make clinician interpretation difficult, with 2 to 15% of ECGs deemed uninterpretable across manufacturers.[22] Although we are not aware of standardized performance metrics or thresholds for regulatory approval, the Food and Drug Administration (FDA) did release guidance to expand the use of over-the-counter ECG products for remote patient monitoring during the coronavirus disease 2019 (Covid-19) pandemic; in 2023, the FDA extended this guidance indefinitely to support the use of patient-facing ECGs (and other noninvasive remote patient monitoring devices) that can help eliminate unnecessary patient contact, ease the burden on providers, and advance health equity by increasing access to DHTs.[23]

Other considerations include wear time and responsiveness to prompts to take an ECG reading, which can vary by person and affect device performance and clinical utility. These devices do not record continuously, and ECGs must be activated by the patient. The lack of a continuous recording or immediate access to the device may preclude ascertainment of the patient's cardiac rhythm at the time of transient symptoms. For example, in one study, the mean (±SD) wear time

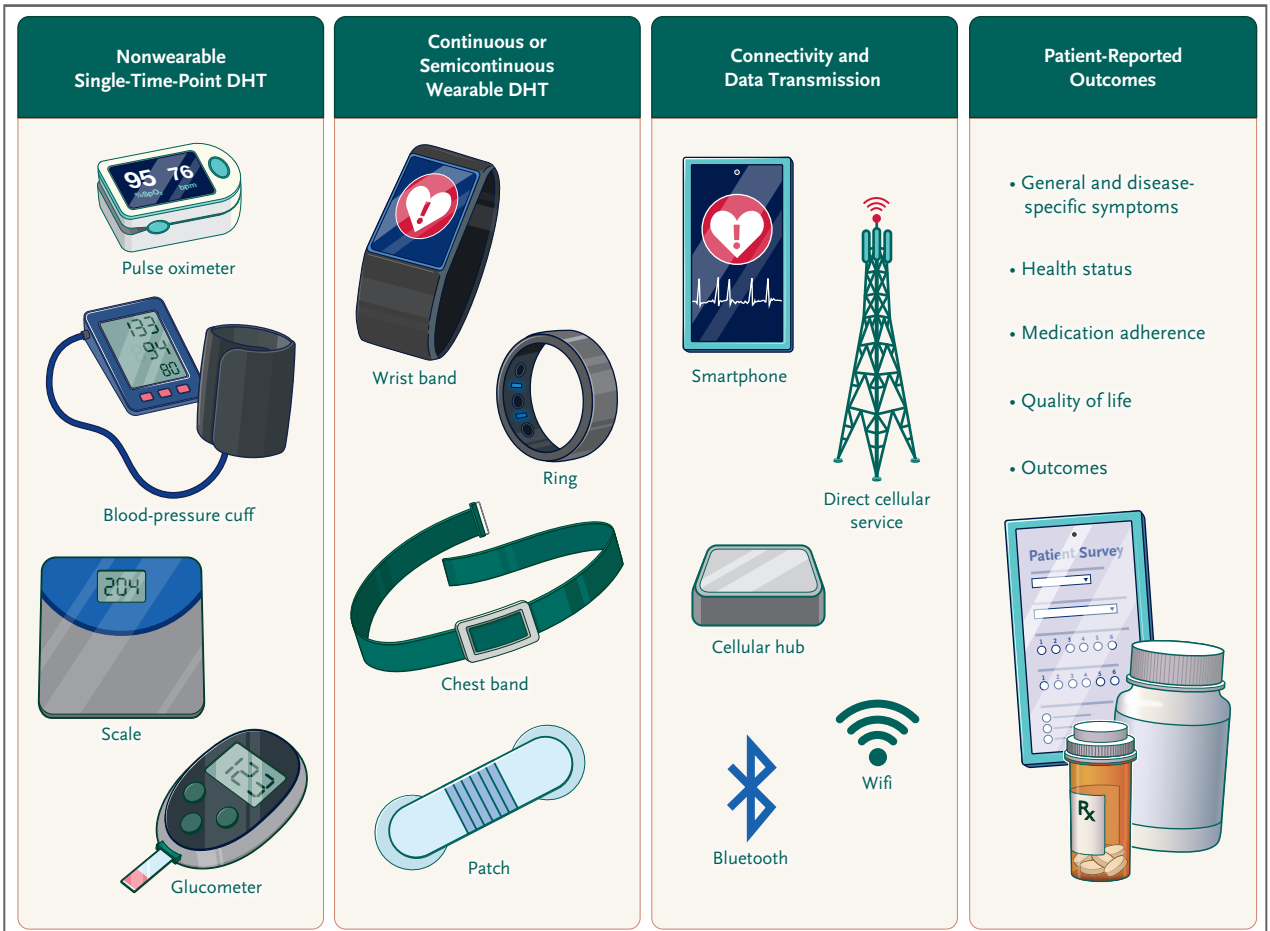


Figure 2. Example Components of a Remote Monitoring Toolkit.

Current technologies include connected nonwearable, single-time-point digital health technologies (DHTs) such as pulse oximetry, blood-pressure cuffs, scales, and glucometers, as well as wearable continuous or semicontinous sensors in the form of wristbands, rings, chest straps, patches, and other forms. These devices may have network capability with smartphone pairing, cellular hubs, or direct cellular connectivity. Patient-reported symptoms, health status, quality of life, and outcomes can be electronically ascertained through surveys completed with the use of smartphone apps or text messaging.

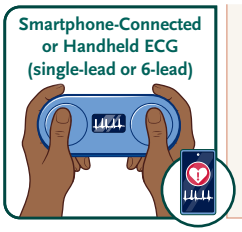
