

SMART Technology: Redefining Geriatric Health Care

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Citation: Miller TW, Kraus RF, Standafer V (2017) SMART Technology: Redefining Geriatric Health Care. Int J Geriatr Gerontol: IJGG-101. DOI: 10.29011/IJGG-101.170001

Received Date: 22 May, 2017; **Accepted Date:** 26 June, 2017; **Published Date:** 03 July, 2017

Abstract

Examined is the advances, availability and use of smart technology for self-monitoring behavior change with a geriatric population. An introduction to SMART technology along with a relevant literature review is offered. A single case study design provides a clinical application model with a geriatric patient. In this case, it is hypothesized that the use of a wearable self-monitoring device while involved in the counseling for multiple health conditions is beneficial to both behavioral compliance and behavioral change in a patient being treated by a multidisciplinary health team utilizing an integrated treatment model. An exploratory case study research design is employed to examine the hypothesis. Wearable SMART technology has a place in contemporary health counseling interventions. There is an emerging research literature in support of an effective intervention methodology for improved health and well-being as measured by health and wellness markers utilizing a wearable SMART technology. Current limitations along with future directions are discussed. Geriatric patients may benefit from the utilization of wearable SMART technology.

Keywords: Dialectic Behavior Therapy; E-Health; SMART Wearable Technology

Introduction

An aging population can find SMART technology a benefit to them in improving their quality of life. There are several home systems and devices that can enable seniors to live in their own homes longer. Seniors have for some time benefited from “Life-Line” type technology to aid them in having quick access to emergency networks. Seniors with early stage Alzheimer’s Syndrome or similar neurological conditions have benefited from automated home features. These devices can help foster a safe and independent living environment.

Several personal wearable smart technology devices are already available and the subject of research beneficial to a growing geriatric population. Among these is the Apple “iWatch” which offers close to a dozen different sensors, tracking the wearers’ health and fitness metrics in terms of steps taken, calories burned, blood glucose, sleep quality and heart rate. There are several customized services available for families who have a senior family member

needing monitoring. The “Smart Medical Home” is a venture to help seniors and caregivers who may benefit from computer based technology in their homes to provide necessary monitoring of behavior and maintain health and wellness for an aging population.

The SMART Medical Home

The 21st century will be the century of quality of life and health. New technologies have been developed to assist patients with Alzheimer’s, Parkinson’s and patients with dementia to adapt and live in a home setting with the aid of the latest technology to assist the with everyday life needs. Designed as a “Living Laboratory,” the University of Rochester’s “SMART Medical Home” is a cross-disciplinary research effort to develop interactive technology for home health care. A joint effort of scientists and engineers from the College, the Medical Center and the University’s Center for Future Health, it is a comfortable apartment type setting surrounded by the busy labs and offices that provide a laboratory that may someday reach real homes.

Thus the “SMART Home” is a venture to help aging persons and caregivers who may benefit from a computer based technol-

ogy in their homes to improve and maintain health and wellness. A cursory glance around the apartment reveals a spacious kitchen, dining room, living room, and bedroom. But it's hard to miss the cameras hanging from the ceiling, the large monitors mounted on the wall and nearby table, and the small sensors located in a grid-like pattern across the ceiling. The wall between the bedroom and living room is open, revealing a series of cameras that would, in the finished product, be located behind a mirror.

Personal Medical Advisor

The SMART medical home provides a computer based medical advisor that provides an interactive option where the aging person can ask a question about their medication and the computer responds with the answer. The personal medical advisor is a flat screen television monitor on a large, wall-mounted monitor, with a computer-animated character called "Chester the Pill" who stands ready to respond with basic information relevant to taking medication accurately and on time. Users are able to interact with the computer by speaking normally, asking questions about which medicines to take or getting advice about symptoms of potential side effects and what to do about such side effects.

Developing the technology to bring Chester to life emphasizes the project's interdisciplinary nature. Computer scientists are developing the virtual intelligence software, while gerontologists are overseeing the database of health and medical information for the targeted aging population.

