International Journal of Cardiology 293 (2019) 294–296

Contents lists available at ScienceDirect

International Journal of Cardiology

journal homepage: www.elsevier.com/locate/ijcard

Review

Technology approaches to digital health literacy

Patrick Dunn [a,b], Eric Hazzard [c,*]

[a] American Heart Association, Dallas, TX, USA
[b] Walden University, Minneapolis, MN, USA
[c] TupeloLife Services, Dallas, TX, USA

ARTICLE INFO

Article history:
Received 3 June 2019
Accepted 14 June 2019
Available online 15 June 2019

Keywords:
Health literacy
Technology
Digital
Remote patient monitoring

ABSTRACT

Digital health literacy is an extension of health literacy and uses the same operational definition, but in the context of technology. Technology solutions have the potential to both promote health literacy or be a barrier. To be effective, health technology solutions should go beyond building literacy and numeracy skills to functional and critical skills, such as navigating the healthcare system, communication with healthcare providers, and shared decision making. New and emerging technologies are highlighted: AI/machine learning, voice first, remote patient monitoring, wearables, and apps and web sites. Health technology represents enormous promise in the building of digital health literacy skills and improved health outcomes in patients with cardiovascular and other chronic conditions. This is a promise, however, that is yet to be fulfilled.

Topics: Hypertension, Rehabilitation, Metabolic Syndrome, Health Policy, Risk Factor.

1. Introduction

Health literacy is the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions [1]. Digital health literacy is the next extension and uses the same operational definition, but in the context of technology. It involves the delivery (the medium) of the information, as well as extent to which the information is understood. Technology solutions have the potential to both promote health literacy or be a barrier. Technology solutions have the potential to increase access to and transparency of information, improving communication between the patient and the healthcare professional. Technology has the capability of presenting information to patients in a more engaging and provide more ongoing, dynamic and highly personalized plans. Technology also can be a barrier if it limits access to groups that may not be able to afford expensive devices, such as smart phones and wearables.

But how does technology specifically address health literacy? As with best practices for promoting health literacy, simply providing individuals with information is likely not enough [2,3]. To be effective, health technology solutions should go beyond building literacy and numeracy skills to functional and critical skills, such as navigating the healthcare system, communication with healthcare providers, and shared decision making [4]. Table 1 includes the opportunities and examples of several new and emerging technologies that are being developed in healthcare.

Artificial intelligence/Machine learning and voice first applications:

From building driverless cars to establishing highly personalized care plans for cancer or common and rare diseases, artificial intelligence and machine learning (AI/ML) represent an amazing opportunity to transform the healthcare system [5,6]. AI/ML also can build health literacy skills considering the many dimensions health management, including the demographic, social, medical and behavioral signatures of the individual, and incorporating the learning preferences and personality traits to create a highly personalized and dynamic experience. Traditional solutions typically address one dimension at a time, such as social determinants, medical care and treatment, behavior and lifestyle, or personality, but with AI/ML an individual signature for each patient can be established. An example of a real-word application is just-in-time adaptive intervention (JITAI) design- AI/ML applied to modify behavior by selecting the appropriate channel (sms, email, phone call, etc.), the content level/preference (reading level, video, voice, etc.) at the right time (25 min prior to usual bedtime) [7].

In addition to the horizontal scaffolding of moving across these dimensions, AI/ML can move vertically by building on the knowledge and skills of the individual and by filling in gaps in care and knowledge. Ultimately, machine learning can be used to build deep learning algorithms that can result in better health outcomes, by focusing on the functional and critical health literacy skills. AI/ML has the potential to be a game-changer for complex, hard to solve problems, such as modifying behaviors (medication adherence and nutrition), reducing readmissions in heart failure patients, improving referral, participation, and completion of cardiac rehabilitation, and reducing medical errors.

Abbreviations: ML, Machine learning; AI, artificial intelligence.

* Corresponding author at: 4761 Greenbrier Ave., San Diego, CA 92120, USA.
E-mail address: eric@tupelolife.com (E. Hazzard).

https://doi.org/10.1016/j.ijcard.2019.06.039
0167-5273/

Table 1
Technology solutions that can improve digital health literacy.

Technology	Opportunity	Example
AI/machine learning	Deep learning algorithms leading to highly personalized treatment and care plans.	Genomics
Voice	Improve communications by using voice vs. numbers. Natural language processing.	Siri, Alexa, Google Home
Wearables	Afib detection	Apple/AliveCor
Remote monitoring	Blood pressure	Check.Change.Control
Apps	Connect knowledge, numeracy, navigation, communication, and decision-making domains of health literacy	Establishing a digital biomarker

Unlike in the case of driverless cars, where the goal is to eliminate human involvement, the opportunity for AI/ML in healthcare is to optimize the balance between humans and machines. AI/ML will likely take over many repetitive tasks, such as documentation, leaving the healthcare professions to be enabled by AI/ML for higher level decision making. For this to occur it will be even more important that technology is used to build health literacy skills in patients, resulting in better communication and decision making by both the patients and their healthcare providers. In addition, the utilization of AI/ML image processing technology (analyzing a video to confirm ingestion of medication) to support medication compliance (the act of taking medication on schedule or taking medication as prescribed) may enable patients, their families, caregivers, and physicians to adhere to a polypharmacy care plan. One such combination of software and hardware is MedCab, an in-home point-of-care device that dispenses medication and confirms ingestion using video intelligence [8].

