Smartphones and medical apps in modern medicine: breaking the health norms

Introduction:

Smartphones are newer mobile device with advanced computing features, with the strength of personal computers. It is estimated that more than 50% of household has smartphones in developed countries, and developing countries are slowly catching up (1). Around 75% of the US population owns smartphones as a result of unprecedented developments in mobile technology (2). The growth has occurred so rapidly that it has become a global indicator of economical prosperity. They have revolutionized the traditional mobile technology with user friendly interface and broad applicability, and are a smart choice to bridge mobile and internet technology, in an agile hand held device.

Smartphones have tremendous utilities in medical science. Their potential to change the modern perception of health and monitoring is unquestionable. Smartphone technologies (s-tech) have been successfully applied for telemedicine and delivery of basic health needs in many developing countries being an excellent audio-visual delivery system for communication. It is a trustworthy companion and can effectively monitor behavioral change. S-tech in tele-medicine has been successful to fill the void for shortage of medical professional providing access to medicine in rural areas (3). This is one of the most cost-effective modern medicinal practices in underprivileged rural areas. Health care delivery through tele-medicine is able to reach and penetrate in most parts of the developing countries. The shift of tele-health system from wired operations to mobile wireless technologies has overcome of the pitfalls, particularly delay, universal access and portability. Their application in tele-medicine has definitely been an
advantage to transfer the traditional one-on-one care to broader mass in unreachable areas. With the emergence of newer and faster wireless tele-communication, smartphones use in telemedicine has a long way to cover (4).

There are estimated more than 40,000 health related apps for smartphones (5). Most of the smartphones run in an android or iOS platform. Smartphones apps are growing every day, and it has been successful in establishing itself as a global health business indicator. App business is a lucrative million-dollar business flourished with smartphones. With the advent of wearable technology, medical apps for smartphones have overcrowded the apps market. Most of these apps target the young people. With overwhelming health and hygiene concern amongst young people, fitness apps have become widely popular in modern times. They can monitor daily activities, record them and interpret data. Analyzed data can be translated to correctly identify the level of activity needed for healthy lifestyle, and track the deviation, that might prove detrimental to health.

**Smartphones in medicine:**

Digital health intervention using mobile and online platform has been tested extensively to improve the general health status. Cardiovascular disease accounts for one-third of all mortality in US (6). Many of these cardiac diseases have preventable risk factors, life style modifications being one of the most important indicators for a healthy heart. Mobile platform fulfilled educational needs, with effective monitoring and assigned a task to target group for improving the cardiac functionality. The large group of cohorts with digital health intervention demonstrated effective reduction in risk factors after one year. The participants had favorable
weight loss and reduction in CVD risk factors like blood pressure and lipids levels (7). Wearable fitness devices have hit the market in last few years and rapidly gained popularity. These devices are linked with smartphones and can be used to monitor various activities. The popularity of these fitness trackers is attributed to the increasing awareness against obesity. The apps installed in smartphones analyze the data from these fitness trackers and interpret as required. They are also a source of great motivation for the patient to change their life styles and live healthy (8).

More than 50% of respondents in a psychiatric outpatient setting showed positive desire to track their mental health with the use of mobile apps (9). There are number of apps currently available targeting suicide. Suicide has strongest association with substance abuse and other co-morbid psychiatric illness. Since there are no distinctive evidence based suicide prevention apps on the market, there is a dire need for the scientific approach to develop one that can target high risk behavior individuals (10). In this regard application of s-tech for behavioral change using the short message service (SMS) text has proven very effective (11). The SMS model of behavioral intervention had the positive outcome and room for future studies.

**Health monitoring system:**

Smartphones can be a handy tool for the differently able population. Global positioning system (GPS) can track the position and guide the mobility. For people living with disability, smartphones function as a virtual personal assistant. It will be a useful tool for assisted living condition in several ways (12). For the elderly person living with dementia, smartphones are new hope to increase the quality of life. Smartphones have voice assisted system, and hands free
modes. These voices assisted system and GPS can be a reliable guide for visually impaired users as well (13).