Neuro-restorative Innovations

Neuro-restoration involves lost neurological function due to the traumatic or ischemic damage to the brain and the associated neurological deficits. SMART technology can contribute to the rehabilitation of traumatic brain injury and stroke. Within the SMART medical home, another computer tracks the location of pre-programmed items such as eyeglasses, coffee cups, or car keys throughout the house so aging person can locate such items when needed. The SMART technology can aid the person in restoring some lost skills due to brain injury. A camera and scanning system can take three-dimensional textured images of one's skin, automatically checking for carefully watched skin features such as moles or skin irritation.

Other trackers are smart monitors that use cameras located around the home, the personal item. When a picture of the sought-after item is touched on a monitor, the system pinpoints where the item was last recorded, an especially helpful tool for aging persons suffering from forgetfulness brought on by some diseases.

Vital signs read at home and transmitted to the Outpatient Clinic

Sensors located in innocuous areas are designed to take bio marker readings readings and gather other helpful information almost without residents' noticing. Environmental sensors could

detect harmful levels of pollen or dust from recycled air and automatically take steps to remedy the situation and alert health care professionals monitoring at a distance not unlike technology similar to life alert technology.

Dermatology Sensors

Researchers envision scanning technology that can take detailed, 3-D images of faces and body parts, and then compare the latest images to those stored from earlier scans. Such comparisons could help detect skin diseases at their earliest stages. Sensors and monitors are now available that are mounted on the wall with small sensors located in a grid-like pattern across the ceiling. A specially programmed computer tracks changes and notes preprogrammed sensors for unexpected behavior changes. A camera and scanning system located behind the mirror can take three-dimensional textured images of a patient's skin, automatically checking for carefully watched skin features such as moles or lesion changes.

Gait Monitors

A gait monitor is being developed to track the way the aging person walks on various surfaces and in different locations. The system's computers will make comparisons over time, checking for any indications of shuffling or limping that may be the precursor to a stroke or for the trembling that may indicate Parkinson's disease. By identifying these ailments early, the hope is that a disease's full effects can be prevented or ameliorated.

SMART Tracking Hydration

Monitoring hydration through SMART technology for determining hydration is now available through multiple SMART items available on the market. For example, LVL provides a fitness tracker that tracks the body's hydration in real time. Hydration is important because water regulates our body's temperature and lubricates our joints during physical activity. It also aids in transporting nutrients to provide needed energy. When adequate hydration is not realized, muscle cramps, dizziness, and exhaustion may occur. SMART technology trackers designed to monitor the body's hydration, heart rate, and physical activity provides the geriatric patient with optimized levels of hydration. Specifically, tracker prompts the patient in real-time, alerting her or him to exactly how much fluid they need and what type of performance advantage they might expect by addressing the need for hydration.

The Smart Bandage

Building on work conducted at the Center for Future Health to develop a "Smart Bandage" that can identify the presence of harmful bacteria, researchers are investigating whether the same technology can be used to identify harmful pathogens in food or on food packaging. Scientists foresee cutting boards that alert you to bacteria like Salmonella or containers and wrapping that will alert consumers when the food is unsafe to eat.

Smart Technology Developers

Boston Life Labs offers wellness, prevention, teaching and disease management through interactive patient communication and complete vital sign monitoring in the home environment through telehealth technology. They provide consumers a complete range of innovative and affordable products for the Smart Medical Home. The SMART Medical Home has the newest advancements in technology and function providing innovation, flexibility, and accessibility. The Bluetooth enabled vital sign monitoring devices such as the wrist blood pressure, SMART Body Scale, a SMART Ear Thermometer, and SMART Pulse Oximeter along with the HPad and HPod are automatically paired with a special e-health monitor box and with the touch of a button, the aging person takes their vital signs or records their answers on the HPad and they are sent automatically by the HBox via telehealth technology to a secure server and finally to health personnel at the medical center and entered into the electronic medical record. The data is easily accessed by patient, clinician, caregiver, or family member allowing enhanced patient care, disease management, and prevention interventions.