Building on AI/ML voice first applications are an emerging technology solution. Common examples of voice first include Siri, Cortana, Alexa, and Google Home. Voice first is also a feature in many robotic solutions. Voice first has the advantage of communicating with the patient/user is a natural communication rather than in a less natural numeric format. Using natural language processing, a voice first application may be able to better understand and build on the vocabulary used by the patient. These voice applications can capture key information from the patient without the need for an endless stream of assessments.

Voice applications also may improve the capture of key information on the clinical side, thereby reducing the documentation load on clinicians. This improved communication between the clinician and the patient has the potential to close health literacy gaps that are created by poor communication and mis-understanding on both parts.

1.1. Remote patient monitoring

While remote patient monitoring systems have traditionally relied on collection of biometric data, such as physical activity, weight, blood pressure and glucose, and subjective behavioral data, such as medication and symptom management, the next generation of patient monitoring includes detection of environmental factors, breathing, and abnormal heart rhythm, including atrial fibrillation. Remote monitoring has been studied extensively in patients with high blood pressure and heart failure. Self-management of blood pressure has resulted in improved blood pressure control and better adherence to blood pressure medications [9,10]. The American Heart Association demonstrated improved blood pressure control in a pharmacist led intervention and in a community setting [9,10] leading to the development of Check. Change.Control, which includes over 35,000 users. Of course, self-monitoring of glucose of is a normal part of the management of diabetes. Blood pressure and glucose monitoring are opportunities to provide the patient with biometric feedback. While remote monitoring of heart failure patients is a strategy for reducing readmissions through early identification of signs of decompensation, evidence from randomized trials has been unfavorable, with inconsistent, and in some cases no or negative results [11,12]. Both Apple and AliveCor have demonstrated that atrial fibrillation can be detected with a wearable [13].

1.2. Apps and web sites

The most obvious technology solution to build health literacy skills are apps and wearable devices. There are over 300,000 health related apps and over half of them are able to connect to biometric data, such as physical activity, blood pressure, or glucose [14]. These apps can provide educational opportunities through video and print, and the ability to connect this information to the numbers. For example, the app can provide information on physical activity and track activity using an accelerometer. Push notifications can be used to remind the patient of activities or behaviors, such as taking medications. Since apps are part of the smartphone ecosystem they also have the ability to connect to social media and can even be used for tele visits. The use of the app itself and become a digital signature that is unique to the individual, incorporating the relevant topics and in a way that best describes the personality and preferences of the individual. The challenge with apps is that the usage and impact on health literacy and health outcomes remains unclear.

1.3. Electronic health records

Since electronic health records (EHR) have become a mainstay in the delivery of healthcare they are an important part of any health technology ecosystem. EHRs also contain vital information, relevant to both the clinician and the patient. Since many third-party technology systems are not connected to the EHR they can disrupt the workflow of the healthcare provider. The most common technology built into the EHR is the patient portal. While the patient portal has the advantage of making many parts of the medical record available to the patient and can be a way for the patient and the provider to communicate, there is no evidence that the EHR is an effective way to build health literacy skills and improve health outcomes.

2. Conclusions

Health technology represents enormous promise in the building of digital health literacy skills and improved health outcomes in patients with cardiovascular and other chronic conditions. This is a promise, however, that is yet to be fulfilled. The American Heart Association has developed a roadmap designed to improve cardiovascular health that embraces the use of new technologies, includes patient centered care plans, and better research and evaluation models [15]. For health technology to fulfill this promise, health literacy should be considered as solutions are being developed. These solutions should find the best mix of human and machine knowledge with the ultimate goal of achieving longer and healthier lives for all. This will require a conceptual model that incorporates the innovative nature of technology and the scientific nature of researchers and clinicians [16].

Declaration of Competing Interest

Eric Hazzard worked for TupeloLife and all the authors report no relationships that could be construed as a conflict of interest.

References

[1] R. Parker, S. Ratzan, Health literacy: a second decade of distinction for Americans, J. Health Commun. 15 (2012) 20–33.
[2] D.A. DeWalt, L.F. Callahan, V.H. Hawk, K.A. Boucksou, A. Hink, R. Rudd, C. Brach, Health Literacy Universal Precautions Toolkit, Agency for Healthcare Research and Quality, Rockville, MD, 2010https://doi.org/10.1001/jama.2010.1844.