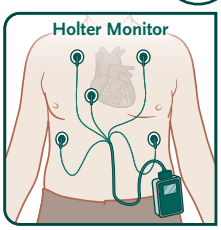
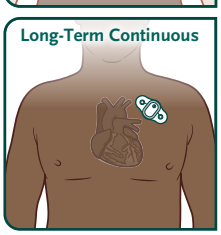
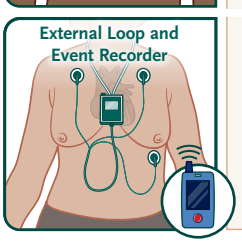
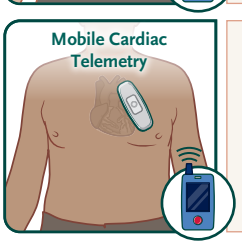
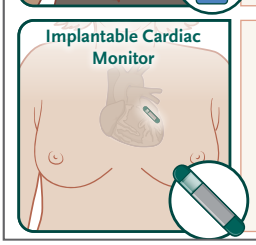
	Monitoring Time	Recording Type	Data Reported	Availability	Clinical Considerations
 Consumer or Retail Smartwatches	Patient activated	30-Second ECG	Episodic	Over-the-counter	• Ease of use • Familiarity • Patient can directly purchase or may already own • May miss transient or asymptomatic arrhythmias since recordings need to be patient activated
 Smartphone-Connected or Handheld ECG (single-lead or 6-lead)	Patient activated	30-Second ECG	Episodic	Over-the-counter or prescribed as patient-activated event recorder	
 Holter Monitor	24–48 Hours	Continuous	Continuous	Prescribed	• May be lead or patch based • Electrodes need frequent changing, and this can lead to less continuous wear time • Continuous ECG recording during wear period • Most offer event triggering for direct symptom–rhythm correlation • Adhesive may cause skin irritation and risk may increase with prolonged wear • Water resistant but with swimming and bathing restrictions (leads only)
 Long-Term Continuous	3–14 Days	Continuous	Continuous	Prescribed	
 External Loop and Event Recorder	Up to 30 days	Loop	Episodic	Prescribed	
 Mobile Cardiac Telemetry	Up to 30 days	Continuous	Episodic or continuous	Prescribed	• May be lead or patch based • Continuous recording during wear period • Allows cellular transmission of arrhythmia episodes for expedited clinical review
 Implantable Cardiac Monitor	Up to 5 years	Loop	Episodic	Prescribed	• Minor procedure for implant and removal • Long battery life • Patient does not need to remember to wear • Recordings are not continuous; alert and storage thresholds are programmable • Requires patient compliance with gateway or smartphone to transmit

Figure 3 (facing page). Examples of ECG Monitoring Devices.