While some of the technologies in the project are fully functional today, others are still in development. The ideas and the thinking that goes into making the home safer and creating a healthier center of wellness in the home can produce an environment where people who are in need of such aids, living their lives in their own smart supported home can continue and maintain their quality of life.

Literature Review

A spectrum of Gerontologists and health care professionals are recognizing the value and benefits of utilizing SMART technology options in providing clinical care. E-health is a relatively recent term for healthcare practice utilizing technology-based assessment and treatment strategies that have the potential to deliver benefit to a broad array of individuals who experience anxiety related to their medical conditions [1,2]. SMART technology is a form of synchronous or asynchronous healthcare delivery that may serve as an adjunct to standardized forms of clinical treatment intervention.

Contemporary models of medically supervised healthcare include integrated clinical models that emphasize multidisciplinary teams treating patients. Mental health counselors are recognized as bringing specialized skills to the multidisciplinary integrated health care teams. In treating the whole person, managed care often requires an integrated team approach that addresses both physical and mental health components involving intervention models that require a limited number of appointments that demonstrate measurable improvements in the current managed care environment. Wearable SMART technology provides a potential adjunct for use in assessing the therapeutic progress of some behavioral activities of patients. SMART stands for Self-Monitoring Analysis and Reporting Technology. Recent clinical research [3-5] has identified

the value and benefits of wearable technology for various populations raising the question as to whether there may be beneficial use with individuals in treatment for health-related conditions. Wearable SMART technology employs digital technologies to collect health data from individuals in one location, such as a patient's home, and electronically transmitting the information to health-care providers in a different location for assessment, monitoring and compliance [6-8].

SMART technology use as an adjunct clinical therapeutic model in healthcare has been the object of recent psychotherapeutic interventions and is receiving greater attention in the literature. There are within the telehealth literature relevant research studies which contribute to the current level of evidence supporting SMART technologies role in health therapeutic interventions [1,4].

E-Health (American Telemedicine Association 2015) [9] allows health care professionals to evaluate, diagnose and treat patients in remote locations using telecommunications technology. SMART wearable technologies are viewed as noninvasive digital technologies. Chan Estève, et al. (2012) [6] examined the use of SMART wearable systems in a broad area of health and wellness interventions. The results of their research concluded that advances in SMART technologies and subsequent SMART devices, ranging from sensors and actuators to multimedia devices, support complex healthcare applications and enable low-cost wearable, non-invasive alternatives for continuous monitoring of health bio marker, activity, mobility, mental status, both indoors and outdoors.

There is a geriatric patient who utilize telemedicine and remote patient monitoring through smartphones and PDA devices. A Personal Digital Assistant (PDA) is a handheld device that combines computing, telephone/fax, Internet and networking features. A typical PDA can function as a cellular phone, fax sender, web browser and personal organizer. PDAs may also be referred to as a palmtop, hand-held computer or pocket computer. There is associated software used to transmit patient data to the patient's health care professional, including multiple health care providers and researchers. Such wearable devices worn or placed on one's body record a number of bio-physiological markers including such things as respiratory rate sensors, sleep and waking patterns of activity and blood pressure. There are also biosensor devices for recording data from biological or chemical reactions such as pulse oximeters or spirometers.

The benefits of smart technology and remote activity monitoring has been the object of several recent research studies. This has included healthy aging adults [10], as well as in populations experiencing multiple medical and psychiatric diagnoses, chronic disease management conditions, treatment adherence, patient outcomes and compliance with prescribed treatment plans [11]. Wearable remote monitoring for physical health conditions have included autoimmune disorders [12]; obesity [13,14]; psychiatric

disorders [15], type 1 diabetes and glycemic control [16,17]; pulmonary rehabilitation [18]; asthma [19], cancer [20]; dementia and cognitive decline [8]; weight management and obesity [13]. There have been a number of studies through the Department of Veterans Affairs targeting specific populations including health informatics, home telehealth, and disease management in support of the care of veteran patients with chronic conditions [1,21]. More specifically, noninvasive technologies are now commonly being integrated into disease management strategies to provide additional patient information, with the goal of improving healthcare decision-making. SMART digital technologies are continually being adopted as an additional method for healthcare systems to increase patient contact and augment the practice of psychotherapeutic care and treatment.