[3] J.W. Magnani, M.S. Mujahid, H.D. Aronow, C.W. Cene, V.V. Dickson, E. Havraneck, L.B. Morganstern, M.K. Paasche-Orlow, A. Pollak, J.Z. Willey, on behalf of the American Heart Association Council on Epidemiology and Prevention, Council on Cardiovascular Disease in the Young, Council on Cardiovascular Stroke Nursing, Council on Peripheral Vascular Disease, Council on Quality of Care, and Outcomes Research and Stroke Council, Health literacy and cardiovascular disease: fundamental relevance to primary and secondary prevention: a scientific statement from the American Heart Association, Circulation 137 (2018) 00.
[4] P. Dunn, S. Conard, Improving health literacy in patients with chronic conditions: a call to action, Int. J. Cardiol. 273 (2018) 240–251.
[5] A.L. Fogel, J.C. Kvedar, Artificial intelligence and powers of digital medicine, NPJ Digit. Med. 1 (2018) 5.
[6] E.J. Topal, High-performance medicine: the convergence of human and artificial intelligence, Nat. Med. 25 (2019) 44–56.
[7] Magid.DJ., Olson, KL., Bilups, SJ., Wagner, NM., Lyons, EE., Kroner, BA, A pharmacist-led, American Heart Association Heart 360 web-enabled home blood pressure monitoring program, Circ. Cardiovasc. Qual. Outcomes 6 (2013) 157–163.
[8] J.G. Thomas, G.S. Bond, Behavioral response to a just-in-time adaptive intervention (JITAI) to reduce sedentary behavior in obese adults: implications JITAI implementation, Health Psychol. 345 (2015) 1261–1267.
[9] Google Cloud, Video AI, N.d. Retrieved from: https://cloud.google.com/video-intelligence/.
[10] K.L. Thomas, B.R. Shah, S. Elliot-Bynum, K.D. Thomas, K. Damon, N.A. LaPointe, S. Calhoun, L. Thomas, K. Breathett, R.M. Mathews, M. Anderson, R.M. Califf, E.D. Peterson, Check it, change it: a community-based, multifaceted intervention to improve blood pressure control, Circ. Cardiovasc. Qual. Outcomes 7 (2014) 828–834.
[11] B. Riegel, D.K. Moser, H.G. Buck, V.V. Dickson, S.B. Dunbar, C.S. Lee, T.A. Lennie, J.A. Lindenfeld, J.E. Mitchell, D.J. Treat-Jacobson, D.E. Webber, on behalf of the American Heart Association Council on Cardiovascular and Stroke Nursing; Council on Peripheral Vascular Disease; and Council on Quality of Care and Outcomes Research, Self-care for the prevention and management of cardiovascular disease and stroke, J. Am. Heart Assoc. (2017) 6.
[12] L.E. Burke, J. Ma, K.M.J. Azar, G.G. Bennett, E.D. Peterson, Y. Zheng, W. Riley, J. Stephens, S.H. Shad, B. Suffoletto, T.N. Turan, B. Spring, J. Steinberger, C.C. Quinn, on behalf of the American Heart Association Publications Committee of the Council on Epidemiology and Prevention, Behavior Change Committee of the Council on Cardiometabolic Health, Council on Cardiovascular and Stroke Nursing, Council on Functional Genomics and Translational Biology, Council on Quality of Care and Outcomes Research, and Stroke Council, Current science on consumer use of mobile health for cardiovascular disease prevention: a scientific statement from the American Heart Association, Circulation 132 (2015) 1157–1213.
[13] J. Halcox, K. Wareham, A. Cardew, M. Gilmore, J.P. Barry, C. Phillips, M.B. Gravenor, Assessment of remote heart rhythm sampling using the AliveCor heart monitor to screen for atrial fibrillation, Circulation 136 (2017) 1784–1794.
[14] IQvia Institute for Human data Science, The Growing Value of Digital Health, Iqvia Institute, Parsippany, NJ, 2017.
[15] Z.J. Eapen, M.P. Turakhia, M.V. McConnell, G. Graham, P. Dunn, C. Tiner, C. Rich, R.A. Harringson, E.D. Peterson, P. Wayte, Defining a mobile health roadmap for cardiovascular health and disease, J. Am. Heart Assoc. 5 (2016), e003119. https://doi.org/10.1161/JAHA.115.003119.
[16] I. Nahum-Shani, S.N. Smith, B.J. Spring, L.M. Collins, K. Witkiewitz, A. Tewari, S.A. Murphy, Just-in-time adaptive interventions (JITAIs) in mobile health: key components and design principles for ongoing health behavior support, Ann. Behav. Med. 52 (6) (2018 May 18) 446–462.