

## Utilizing Digital Health Technologies for Patient Education in Lifestyle Medicine

**Abstract:** *Technology has redefined the way patients and providers communicate and obtain health information. The realm of digital health encompasses a diverse set of technologies, including mobile health, health information technology, wearable devices, telehealth and telemedicine, and personalized medicine. These technologies have begun to improve care delivery without the traditional constraints of distance, location, and time. A growing body of evidence supports the use of digital health technology for improving patient education and implementation of skills and behaviors integral to lifestyle medicine. Patient education can now be delivered in standard formats (eg, articles, written messages) as well a wide array of multimedia (video, audio, interactive games, etc), which may be more appropriate for certain topics and learning styles. In addition, patient engagement in their care plays an important role in improving health outcomes. Despite digital health technology development often outpacing its research, there is sufficient evidence to support the use of many current technologies in clinical practice. Digital health tools will continue to grow in*

*their ability to cost-effectively monitor and encourage healthy behaviors at scale, and better methods of evaluation will likely increase clinician confidence in their use.*

**Keywords:** Digital health technology, patient education, lifestyle medicine



**[Digital] technologies have begun to improve care delivery without the traditional constraints of distance, location, and time.**



Technology has redefined the way patients and providers communicate and obtain health information. Globally, an estimated 6.75 million internet queries on health-related topics are conducted every day.<sup>1</sup> In 2013, the Pew Research Center found that 72% of Internet users in the United States searched for health information the previous year, with 35% using the Internet to determine their own or someone else's medical condition.<sup>2</sup>

Digital health encompasses a diverse set of technologies, including mobile health, health information technology,

wearable devices, telehealth and telemedicine, and personalized medicine.<sup>3</sup> These technologies have begun to improve care delivery without the traditional constraints of distance, location, and time.<sup>4</sup> They also offer new opportunities to educate patients and facilitate the process of behavior change

integral to lifestyle medicine. Patient education can now be delivered in standard formats (eg, articles, written messages) as well a wide array of multimedia (video, audio, interactive games, etc), which may be more appropriate for certain topics and learning styles. Furthermore, education is not only the consumption of information but also the implementation and mastery of skills, sometimes referred to as experiential learning. Patient engagement in their care plays an important role in health outcomes. Engaged patients cost health care systems 8% less than

nonengaged patients in their base year, and 21% less in future years.<sup>5</sup>

### Text Messaging

Text messaging is the most widely used data application in the world—used by over 78% of all mobile phone subscribers as of 2012<sup>6,7</sup> and over 97% of all mobile phone subscribers in the United States as of 2015.<sup>8</sup> It is effective for reaching its audience, with estimates that 99% of received mobile text messages are opened and 90% within three minutes of receipt.<sup>9,10</sup> Messages can be timed precisely, ranging from infrequent reminders to bursts throughout the day to specific moments of decision making. Multiple reviews have shown benefit in diabetes, cardiovascular disease, weight loss, physical activity, smoking cessation, and medication adherence.<sup>11-15</sup>

Extensive literature exists on user-centered design for provision of educational material. Considerations include the length of the message,<sup>16</sup> sender of the message, style of writing, cultural and linguistic appropriateness,<sup>6,17</sup> literacy level of the population (generally eighth-grade level is maximum used for adults), and the need for translations.<sup>18</sup> Some studies provide more messages during key behavior change periods, some only send messages when requested by a user, and others vary frequency based on the text habits of their users or based on users' adherence (e.g. higher frequency when adherence is low).<sup>18</sup> An example includes The Tobacco, Exercise and Diet Messages (TEXT ME) trial, a randomized clinical trial of 710 patients with coronary heart disease. The intervention group received 4 text messages per week for 6 months in addition to usual care. Text messages provided advice, motivational reminders, and support to change lifestyle behaviors. Compared with usual care, this intervention resulted in a modest improvement in LDL-C (low-density lipoprotein cholesterol) level and greater improvement in other cardiovascular disease risk factors.<sup>19</sup>