SMART technologies can provide geriatric health care providers with the option of monitoring patients for compliance and sharing health data with remotely based clinical experts for consultation, saving time and expense for practitioners and patients, and actively managing treatments for those with chronic conditions. The accuracy, validity and reliability of trackers has been addressed by researchers with favorable results [22]. Health data are typically transmitted to healthcare professionals in facilities such as monitoring centers in primary care settings, hospitals and intensive care units, skilled nursing facilities, and centralized management programs, among others. Figure 1 provides a schematic for this model of SMART healthcare delivery.

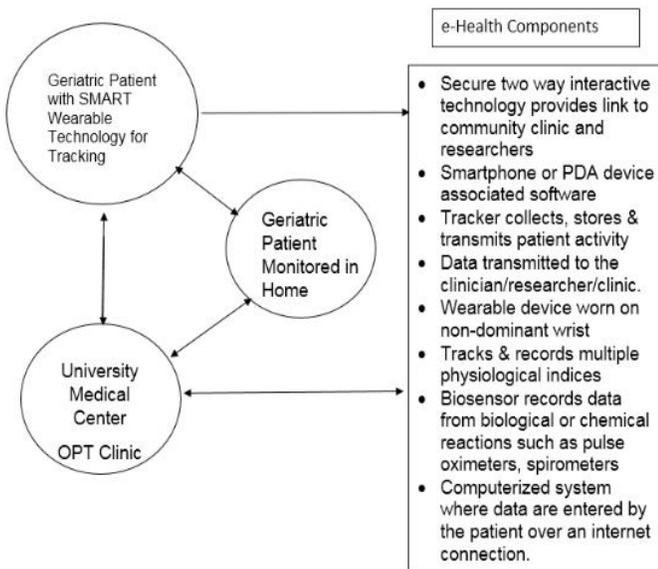


Figure 1: SMART Technology Model in Geriatric Health Care [23].

Figure 1 summarizes the core elements of SMART technology available for use with mental health interventions. Patient motivation is a critical element in therapeutic change and can best be measured by patient commitment and compliance with prescribed treatment interventions. It assumes an understanding of patient's

readiness to change [24] and the importance of working with a motivated patient using SMART technology as an adjunct to counseling and psychotherapy strategies. The use of a Dialectical Behavior Therapy [25] model and utilizing available SMART technology for monitoring compliance and behavior changes with a patient. Dialectical Behavior Therapy (DBT) combines both cognitive and behavioral techniques for treating individuals.

The initial intervention module in this study used a cognitive behavioral integrated approach with individual counseling sessions focusing on understanding the chronicity of the medical and health related problems this patient is facing. Emphasis was placed on specific skills acquisition focusing on the need for the patient to learn new skillful behaviors to replace ineffective behaviors and help this person achieve the goals that are identified and agreed to, understanding the risks versus benefits of the critical life style changes and self-management activities in that process. Insight by the patient leads to increased motivation toward improving both physical and mental health thinking and behavior as well as the necessary lifestyle changes to maintain those factors over time.