Shown are a variety of commonly available smartwatches, handheld ECGs, and ambulatory cardiac monitoring devices. Over-the-counter FDA-cleared devices are directly available to consumers without prescription. Medical devices for ECG monitoring include a variety of wearable forms, monitoring-duration options, and connectivity options.

was 19.5±4.2 hours per day and the responsiveness to an alert to take an ECG was 66.7%.[24] Regardless of device, identification of more subtle low-amplitude atrial rhythms, such as focal or reentrant atrial tachycardias, from a single-lead ECG report can be difficult. Advantages of these devices are that they can show when a patient is in sinus rhythm, and they are able to identify some arrhythmias.

When continuous ECG monitoring is required, ambulatory ECG monitoring can be useful. Continuous monitoring may allow for assessment of the atrial fibrillation burden (the percentage of time in atrial fibrillation relative to the time being monitored), antiarrhythmic effectiveness and safety, and heart-rate control in atrial fibrillation, which can be especially useful when a patient is unaware of tachycardia or atrial fibrillation. Ambulatory ECG monitoring comes in a variety of device configurations that are tailored for specific use cases defined according to duration of use (24 hours to 30 days), single or multiple ECG vectors, lead or patch system, continuous or noncontinuous recording, and timeliness of transmission and interpretation[25,26] (Fig. 3). When these devices are paired to a cellular relay hub by means of a wireless connection, they can transmit patient-triggered ECGs or device-detected rhythms during wear and thus allow the potential for rapid review by a technician who may be available 24 hours a day. Some ECG monitoring devices that use patches also include more continuous recording and transmission of ECG measurements, respiratory rate, and skin temperature, thereby supporting acute care provided in patients' homes, also known as hospital-at-home monitoring.[27]

PHOTOPLETHYSMOGRAPHY FOR PULSE RATE, OXYGEN SATURATION, AND RHYTHM ASSESSMENT

Watch-based devices are capable of detecting pulse rate and oxygen saturation by means of an optical sensor and a diode on the back of the watch face using photoplethysmography intermittently or semicontinuously. In smartwatches and bands, the photoplethysmography sensor can be programmed to record intermittent pulse tachograms during periods of noise-free signal (i.e., limited activity and good sensor–wrist contact). These algorithms will passively look for several consecutive or near-consecutive tachograms that meet criteria of irregularity over hours or days as a surrogate for detecting possible atrial fibrillation; some devices include both photoplethysmography and ECG functionality. Two of the three large consumer-facing device trials were performed in the United States,[28-30] involving over 400,000 participants with no history of atrial fibrillation in each trial (Apple, Cupertino, CA; Google Fitbit, Mountain View, CA). Both trials enrolled diverse populations and showed high positive predictive value for observing atrial fibrillation on an ECG subsequently performed after an irregular pulse notification (84% in the Apple trial and 98% in the Fitbit trial). The diagnostic yield of subsequent ambulatory ECG monitoring in these trials was 32 to 34%. Although false positives are possible, this finding could be, in part, due to the paroxysmal nature of atrial fibrillation, which is missed if the patient returned to sinus rhythm after the irregular pulse notification. Additional ECGs or ambulatory ECG monitoring may be appropriate, depending on clinical suspicion. The irregular pulse notification algorithms in these consumer devices are FDA-cleared for use only in patients without previously diagnosed atrial fibrillation. In one study, atrial fibrillation had developed in 25 of 50 patients who had undergone cardiac surgery, and in this population the episode-level sensitivity of the algorithm as compared with inpatient telemetry was only 41%, although the specificity was 100%.[31] Newer consumer smartwatch algorithms can approximate the atrial fibrillation burden (the percentage of time in atrial fibrillation relative to the time spent wearing the smartwatch); these algorithms are approved for over-the-counter use in patients with a diagnosis of atrial fibrillation and are not intended for medical decision making.[32,33] One prescription-only FDA-cleared algorithm and smartwatch intended for use in health care environments had an episode-level sensitivity of 96.1% and a specificity of 98.1% for 15-minute atrial fibrillation intervals as com-

pared with simultaneous continuous ambulatory ECG monitoring.[34]