### Mobile (Smartphone and Tablet) Applications

A mobile application (“app”) is a computer program designed to run on a mobile device such as a smartphone or tablet. An estimated 81% of US adults owned a smartphone as of 2018,<sup>20</sup> and approximately 325 000 health-related applications existed in 2017 for Apple iOS or Android smartphones,<sup>21</sup> with the most popular apps focused on healthy eating and physical activity.<sup>22,23</sup> Apps educate patients by providing insight into their behaviors and opportunities to practice new skills. A systematic review demonstrated that women with diabetes receiving preconception care education delivered either digitally or via health care professionals had significantly improved levels of glycosylated hemoglobin with fewer preterm deliveries and adverse fetal outcomes. The digital interventions further showed significant improvements in knowledge and attitudes toward preconception care, along with reduced barriers.<sup>24</sup> Other examples of apps that provide education include myIBDcoach, my AF and mySinusitisCoach.<sup>25-27</sup>

### Wearables Devices

Wearable devices and sensors most commonly provide heart rate tracking and physical activity monitoring. Additionally, they can monitor sleep, track mood or stress levels, or deliver workouts. One in 6 consumers in the United States now uses wearable technology,<sup>28</sup> with over half being smartwatches. As of 2017, 17% of US adults used a wearable device such as a smartwatch or a wrist-worn fitness band.<sup>29</sup> Nonwearable sensors are contributing to the rise of the Internet of Things—a network of sensor-equipped devices able to exchange data. For example, digital scales can now detect not only weight and body fat measurements but also streamline daily weigh-ins by automatically sending measurements to a smartphone application or an online database.<sup>30</sup> Smart refrigerators can help track

available groceries, create shopping lists, and even help order food.<sup>31</sup> Mattress covers connected to the internet can monitor temperature, breathing, and heart rate to track sleep quality.<sup>32</sup> Eventually, these smart devices may operate in concert to monitor patient lifestyle and provide personalized education and feedback to encourage healthier behaviors.

### Social Media

Social media is defined as an online means of communication used to share information and develop social contacts.<sup>33</sup> It includes online social networks, forums, and messaging boards. Though it does not replace the need for in-person networks and connections, social media creates a new space for education, emotional support, campaigning, fundraising, and network formation.<sup>34</sup> Online social support is particularly valuable for individuals with limited mobility as it decreases barriers for physical transportation. There have been positive studies with weight loss and smoking cessation.<sup>35-40</sup> Patient-shared data can also be collected online to create research databases. For example, a social network focused on ALS (amyotrophic lateral sclerosis) treatment compiled patient outcomes showing that lithium had no clinical effect within the first 12 months,<sup>41</sup> highlighting the potential of patient shared data to accelerate clinical findings. Evidence about social media's impact on health knowledge, behavior, and outcomes shows these tools can be effective in meeting individual and population health needs.<sup>42</sup>

### Telehealth

Telemedicine is broadly defined as the use of technologies to remotely diagnose, monitor, and treat patients.<sup>43</sup> Telemedicine fits under the larger umbrella of telehealth services, which entails the application of technologies to help patients manage their own illnesses through improved self-care and access to education and support systems.<sup>44</sup> Examples of telehealth interventions that

have shown benefit in mortality and cost-savings include home telemonitoring programs for congestive heart failure, remote intensive care unit monitoring, and home health monitoring for veterans. Additionally, telehealth programs have been shown to improve medication adherence and access to specialty providers.<sup>44</sup> A telehealth educational platform and interactive care plan for people with diabetes uses a voice-enabled scale and diabetic foot scanner.<sup>5</sup>

### Digital Therapeutics

Digital therapeutics are evidence-based digital health tools, often Food and Drug Administration approved, which integrate the above technologies in order to treat or reverse disease conditions. They are comprehensive treatment programs that may be prescribed by a clinician to replace or augment traditional treatments. Some digital therapeutic programs for diabetes and weight loss are now covered by insurance plans.<sup>45</sup> Digital therapeutics can collect a high volume of user data from a variety of sources, ranging from traditional clinical biomarkers to physiologic sensors<sup>46-48</sup> and social patterns.<sup>49</sup> These data sets allow for big data analytics during active treatment periods, easy access to longitudinal data patterns, insight into the effectiveness of specific lifestyle medicine program variations, and opportunities to provide education. Most digital therapeutics provide some form of patient education. For example, a randomized control trial demonstrated a 12-week remote digital care program improved low back pain by providing sensor-guided exercise therapy, education, cognitive behavioral therapy, behavioral coaching and tracking.<sup>50</sup> Other programs providing patient education have shown benefit in improving sleep,<sup>51</sup> diabetes and other chronic disease management.<sup>52,53</sup>

