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Increasing Patient Engagement Through the Use of Wearable Technology

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A B S T R A C T

With digital technology, patients can be more active in their care and better understand how their behaviors can affect their health in real time. Wearables can provide data and automatic analytics that can help nurse practitioners diagnose issues more quickly and intervene sooner to prevent readmissions or negative sequelae. The purpose of this article is to provide an overview of the state of the wearable technology, discuss advantages and challenges, and consider implications for informatics, patient care, and future research.

This CE learning activity is designed to augment the knowledge, skills, and attitudes of nurse practitioners and assist in their utilization of wearable technology to enhance patient engagement in their health evaluation and care.

At the conclusion of this activity, the participant will be able to:

A. Describe the current state of wearable technology for health care
B. Discuss advantages of wearable technology for health care
C. Evaluate common challenges NPs face including the areas of needed research to support patients' use of wearables

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The author does not present any off-label or non-FDA-approved recommendations for treatment.

This activity has been awarded 1 Contact Hours of which 0 credit are in the area of Pharmacology. The activity is valid for CE credit until Oct 1, 2021.

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Introduction

Consumers embracing wearable technology to track personalized data, such as steps and heart rate, started the quantified self (QS) movement. This QS movement refers to "the notion that various self-tracking tools and applications, including emotion trackers, food trackers, and pedometers, offer an effective opportunity for people to understand their bodies, minds, and daily lives as a series of quantifications that can be examined and acted upon" (p. 402).[1] Single devices such as smartwatches that are able to monitor a large range of personal medical data, including heart rate, physical activity, and sleep patterns, have helped to expand the QS movement and general use of personalized data. Although QS is relatively new as a concept, even as early as 2012, Pew Research (n = 3,014) reported that 7 in 10 US adults tracked a health indicator for themselves or for a loved one, and 21% of these adults tracked via a wearable device.[2]

Patients are more digitally savvy today, and many expect their nurse practitioners (NP) to use data they have personally tracked when receiving care.[3-5] The line between consumer wearable technology devices (wearables) and medical devices is beginning to blur. How do we help patients make sense of all the available data and understand the validity and reliability of that data and engage more in their own care? The purpose of this article is to provide an overview of the state of the wearable technology, discuss advantages and challenges, and consider implications for informatics, patient care and future research.

Background and Definitions

Collections of personally relevant data available through wearables can help add to self-knowledge and could potentially have an impact on a person's health. The use of wearables doubled from 2014 to 2016 (n = 4109) and continues to grow quickly.[6] According to Levine,[7] wearables are currently a $1 billion business. CCS Insight predicts that worldwide smart wearable device sales are expected to become a $27 billion plus market with the growth powered by smartwatches.[8]

Many terms exist to describe personally tracked health data from wearables, including "quantified self" and "wearable

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technology." An understanding of the differences and similarities of these terms will help focus next steps to influence clinical practice and patient outcomes.

Quantified Self

The QS movement started as an attempt to describe the use of personal fitness trackers by *Wired Magazine* writers Gary Wolf and Kevin Kelly, but the concept has expanded, and a new culture of tracking and sharing personal data has exploded.[9] This is, in large part, due to the ease of tracking data using smartphones and wearables such as smartwatches and Fitbits. Wearable technology automates data collection and often uses algorithms to analyze the data and presents the user with recommendations based on the data. Wearables are embraced by users because they are an automated way to journal and do not depend on the user taking the time to assess and document; instead, they constantly track as long as the user is wearing or carrying the device. So-called quantified selfers apply the personal numeric data collected from the wearables to activities such as eating, sleeping, and exercising and use it to potentially change their habits. By measuring these factors, quantified selfers (n = 4109) believe they can improve aspects of their life.[6]

Wearable Technology

Rhodes[10] defined wearables using both the general terms of "a wearable computer is a computer that is always with you, is comfortable and easy to keep and use, and is as unobtrusive as clothing" as well as more specifics to include "portable while operational … hands-free use … have sensors for the physical environment … be able to convey information to its user even when not actively being used … [and] always on, always running" (p. 218). Dehghania, Kim, and Dangelico[11] further defined the terms "smart wearables" and "wearable technology" as "seamlessly embedded portable computers … worn on the body" (2018, p. 480). Wearables range from simple step-counters to smart fabrics. Fitness trackers are the simplest wearables and track a large variety of personal data, including steps, heart rate, energy expenditure, sleep patterns and more (see Figure).