BLOOD PRESSURE

Traditionally, blood pressure is measured with an inflatable cuff and either manual auscultatory or automated oscillometric methods. The latter has enabled patients to measure their own blood pressure at home.[35] Still, these devices do not capture fluctuations in blood pressure that occur throughout the day and night and that are associated with patient outcomes. Additionally, the cuff inflation itself may affect blood-pressure readings.[36,37] Miniaturized wrist-worn devices that use oscillometry are now available,[38] although a comparison of wrist measurements with traditional upper-arm measurements (with the use of either oscillometric or auscultatory methods) showed overestimation in normotensive subjects and underestimation in hypertensive subjects and that the measurements differed by at least 5 mm Hg in 40 to 50% of readings.[39] Cuffless technologies have also emerged; these rely on indirect estimation of continuous or episodic blood pressure as measured by machine-learning algorithms with the use of electric (e.g., ECG and bioimpedance electrodes), optical (photoplethysmography) or mechanical (e.g., pressure, ultrasound) sensors.[40] Most of the FDA-cleared devices use pulse wave analysis from photoplethysmography with or without pulse arrival time derived from a simultaneous ECG.[41]

Despite instrumentation standards for cuffless blood-pressure devices,[42] several questions remain about their accuracy between calibrations (i.e., accuracy drift), across diverse patient characteristics (e.g., body type, skin tone, and coexisting conditions), with movement and changes in position, and across settings (e.g., hospital, office, and home); there are also questions about whether a blood-pressure cuff is the appropriate reference standard and how best to present continuous blood-pressure data in a way that is clinically meaningful. The American Medical Association has convened technical and clinical experts, who have developed criteria for clinical accuracy and have determined which devices meet these criteria (available at www.validatebp.org). There are currently no cuffless devices on this list.

It seems reasonable to anticipate that in the future more and more wearable DHTs will have multisensing capabilities, such as the ability to detect activity, skin temperature, step count, sleep, posture, and falls. These metrics could have the potential to provide important contextual data for patients and clinicians, such as evaluating physical activity or sleep in relation to the severity of heart failure or atrial fibrillation. Trajectories of measures such as physical activity or sedentary time could be used to prompt questions about health status, and psychological factors such as depression, loneliness, and isolation could be captured and addressed to improve cardiovascular health.[43] However, most of the analytics from consumer-facing devices and remote patient monitoring are still fairly elementary. Direct-to-consumer subscription models for some analytics, including heart-rate variability and sleep staging, are available but intended for wellness rather than medical diagnostic use.

PRACTICAL CHALLENGES

Clinicians are interested in the potential for remote patient monitoring and wearable technologies to increase the efficiency and efficacy of cardiovascular disease management. Yet, to date, the uptake has been limited across most health care settings, systems, and payment models. Most cases of cardiovascular disease are still managed by episodic face-to-face patient care. We considered the following key barriers and limitations that health professionals may need to address proactively.

Reimbursement models for the use of remote patient monitoring and wearable technologies are nascent. Monthly reimbursement for remote patient monitoring from Medicare requires the collection and transmission of physiological measurements on more than 50% of the days of the month, which may be unnecessary for some conditions (hypertension) and insufficient for others (diabetes). Any FDA-cleared medical device may be used without direct proof of its safety or utility in the context of remote patient monitoring.[44] For example, cuffless blood-pressure measurement devices are emerging[45] and some have been FDA-cleared for use, but their effectiveness has not been studied in the context of remote patient monitoring. Another concern is that the accuracy of pulse oximetry is reduced in people with dark

skin pigmentation, which has been recognized as a source of health disparities between persons with dark skin and those with light skin. Persons with dark skin may not receive the attention they would have received if their true oxygen saturation were known, because their actual oxygen saturation is lower than that reported by pulse oximetry.[46,47]

Although observational data show short-term improvement in physiological measures, whether remote patient monitoring in its current form can lead to reductions in long-term cardiovascular events, prevent death, or offer other benefits remains unproven.[48] Remote patient monitoring is also heterogeneous; the program design, devices, software, care protocols, and engagement strategies vary according to manufacturers and bundles. Even so, patient-level, explanatory randomized trials of DHTs are subject to enrollment biases (i.e., study participants are more likely to be motivated and engaged than patients in the general population) with unblinded interventions in highly controlled trial settings, which makes these trials vulnerable to contamination, the Hawthorne effect (i.e., changes in behavior because of being observed), and nongeneralizable results. Therefore, assessment of effectiveness is currently best left to the individual care setting, either with implementation study designs or cluster trials.[49,50]

VIGNETTE, PART 3: GRADUATING FROM REMOTE PATIENT MONITORING

The patient continued working with the remote patient monitoring team to adjust the guideline-directed medical therapy as needed. Her symptoms improved, and her weight and blood pressure were stable. Ambulatory ECG monitoring showed sinus rhythm with rare premature ventricular contractions but no atrial fibrillation. After 90 days of monitoring, she had not required readmission, had verbalized understanding of her medications, and planned to continue to monitor her weight and blood pressure daily. She met criteria for readiness to graduate from the program. Remote patient monitoring was discontinued and the patient was referred to her clinical team for ongoing care.