Case Study

The patient, a 67-year-old Hispanic female, presents with anxiety associated with elevated lipids, high blood pressure, and obesity is referred to the outpatient multidisciplinary team. The patient shows little understanding of the implications of her health and a sedentary life style. She is diagnosed with both a psychiatric and physical health set of diagnoses. These include a diagnosis of anxiety related to poor management of her medical conditions that include type 2 diabetes with complications of obesity, hypertension and cardiovascular disease. She was judged to be at the contemplative level of stage of change [24]. Eight sessions over sixteen weeks involved short term, modified Dialectic Behavior Therapy (DBT) focusing on triggers, thoughts, behaviors that impair her ability to understand the implications of doing nothing about her physical condition. Examining the patient's options to better manage her health condition, the use of SMART wearable technology was introduced to the patient. Two sessions focused on a review of the benefits of its measurable use to monitor physical activity, along with sleep monitoring, exercise activity levels and calorie control for his diabetes, coronary artery disease and other medical problems.

The intervention using SMART technology focused on this patient's thoughts, feelings and bodily sensations related to her current health and medical conditions were explored along with managing his condition. This was crucial in creating a mindful recognition and her commitment to assuming some responsibility for addressing it. From a dialectical behavior therapy standpoint, maladaptive behaviors continue because the consequences of the behavior provide some kind of reinforcement. For example, if the patient fails to assume a more active lifestyle, more closely managing her food and calorie intake and fails to monitor sleep habits

and patterns, then one can only expect that more serious medical concerns will result and the anxiety associated with these more serious medical problems will find no relief.

This pattern of behavior will lead to cardiovascular complications along with peripheral neuropathy which may result in serious limitations in her life. Recent research [11] has provided support for applying SMART technology for patients with anxiety over being diagnosed with multiple health related problems that may benefit from psychotherapeutic intervention. The next session then focused on the use of a wearable device for remote monitoring using of a FitBit device synchronized to her Smartphone for tracking. The use of the Fitbit measures several variables related to health and wellness. The mechanism as to how this SMART technology works is best explained by understanding that it is a synchronized tracker that use a 3-axis accelerometer to understand one's physical movement to assess level of activity. By analyzing acceleration data, the tracker provides detailed operational information about frequency, duration, intensity, and patterns of movement to determine steps taken, distance traveled, calories burned, and sleep quality. Using a self-monitoring device to gauge changes over time that addressed physical activity, sleep patterns, weight and calorie intake and expenditure, she agreed through a behavioral contract to increase exercise on a graduated basis and agreed to work with a registered dietician to set goals that would restrict caloric intake to 1,200 calories per day, using a diet of nutritionally balanced supplements and one daily meal, and self-monitoring.

The patient in this case was provided with a Fitbit One which is a wireless activity tracker that syncs using Bluetooth SMART technology on the patient's personal Android smartphone. This technology permits the patient to record several daily activities including but not limited to the number of steps taken, distance walked or ran, on foot, calories burned by the patient during activity periods, sleep efficiency periods of movement during sleep, number of wake ups during sleep and other personal biomarkers.

Specific training was provided the patient on how to use, store, tabulate, self-enter certain data and recharge the Fitbit. Specificity in self-entered data included how to enter the logging of food consumption, activities, water intake and weight monitoring, as well as track fitness goals throughout the day even while offline. Tracking assessments were chosen to detect changes in management related activities. Fitbit is an American made product which is developed and designed to measure biomarkers that include several personal metrics. The Fitbit technology is worn on the non-dominant wrist and includes an activity tracker. This type of wireless-enabled wearable technology device measures and stores data that can be transmitted to clinical and research professionals when research participants elect to "Share" their FitBit data and information with research professionals.

Based on the use of the wearable SMART technology, the results revealed that the patient began to realize short term goals early on which served as a motivator to continued use. The initial

benefit was a five-pound weight loss the first week. He continued to lose weight fairly steadily with a total weight reduction of 10 pounds after 16 weeks. In addition to the obvious benefits of enhanced self-esteem and healthier eating habits, this patient showed signs of enjoying some very important, perhaps life-saving, health benefits. Her HbA1C dropped to 7.8 from 8.9 attributed to increased physical exercise and physical activity as measured and confirmed by the wearable SMART technology. Similarly, cholesterol was reduced and her blood pressure was reduced to 113/86 at the end of the 16-week period. After the 16-week intervention program, results revealed significant qualitative improvements in the active minutes, steps taken and miles walked by the patient. In addition, the technology reported on calories burned, hours slept and water consumed during each 24-hour period had achieved normal levels.