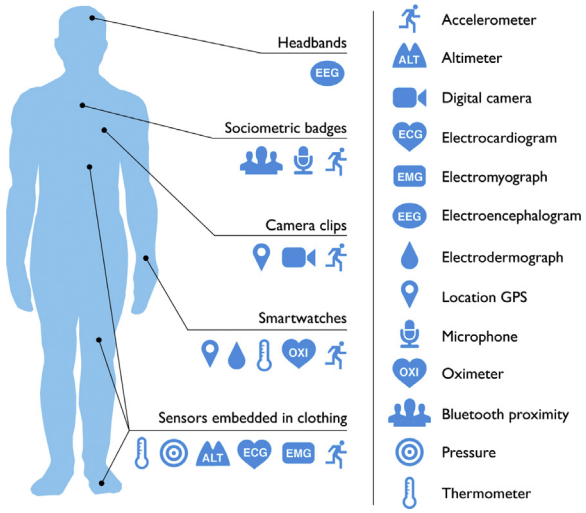

Figure. Consumer wearables. Source: Piwek L, Ellis DA, Andrews S, Joinson A. The rise of consumer health wearables: promises and barriers. *PLoS Med*. 2016;13(2):e1001953. https://doi.org/10.1371/journal.pmed.1001953.

Another type of wearable includes smart glasses, which are an optical head-mounted display designed in the style of eyeglasses. Although smart glasses were thought to be game changers when they were first released, they require more research to determine how they can best be used with patients. Other smart-wearable devices in development include necklaces to monitor heart function; contact lenses to track glucose level or eye pressure; head bands to capture electroencephalograms; camera technology for physical examinations; measurement of the state of mental health through composite of real-time data, such as tone, inflection and facial expressions; and shirts embedded with technology to measure cardiac parameters.[12] Many of these devices are still used mostly for research and development but are expanding rapidly as the technology continues to improve.

Smartwatches have more recently exploded on the market, expanding the applications of wearables. They are unobtrusive and fit most lifestyles and do much more than basic tracking when paired with smartphones. Eric Topol, physician and futurist, believes smartphones can "reduce use of doctors, cut costs, speed up the practice of care, and give more power to patients" (p. 1).[12] Much of the current research using smartwatches has been focused on chronic elderly populations or the aging process, although there are also studies looking at the impact of wearables on depression, Parkinson disease, and cardiac disease.[13]

Advantages of Wearable Technology

Wearables bring a new set of advantages to NPs. Patients can be more active in their care and can better understand how their behaviors, such as exercise, eating and sleeping, can affect their health in real time. Health care is more accessible to patients in remote areas or while homebound. Patients do not have to travel to centers to meet with experts but instead can transmit their data or have virtual visits with NPs. Lay caregivers can also benefit from the use of the data from wearables to track care of elderly parents and other homebound patients. Wearables can provide data such as steps, sleep patterns, and electrocardiograms, along with automatic analytics. These data can help NPs more quickly diagnose issues and intervene sooner to prevent readmissions or negative sequelae because they give more insight to day-to-day patient activities.[14] In addition, wearables gather information automatically therefore helping to overcome limited memories and capacity for accuracy. This can help NPs have a more comprehensive view of the patient.

A number of studies support the potential health care value of the measured data from wearables. The use of pedometers has been associated with increases in physical activity and decreases in blood pressure and body mass index (total n = 2767).[15] Low et al[16] found an association between steps and 30- and 60-day readmission rates in patients with metastatic peritoneal cancer (n = 71). More steps were also associated with lower readmission rates and reduced risk of cardiovascular events in cardiac surgery patients (n = 133).[17]

Challenges of Wearable Technology

For some, however, the challenges may outweigh the benefits. Although the advantages of wearables continue to multiply, a number of challenges need to be overcome to increase adoption by NPs and patients alike.

Sustainability

Although there are more than 5 billion consumer smart devices in use globally as of 2017, not all consumers continue to use the data from these devices.[6] Epstein et al[18] proposed a model of continued use of these devices in four stages: stage 1 is the actual decision to

track data with a wearable. Users usually track data for a specific reason or incentive, such as weight loss or improved health in general, although some just use these devices because it is the "thing to do." Once a decision is made to track data via a wearable, stage 2 is selecting the actual device, which is usually selected based on price and features, as well as what the user is hoping to accomplish with the device. Stage 3 relates to acting on the data tracked, learning about the data, and making meaningful and positive changes. Stage 4 is lapsing; that is, stopping self-tracking with the possibility of resuming use at a later time. Although not all users stop using the wearable, some stop tracking for reasons, such as cost, technology failure, lack of interest and time, or having met their goals or the benefit from tracking fades.[18] As wearables become more convenient and attractive, sustained use will also increase.[19]

Dehghania et al[11] applied technology adoption models to smartwatches to study users' intentions to continue to use these devices to track personal data, including exercise, diet and caloric intake. Their study demonstrated that "aesthetic appeal" increased the likelihood of continued use while technology issues often led users to abandon these devices (n = 385) (p 487). Jarrahi, Gafinowitz, and Shin[20] looked at Fitbit activity trackers with faculty and staff (n = 29) at a large US university and concluded that these devices tend to be used by already-motivated individuals, and unless the data continues to be valuable to the users, they will not sustain use. They found that the devices themselves do not create incentive but instead can potentially help users to create new goals to track. Encouraging patients to use wearable devices can increase engagment in their own care and increase the likelihodd they will continue to wear the device and track data.