IMPLEMENTATION IN CLINICAL PRACTICE

The use of wearable DHTs for cardiovascular diagnosis and disease management continues to mature. A major challenge in the field is that innovations in technology often outpace our capability to show that a technological advance can translate into a clinical advance. Once a DHT is shown to have true clinical benefit, uptake by patients and physicians may be slow, in part because reimbursement may not follow within frameworks that determine whether the use of a DHT is appropriate in the context of a fee-for-service or value-based health care model. Although adoption and coverage are increasing, the potential clinical value of wearable DHTs has yet to be fully realized. Computational analytics and applications to interpret data from a multitude of physiological measures may be necessary in testing new wearable DHTs in clinical practice. This is likely to require new staffing models, team-based care, and redesigned workflows. For example, in the case of heart failure, technologies for remote patient monitoring have evolved from telemonitoring based on single-time-point weight, blood-pressure, and symptom assessment[51,52] to continuous sensors with implantable devices[17,53] and wearable DHTs in the form of smart-bands, -watches, -patches, and -clothes.[54,55] Yet important questions remain about implementation (e.g., patient and device selection), the evidence base supporting predictive analytics and protocols that respond to incoming data for improved clinical outcomes, and sustainable workflow models.[50]

Remote-monitoring hubs or teams, dating back to the 1990s, are well established in cardiology to manage remote transmissions from pacemakers and implantable cardioverter–defibrillators and are supported by a mature reimbursement framework. More recently, this hub model has been successfully adopted by the Veterans Health Administration[56] and by academic health systems for cardiovascular specialty care.[57] The hub model may be both more scalable and more effective than a clinic-by-clinic implementation approach because of easier resource allocation and technology integration, simplified training of staff, a single point of accountability,

aligned incentives, and a shared focus on performance measures related to remote patient monitoring and hub care for the management of arrhythmias and heart failure (Fig. 4).

CONCLUSION

The Covid-19 pandemic accelerated the interest and investment of health systems in remote care and