The use of SMART technology to monitor changes made over time and noted improved time dedicated to exercise, walking and total miles walked. On miles walked per day, the results showed that the patient increased miles walked from less than one mile per day to more than 4.4 miles per day which approached the recommended 5 miles per day or 10,000 steps recommended by the Surgeon General (US Surgeon General 2012) [26]. The calorie monitor aided the patient in changing calorie intake from that which exceeded 3500 calories per day to the recommended 2500 calories per day. Furthermore, the sleep total hours slept per night changed from less than 5.8 per night to 8.5, as encouraged by his physician.

Discussion

The wearable SMART device Fitbit shows potential for aging patients with current health related medical problems. Our patient appears to have benefited from a healthier diet and exercise program. Most people are surprised to find that they have vastly underestimated their caloric intake and overestimated their physical activity. Also, many people overestimate or underestimate their weight problem. Often, seriously overweight people spend much of their lives struggling to lose weight, jumping from one fad diet or new remedy to another without ever achieving lasting success. The problem isn't necessarily a lack of motivation; they may have simply been misguided by mixed messages in the media or friends and less than accurate caloric intake and caloric expenditure.

Utilization of SMART technology along with an effective diet and exercise program can make all the difference for these patients in achieving improved and recommended health goals including weight, diet, sleep, exercise, self-esteem and an improved quality of life. The use of wearable technology devices like the popular Fitbit has become an enormously popular health & fitness gauge for about a decade. Health and wellness prone individuals' benefit from self-tracking using such a device as they provide a variety of self-monitoring information and biomarkers. When one begins to catch on to self-monitoring various health and wellness

factors, one begins to compete with oneself. It can drive almost anyone to check weight on a daily basis, exercise more, monitor sleep cycles and patterns, and help detect mood shifts over time.

Some of the current SMART technologies include the Fitbit, Quantified Self, Nike Fuel band, Jawbone provide clinicians, patients and researchers with accurate measurable data in tracking and understanding change during psychotherapeutic interventions. There are alarms that aid in monitoring when one exceeds caloric intake against the amount of calories burned through various forms of exercise during the day. For example, one can make sure that he/she hits a daily minimum calorie burned that they have set for themselves. Knowing one's overall daily caloric intake and expenditure and how many calories one burns per day via exercise, seems to be very useful information to have in self-monitoring. Monitoring hydration through a SMART tracking device impacts the health promotion, wellness and risk reduction related to mortality and quality of life for the geriatric patient.

The usefulness of such devices for behavioral management for weight will be a direct function of how much it helps each individual using it and how compliant they are with accurately getting calories expended greater than calories consumed over time. Clinical data captured by these SMART technologies signal promise for application and accuracy of measurement for vital signs, weight, blood pressure, oxygen levels, and heart rate [5,7,10]. The future is likely to bring greater and more rapid technological advances, opportunities for academic health centers to expand their reach, and changes to the nature of medical care. In the near term, many advances will probably be linked to smartphones, which 90% of the world population will have in another decade [27]. From a clinical research perspective, the ability to monitor patient-generated real-world data, including data from sensors, laboratories, and imaging, for the clinicians and researchers during treatment interventions comes with security and privacy concerns.

The user of e-health technology can enable academic health centers to expand their reach by improving access for patients [2]. With the growing global burden of chronic conditions academic health centers can use telehealth to reach many clinicians and their patients globally. Such efforts could expand and even integrate many of the health services that are currently provided by academic health centers. The reputations of these academic health centers could be especially helpful for engendering trust in patients who may receive care from clinicians whom they have not actually met in person.