Digital Divide

The use of wearable devices has doubled from 2014 to 2016, but 36% of users are millennials.[21] Individuals who have the most access issues, such as low-income, rural, and homebound populations, are those who could most benefit from wearables. The International Telecommunication Union, the United Nations' official source for global information and communications technology statistics, reported that 53.6% of households worldwide have Internet access, whereas 84% of households in developed countries have access from home.[22] Although 87% of households have broadband access and more than 84% have at least 1 smartphone, rural households and older Americans are still the largest groups of non-Internet users.[23] Without access to the Internet at home, wearables are not always usable. This divide may alter how NPs need to work with patients and may further extend differences in care between populations.

Failure Rates

The US Food and Drug Administration assesses devices that function like medical devices, such as those that use an attachment to the phone to measure, diagnose, or treat a medical problem, turning the phone into the controller or screen for the device.[24] It does not, however, regulate most wearable devices or apps because these do not qualify as medical devices or they pose such a low risk to patients that medical device requirements are not currently enforced.[25] Wearable devices, and the supporting apps, vary on the information they provide, as well as the reliability, validity, and accuracy of the data. For example, devices worn on the hip are the most accurate for counting steps.[4] Devices worn on the wrist are not as accurate for measuring steps, although they are close.[26] Each type of wearable device is less accurate for measuring energy expenditure than they are for measuring steps.[26] Some devices have error margins up to 25% for tracking physical activity.[27,28]

The lack of accuracy and/or failure rates of the devices presents a conundrum for NPs. If the data are not accurate, then they should not be used to direct care or diagnose symptoms. Patients, however, do not always understand the need for validity and reliability of these devices and often believe the data they provide are factual. NPs can to help patients understand the meaning and accuracy of their data.

Lack of Predictive Comparability

In general, studies do not support evidence that wearables make people healthier.[29-32] Often, the person who is using the wearables is already healthier than the person who is not tracking. In addition, Piwek, Ellis, Andrews, and Joinson[33] reported that 32% of consumers stop tracking after 6 months and 50% after 1 year. With the explosion of smartwatches, however, more people may continue to track for longer periods of time.

Privacy and Security

Agreement to the devices' terms and conditions usually includes consent to the use of data. During this consent process, users are agreeing to allow the developer to be able to share data collected with third parties for marketing and marketing research purposes. Users rarely understand the full breadth of the availability of their data to others, either through consented or unconsented use. Too much tracking can also feel intrusive and patients may be resistant to use these devices and/or share the data. In 1 study tracking blood glucose that included 184 patients over age 70 newly diagnosis with type II diabetes, patients showed higher scores on a depression subscale when they used self-trackers.[34] In addition, patients may become over-reliant on tracked data and/or inaccurately self-diagnose. According to a 7-country survey of more than 7,000 health care consumers, however, both users and NPs are willing to use this data, but clear parameters are needed.[21] Although NPs may be willing to use patient-generated data, however, integrating these data into the patient's electronic health record (EHR) is not easily accomplished.

Implications for Informatics

Informatics nurses are "concerned with the creation, structure, storage, delivery, exchange, interoperability, and reuse of nursing and clinical information along the continuum of care" (p. 6).[35] Informatics nurses are often seen to be digitally savvy in many types of technology and are well positioned to help NPs use patient generated data. Informatics nurses have at least a basic understanding of the available types of data from trackers and an appreciation of the value some patients see in this data. In addition, they understand the accuracy, reliability, and validity of data and know how to assess its potential value in the EHR.

Once informatics nurses assess the tracked data available, they can work with NPs to determine which data are worth tracking in the EHR. For example, informatics nurses can help to add questions about the use of digital self-tracking in the initial visit data, which may help prompt patient data sharing. Other questions could assess whether the patient uses a tracker, what type of data they tracked, the frequency and regularity of tracking, or why they do not currently track any personal data.