### Emerging Technologies

#### Virtual and Augmented Reality

Virtual reality (VR) is an artificial, computer-generated simulation of a

real-life environment, usually requiring users to wear a headset for an immersive experience. Augmented reality (AR) is a technology that layers computer-generated enhancements atop an existing reality. AR is built into applications on mobile devices to add digital components into the real world.<sup>54</sup> This technology allows patients to implement new behaviors and skills through experiential learning. A lifestyle medicine application is the augmented reality game called *Pokemon Go* (developed by Niantic, Inc) that was developed for iOS and Android devices. The application was adopted by 40 million users worldwide and had 500 million downloads.<sup>55</sup> A study showed a 34.8% relative increase in step counts, while the number of participants achieving a goal of 10,000 steps per day increased from 15.3% to 27.5%.<sup>56</sup> A recent randomized review presented another augmented reality example in which a tablet application helped participants more accurately measure standard serving sizes compared with those who received information only.<sup>57</sup> Finally, a 2017 systematic review and meta-analysis of 28 studies showed that virtual reality games had positive effects on balance and fear of falling in community-dwelling older adults.<sup>58</sup>

#### Big Data and Machine Learning

The technologies described in the preceding sections will generate massive amounts of data, requiring advanced analytics to make the data meaningful and actionable. Artificial intelligence—the ability for machines to mimic facets of human cognition—is already being applied to other fields of medicine, such as making diagnoses in radiology and pathology.<sup>59</sup> The branch of artificial intelligence that likely holds the most short-term relevance for lifestyle medicine is that of machine learning (ML). ML is an analytical method that allows a computer to be trained on massive quantities of data to make decisions about other data.<sup>60</sup> ML can identify certain patterns of physiological or behavioral data, sometimes referred to

as digital biomarkers, which can be used to predict the likelihood of future clinical outcomes. Such “predictive analytics” have potential to augment digital lifestyle medicine, as they could be embedded in behavioral feedback loops and population medicine strategies.<sup>61</sup> For example, a digital therapeutic could capture patient text messaging patterns to assess the need for mental health intervention<sup>62</sup> or monitor arm movements to determine abnormal eating patterns.<sup>63</sup>

### Physician's Role

The 2003 Health Information National Trends Survey found that nearly half of 6,369 surveyed adults searched online first for information on cancer compared to only 11% who sought a physician's counsel first. Information available on the internet has helped inform and empower patients, shifting the patient-physician dynamic in the process.<sup>64</sup> Despite the ease of access to information, there remains a lack of standards and a broad spectrum of quality and rigor.<sup>65</sup> Physicians can play a major role in directing patients toward appropriate and substantiated educational materials and facilitating the uptake of digital health technologies in their patient populations.<sup>66</sup> For example, physicians can communicate electronically with patients through the electronic medical record, which has been shown to increase patient satisfaction, promote adherence to preventative and treatment recommendations, improve clinical outcomes, and lower medical costs.<sup>67</sup> However, physicians themselves need better ability to assess the validity and utility of digital health products, and recent proposals such as a digital health scorecard utilizing an evaluation framework with technical, clinical, usability, and cost domains may increase clinician confidence.<sup>68</sup>

### Conclusion

A growing body of evidence supports the use of digital health technology for improving patient education and

implementation of skills and behaviors integral to lifestyle medicine. Despite digital health technology development outpacing its research, there is sufficient evidence to support the use of many current technologies in clinical practice. Digital health tools will continue to grow in their ability to cost-effectively monitor and encourage healthy behaviors at scale, and better methods of evaluation will likely increase clinician confidence in their use.

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Not applicable, because this article does not contain any studies with human or animal subjects.

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### Trial Registration

Not applicable, because this article does not contain any clinical trials. **AJLM**

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