Wearable Digital Health Technology

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"Wearables" is a term used for forms of technology that are worn on the body, such as smartwatches or adhesive patches containing sensors, and that perform a useful function for the wearer or a caregiver. Common examples include devices that track physical activity and sleep or provide physiological data about the wearer, such as heart rate and rhythm or blood glucose levels. Increasingly, wearables are being used by medical professionals to provide clinical data on their patients and for their patients. This digital health technology (DHT) that is worn by patients and connected through mobile apps or personal digital assistants can be used for disease monitoring, diagnostics, alerts, or other clinical care services. In this series, we refer to this specific class of technology as "wearable DHT."

Is wearable DHT going to improve patient outcomes and clinical practice? Or is it just a trend that will pass, like so many consumer devices and their well-being claims?

The first in a series of articles on the clinical applications of wearable DHT[1] appears in this issue of the *Journal*. We are publishing this now that wearable DHT is at an inflection point between fanciful descriptions and practical applications that are being woven into health monitoring, clinical diagnoses, and administrative approvals for new therapies. As recently as 5 years ago, almost all discussions about wearable DHT were in the future tense; it is now reasonable to assume that before the end of this decade the use of wearable DHT will be mainstream and underlie many aspects of medical care assessments and decision making for both patients and clinicians.

As of 2020, some 84 million persons in the United States used apps with health and health-related content.[2] It is estimated that worldwide there are more than 200 million smartwatches providing health information, with 45% of Americans wearing some form of smartwatch as of April 2022.[3] Some 92% of smartwatch users reported that they used the devices to maintain their health and manage it. As for other wearables, more than a million smart rings had been sold by 2022, and more than 7 million continuous glucose sensors will be sold this year. As for the market for wearable medical devices, Bloomberg estimates that it will grow to $76 billion by 2028.[4] At the same time, these devices are collecting increasingly reliable data, and programmers are developing ever more powerful algorithms to process them. The goal of this series in the *Journal* is to bring awareness to emerging forms of wearable DHT that are affecting medical research and clinical care in ways worth framing for clinicians and medical researchers ahead of general awareness or consensus on their benefits and risks.

Wearable DHT as well as artificial intelligence and machine learning (AI–ML) are closely related fields, but each has its own distinct focus and applications. Wearable DHT encompasses a broad range of tools, platforms, forms of technology, and devices to monitor physiology and health conditions, enable remote care delivery, and potentially improve health outcomes. The field of AI–ML, on the other hand, focuses on the development of algorithms and models that can learn from data, including the broad range of DHT-derived data, to make predictions or enable better decisions based on that learning. AI–ML may be used to analyze images, diagnose diseases, identify risk factors, and develop personalized treatment plans. Forms of wearable DHT often incorporate AI–ML, but they are distinct in that they focus more broadly on the use of technology to remotely monitor a patient's physiology or symptoms, thus reducing the need for in-person visits, and to empower and engage the patient in their health data with self-care, as appropriate. With or without AI–ML algorithms, wearable DHT may be used by clinicians for personalized treatment plans and early detection of diseases.

The articles in this series are focused on

wearable DHT that has been integrated into clinical care but is currently in limited use. They are written so as to enable practitioners, researchers, and students who wish to gain a better understanding of how wearable DHT can affect their work and clinical practice if adopted. The series aims to provide real-world examples of how wearable DHT is increasingly being applied in clinical situations today and how such uses are likely to expand or be constrained until they are fully implementable into health care systems and reimbursable by medical insurance plans.

Each article opens with one or more clinical vignettes based on actual clinical cases that describe a patient and a clinical conundrum that today is more solvable using one or more types of wearable DHT. The first article in this series focuses on wearable DHT for diabetes and the emerging uses of continuous glucose monitors and active insulin-delivery devices for patients with type 1 or type 2 diabetes and within the hospital setting.[1] The series will also feature articles on wearable DHT in other clinical areas such as psychiatry and cardiology and in the treatment of epilepsy.

In the final article in this series, we will address cross-cutting challenges for these emerging clinical techniques such as: What overarching barriers must be overcome to enable patients and clinicians to maximally benefit from these new forms of technology? What is the evidence needed for wearable DHT to make medical claims that it improves patient outcomes? Can wearable DHT improve patient care while reducing the burden on clinicians? Where should makers of wearable DHT be careful not to overpromise or overburden patients and providers? And how can technologists, data scientists, and clinicians collaborate to bring about the promise of personalized and revolutionary new medical insights in a world that already feels overloaded by data and new findings?

Because these are commercial devices, some of our authors will be employed by or receive financial payments from manufacturers of wearable DHT. These associations will be disclosed in each article; through the editing process, we have endeavored to use language and images that are not specific to any particular device. Throughout the series, it will be reiterated that the *Journal* and its owner and publisher, the Massachusetts Medical Society, do not recommend or endorse the use of any particular wearable DHT for any purpose.

It is our hope that the broad readership of the *Journal* will be grounded and motivated by this series to explore and deploy validated wearable DHT in the day-to-day care of patients, as the authors of this series have done. The series aims to accelerate the appropriate adoption of wearable DHT such that the focus of assessment and care of patients is no longer exclusively hospital- and office-based and enables effective "care anywhere" for patients.

Disclosure forms provided by the authors are available with the full text of this editorial at NEJM.org.

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DOI: 10.1056/NEJMe2303219