Recent research trends have used different terminology to capture the essence of e-health and the overall language used to describe the benefits of wearable SMART technologies. There is clear evidence that the utility and benefits of such technology is being established and beneficial to aging individuals [2,7,12,28]. SMART technology advances for improving healthcare delivery, wearable appliances that form an integral part of our personal life have emerged.

Future Directions

The use of 21st century technology is shaping the delivery of clinical care for geriatric patients. On the positive side, technology's integration with specific counseling skills is inevitable and show favorable potential to assist with improved patient self-management. This single case study design has served as a pilot with the realization that there are a number of limitations. It lacks a multiple subject design model and randomization to assess the effectiveness of multiple models of the wearable technology. What it represents is an introduction to the use of SMART wearable technology in monitoring and promoting self-monitoring among aging patients who experience anxiety related to medical condition that could benefit from life style changes.

SMART technology and the web culture provides significant promise in prevention intervention stratifies for geriatric patients [29]. We have examined the adjunct use of SMART technology effectiveness in self-monitoring behavior change with a patient motivated to utilize smart technology in complying with prescribed clinical treatment. An exploratory case study research design was employed to explore those situations in which may be beneficial in improving self-management skills for a patient who has poorly managed her medical condition. After the 36-week intervention program, results revealed significant qualitative improvements in the active minutes, steps taken and miles walked by the patient. In addition, the wearable SMART technology resulted in improved health of this geriatric patient.

References

1. Miller TW, Wood J (2012) Telepractice: A 21st Century Model of Health Care Delivery. In: Guah, Matthew (Ed), *Healthcare Delivery: Reform and New Technologies*. New York: Information Science Publishers, ISBN: 1609601831.
2. Bashshur RL, Howell JD, Krupinski KA, Harms KM, Bashshur N, et al. (2016) The Empirical Foundations of Telemedicine Interventions in Primary Care. *Telemedicine & e-health* 22: 342-375.
3. DeLucia PR, Harold SA, Tang Y-Y (2013) Innovation in technology-aided psychotherapy through human factors/ergonomics: Toward a collaborative approach. *Journal of Contemporary Psychotherapy* 43: 253-260.
4. Steinhubl S, Muse E, Topol E (2015) The emerging field of mobile health. *Sci Transl Med* 7: 283rv283.
5. Wang JB (2014) A Wearable Sensor (Fitbit One) and Text-Messaging to Promote Physical Activity and Participants' Level of Engagement: A Randomized Controlled Feasibility Trial, Doctoral dissertation, University of California, San Diego: 1-144.
6. Chan M, Esteve D, Fourniols JY, Escriba C, Campo E (2012) Smart wearable systems: Current status and future challenges. *Artificial Intelligence in Medicine* 56: 137-156.
7. Field MJ, Grigsby J (2002) Telemedicine and remote patient monitoring. *JAMA* 288: 423-425.
8. Allard M, Husky M, Catheline G, Pelletier A, Dilharreguy B, Amieva H, et al. (2014) Mobile technologies in the early detection of cognitive decline. *PLoS One* 9: e112197.