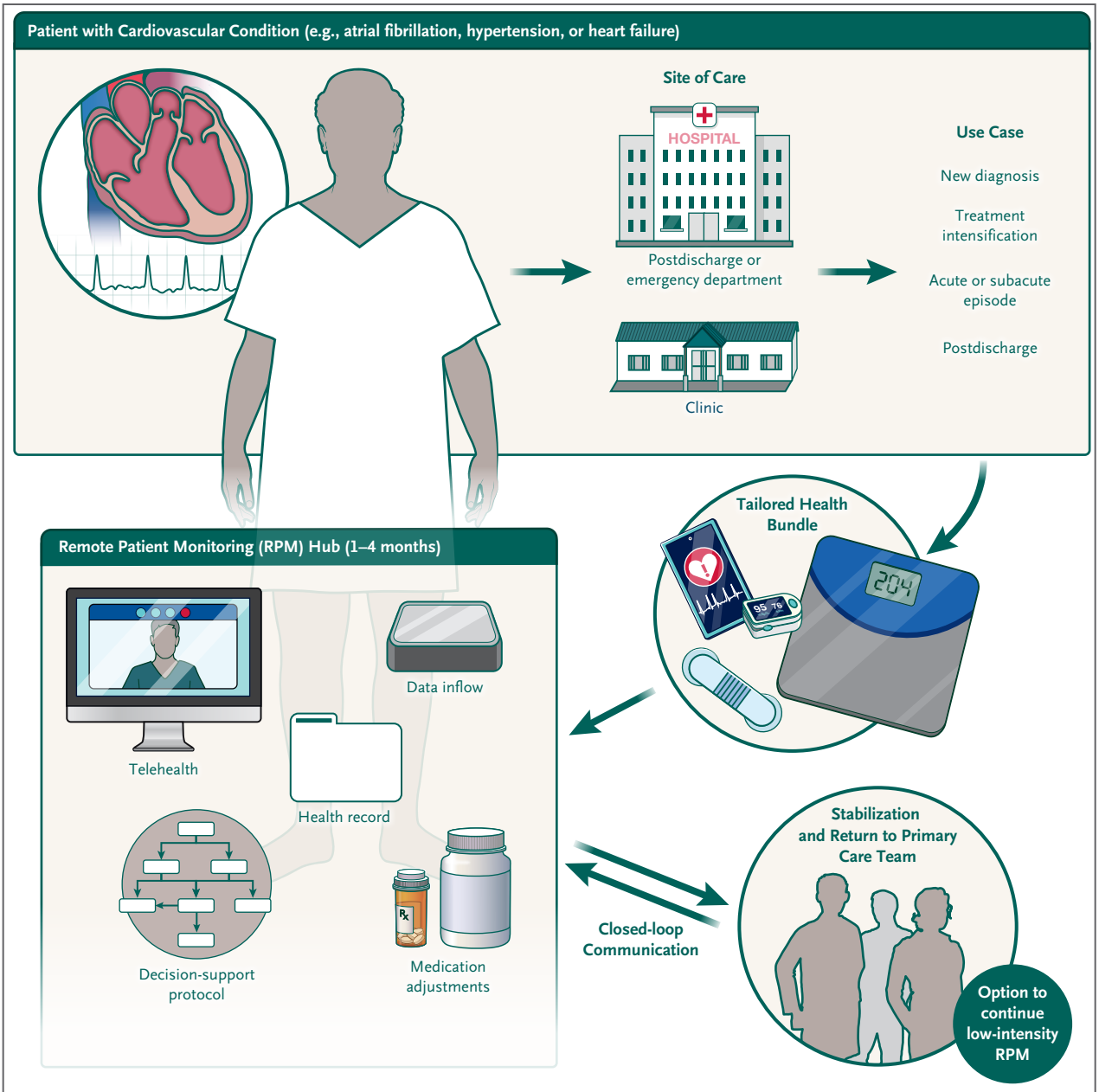


Figure 4. Hub Model for Remote Patient Monitoring.

Cardiovascular conditions (e.g., atrial fibrillation, hypertension, and heart failure) may require a period of intensive monitoring and medication adjustment after a new diagnosis or exacerbation, after hospital discharge, or during periods of treatment intensification. In this model of remote patient monitoring (RPM), a digital health bundle with remote management through a centralized hub may be prescribed. Remote clinicians manage data intake and may apply protocols and decision-support tools to adjust medication doses or treatment. After the period of adjustment, the patient's disease management is handed back to the primary care team with the option to continue low-intensity RPM if needed. Closed-loop communication with the primary care team occurs throughout.

digital technologies. Digital technologies will continue to advance, but whether remote patient monitoring and wearable technologies succeed in achieving the goals of these health systems is unlikely to depend on technological advances, which are far outpacing adoption. Instead, their success depends on the speed of their adoption and the evolution of cardiovascular care, which in turn depends on navigation of key barriers of clinical care integration, demonstration of value, and aligned reimbursement. Implementation studies and risk-sharing programs can provide better data to evaluate the effectiveness of these solutions at the level of the health care system.

Still, the foundational elements of remote patient monitoring and wearable technologies are present in cardiovascular practice today and are expected to mature in a manner similar to that of remote monitoring of pacemakers, defibrillators, and ambulatory ECG. The overall goals are to shift from episodic care to asynchronous and continuous care, minimize burden on patients and caregivers, reduce structural inequities in access to care, and improve efficiency of evidence-based care delivery.

Neither the *Journal* nor the Massachusetts Medical Society endorses any specific wearable digital health technology. Examples of such technology appear in this article for illustrative purposes only and do not constitute an endorsement.

The contents to not represent the views of the National Institutes of Health or the U.S. government, iRhythm Technologies, Meta Platforms, or the academic institutions listed in the authors' affiliations.

Disclosure forms provided by the authors are available with the full text of this article at NEJM.org. Dr. Turakhia is an employee of iRhythm Technologies, which manufacturers ambulatory ECG monitors.

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