In addition, informatics nurses can help to create separate fields for NPs to document patient-generated findings in the EHR, which can help NPs to begin to get a better picture of patient behaviors. Most NPs do not want all the data from the trackers integrated into the EHR; however, third-party software that can be used to interface data from trackers.[4] This software is currently used mostly in research rather than in practice. More investigation is needed to

determine whether there is a real need to interface all the data from a tracker in the EHR.

Implications for Patient Care

Although not all patients track their data, studies suggest that patients would likely share their data with their NP.[7] Wearable data can be one more input incorporated into the plan of care to help NPs improve patient outcomes. NPs should be prepared to interact with this patient data along with other reported data. Querying patients about their use of wearable technology and what they are tracking can initiate a discussion about their compliance with care. For example, most wearables remind users to stand up or walk when they are not meeting the defined goals and NPs can encourage compliance with these goals.

NPs can also review the trended data from the wearable to address outliers, such as days with few steps or drops in heart rate. This could start a conversation with the patient to encourage the use of self-tracking and how and when to share it or seek help based on these data. In addition, NPs can discuss the accuracy and usefulness of self-tracking with both patients and family members.

Patients are collecting more and more data outside of hospital and NP offices. If patients are tracking data, they may be changing their behavior and already paying more attention to their care. Bringing these data into a visit even if it is just a discussion about the use or the trends of the data or how patients felt when they saw the data in their everyday life has value. More feasibility studies are needed to determine the best way to incorporate wearables data into patient care.

Implications for Future Research

Researchers are reporting some value to wearables when used as a secondary diagnostic tool for preventable and chronic diseases such as depression, Parkinson disease, and sleep apnea.[33,36] Wearables can also provide instant feedback for patients with obesity, anxiety, panic disorders, posttraumatic stress disorders, and asthma, which may help improve outcomes.[37] With more instant feedback and an individualistic approach, patients may be more likely to use wearables to track data than they were for static (or paper) methods. Stanford University's Apple Heart Study is gathering electrocardiograms from volunteers using the Apple Watch to "improve the technology used to detect and analyze irregular heart rhythms" (https://med.stanford.edu/appleheartstudy.html). Cella et al[38] used a wearable to track autonomic activity and movements and found that patients with schizophrenia (n = 30) had less autonomic activity and movements compared with their control group (n = 25). Nunes, Montero, and Filho[39] are studying design to determine which "characteristics positively and negatively influence current adoption of wearable technologies" (p. 231). More research is needed, however, so these findings can be applied to larger populations.

According to Statista, a provider of market and consumer data, there were more 47,000 healthcare apps in the Apple Store as of the first quarter 2018 (https://www.statista.com/statistics/779910/health-apps-available-ios-worldwide/). Apple has a specific site (www.apple.com/healthcare) to market healthcare apps to developers, hospitals, NPs, and patients. Apple's ResearchKit is an open source framework for building apps and is touted to make "it easier to enroll participants and conduct studies" (https://www.apple.com/researchkit). Apple's CareKit is an expansion of this framework to help developers build apps to help patients manage their own care.

Google has also focused on healthcare with their Calico product. Unlike Apple, Google's Calico is not focused on developing apps but instead is focusing on the data produced. Google describes Calico's mission to "harness advanced technologies to increase our understanding of the biology that controls lifespan" (https://www.calicolabs.com). Although most of Calico's research is still in the think-tank stage across populations, it is focused on helping people lead healthier, longer lives. Most of their published research has been in the laboratory looking at animals and cells, rather than a user's data. There is, however, funding and studies are focused on curing cancer and intractable diseases with a goal to increase longevity.[40]

Summary

Data from wearables can be used as a secondary diagnostic tool by providing data to track patient information over time. Users can see their data instantly and use this information to change their activities or determine when to contact an NP for further assessment. This can be especially useful for homebound patients or for those who have a hard time accessing an NP. By integrating these data into a scheduled patient visit or hospital stay, NPs can instruct patients on normal values and when to contact their NP for further assessment. Because there is so much potential information, the data can be made available in the EHR and documented as part of the visit as findings. Rather than just looking at performance—increasing and decreasing numbers—NPs can use the data as part of their assessment. In this way, the information will become more useful in the care of the patient.

Although wearable data can provide useful information for NPs, effort is still needed to help patients sustain the use of the devices and understand the accuracy of the data. NPs, as well as patients, need to treat data from wearables as they do other clinical data to maintain privacy. More research is needed to determine the best use of these extensive data.

Eric Topol[12] sums up the value of these devices as follows: "anywhere you can get a mobile signal, you'll have new ways to practice data-driven medicine. Patients won't just be empowered; they'll be emancipated" (p. 5). NPs have the ability to help empower and emancipate patients and increase patient centered care.

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