9. American Telemedicine Association (2015) Telemedicine definition.
10. Gusmer RJ, Bosch TA, Watkins AN, Ostrem JD, Dengel DR (2014). Comparison of FitBit® Ultra to ActiGraph™ GT1M for Assessment of Physical Activity in Young Adults during Treadmill Walking. *Open Sports Medicine Journal* 8: 11-15.
11. Mochari-Greenberger H, Vue L, Luka A, Peters A, Pande RL (2016) A Tele-Behavioral Health Intervention to Reduce Depression, Anxiety, and Stress and Improve Diabetes Self-Management. *Telemedicine & e-Health* 22: 624-630.
12. Hamine S, Gerth-Guyette E, Faulx D, Green BB, Ginsburg AS (2015) Impact of mHealth chronic disease management on treatment adherence and patient outcomes: A systematic review. *J Med Internet Res* 17: e52.
13. Allen JK, Stephens J, Dennison Himmelfarb CR, Stewart KJ, Hauck S (2013) Randomized controlled pilot study testing use of smartphone technology for obesity treatment. *J Obesity* 15: 151597.
14. Nollen NL, Mayo MS, Carlson SE, Rapoff MA, Goggin KJ, Ellerbeck EF (2014) Mobile technology for obesity prevention: A randomized pilot study in racial- and ethnic-minority girls. *Am J Prev Med* 46: 404-408.
15. Faurholt-Jepsen M, Ritz C, Frost M, Mikkelsen RL, Margrethe Christensen E, et al. (2015) Mood instability in bipolar disorder type I versus type II-continuous daily electronic self-monitoring of illness activity using smartphones. *J Affect Disord* 186: 342-349.
16. Franc S, Borot S, Ronsin O, Quesada JL, Dardari D, et al. (2014) Telemedicine and type 1 diabetes: Is Technology per se sufficient to improve glycaemic control? *Diabetes Metab* 40: 61-66.
17. Fukuoka Y, Gay CL, Joiner KL, Vittinghoff E (2015) A novel diabetes prevention intervention using a mobile App: A randomized controlled trial with overweight adults at risk. *Am J Prev Med* 49: 223-237.
18. DeVito Dabbs A, Dew MA, Myers B, Begey A, Hawkins R, et al. (2009) Evaluation of a hand-held, computer based intervention to promote early self-care behaviors after lung transplant. *Clin Transplant* 23: 537-545.
19. Ryan, D, Price D, Musgrave SD, Malhotra S, Lee AJ, et al. (2012) Clinical and cost effectiveness of mobile phone supported self-monitoring of asthma: Multicentre randomised controlled trial. *BMJ* 344: e1756.
20. Kearney N, McCann L, Norrie J, Taylor L, Gray P, et al. (2009) Evaluation of a mobile phone-based, advanced symptom management system (ASyMS) in the management of chemotherapy-related toxicity. *Support Care Cancer* 17: 437-444.
21. Darkins A, Ryan P, Kobb R, Foster L, Edmonson E, Wakefield B (2008) Care Coordination/Home Telehealth: The systematic implementation of health informatics, home telehealth, and disease management to support the care of veteran patients with chronic conditions. *Telemed J E Health* 14: 1118.
22. Mammen G, Gardiner S, Senthinathan A, McClemon L, Stone M, et al. (2012) Is this Bit Fit? Measuring the Quality of the Fitbit Step-Counter. *The Health & Fitness Journal of Canada* 5: 30-39.
23. Miller TW, Wood J (2012) Telepractice: A 21st Century Model of Health Care Delivery. In: Guah, Matthew (Ed), *Healthcare Delivery: Reform and New Technologies*. New York: Information Science Publishers, ISBN: 1609601831.
24. Prochaska JO, Norcross JC (2013) Systems of psychotherapy: a trans-theoretical analysis. In: 8th ed. Pacific Grove, CA: Brooks/Cole.
25. Linehan M (2016) *Behavior Therapy: Where We Were, Where We Are and Where We Need to Be Going Cognitive and Behavioral Practice*. New York: Elsevier Ltd. 13: 1077-7229.
26. United States, Office of the Surgeon General (2012) *Shape Up America*. Washington DC: The U.S. Surgeon General's Guidelines on Promoting Physical Activity among All Americans.
27. Free C, Phillips G, Watson L, Galli L, Felix L, et al. (2013) The effectiveness of mobile-health technologies to improve health care service delivery processes: A systematic review and meta-analysis. *PLoS Med* 10: e1001363.
28. Munson SA, Consolvo S (2012) Exploring goal-setting, rewards, self-monitoring, and sharing to motivate physical activity. In *Pervasive Computing Technologies for Healthcare (Pervasive Health) 6th International Conference IEEE*: 25-32.
29. Nagel DM, Anthony K (2009) *Ethical Framework for the Use of Technology in Mental Health*.