The burden of long-term hospital surveillance and monitoring can be drastically reduced with smartphones based monitoring technique. Smartphone based on the android has been used in portable home epileptic seizure monitoring system. They are feasible cost effective devices with high portability. (14) Cardiovascular diseases have become a global burden in the recent times. With unhealthy life styles and food habits, there is a rapid surge of adverse cardiovascular events in community at every level. The beneficial use of s-tech in the electrocardiogram (ECG) monitoring of cardiovascular disease has been documented. It has an added advantage due to personalized customization features. There were also additional mechanisms to sense high lightened risk for detection of the ECG abnormalities, and notify the health professional for quick response. There was significant reduction of morbidity and mortality due to this portable surveillance and notification technology. (15) The most effective way to decrease mortality and morbidity related with cardiovascular events is prevention. There cannot be more effective health policies than prevention. Smartphones can be employed in different roles for prevention of these diseases. They are capable of monitoring heart rate, abnormal rhythm, any variability and prevent an adverse cardiac outcome (16).

The eCAALYX (Enhanced Complete Ambient Assisted Living Experiment), 2009-2012 distant monitoring system is an example of an established health monitoring based on s-tech (17). It was a European Union (EU) funded project targeted for elder people with chronic debilitating diseases. Patient was directly monitored through a wearable health sensor, linked to
smartphones and GPS. The data, so obtained were conveyed to the data center and channeled to health professionals. The use of smartphones based on the user customized platform also made it easy to analyze and process data, helping in early detection of abnormal clinical conditions. Similarly, the user interface also provides opportunities to view and evaluate the medical records stored within smartphones.

Advances in s-tech have also paved a way for biomedical science in the field of screening and diagnosis. It is possible to perform the diagnostic tests outside the traditional laboratory in a convenient as well as cost effective means. Use of off the tract simple common devices for diagnosis is always an advantage. Point-of-care (POC) is a suitable biomedical technology that can be paired with smartphones for medical diagnosis. POC target proteins, nucleic acids and detect these markers through immunoassay (18). As such they are bonded effectively with smartphones for reliable cellular and biochemical diagnosis of common diseases (19). These portable devices to be used in conjunction with smartphones can be an alternative to conventional diagnostic technique, playing a crucial role in early detection and treatment.

**Smartphone and drug monitoring:**

Certain diseases with long term treatment and drug adherence have always been a challenge for the physician. These diseases possess a significant threat in developing countries and s-tech is a promising application. There is a rapid emergence of drug resistant cases due to non adherence. Drug resistance not only interferes with successful treatment but also has a negative impact in overall disease control and prevention of spread. Smartphones have been
successfully used to monitor the adherence of the drug regimen in these situations. Diseases like HIV and TB have extended treatment course and non adherence are very common.

Multidrug resistance TB leading to increased morbidity and mortality is a common determinant for successful treatment and eradication. Pulmonary TB is the major opportunistic condition in HIV/AIDS and is the cause of significant morbidity and mortality. Given the fact, TB and HIV are fairly common in some parts of the world; use of technology to curb them is appreciable. This has been well proved in antiretroviral retention program in sub-Saharan Africa (20). Text messaging for clinical attendance and follow up is also cost effective and significantly increases compliance (21). U.S. President’s Emergency Plan for AIDS Relief (PEPFAR) was an ambitious 5-year program launched in 2000, targeting HIV/AIDS. It utilized software inventory report and other different software tools. It was an effective tool to target the people living with HIV/AIDS and high risk groups for prevention, control of transmission and halting progression. (22)

**Data collection utility:**

Data collection, interpretation and storage for future reference are an integral part of medicinal practice. Data collection also has an important role in epidemiological study of the disease, surveillance and follow up for treatment, planning and decision making. Smartphone can be used to collect and store them. This can be achieved with the use of special apps designed for data collection or simply using smartphones for the purpose. In comparison with traditional handheld paper method, the use of smartphones is efficient, faster, cheaper and convenient. (23)
Although technical malfunction can be the chief constraints for these devices, the overall data accuracy and feasibility is the main advantage over traditional pen and paper methods (24).

**Constraints of smartphones technology:**

Successful applications of smartphones in medicine have multiple challenges. These challenges in s-tech can be broadly divided into: developers and target user challenge. Developing apps and programs to crater the medicinal needs of an individual patient is indeed a difficult task. Different individuals have different health needs, and the successful programs should satisfy them. Smartphones with wide user interface and multitaskinging can be an economical burden for many target groups. Many of them have variable system reliability, and a limited battery life. With a rapid advancement in technology, there is a constant need for upgrading smartphones, adding a financial burden in patients. Smartphones use can also be a challenge to elder patient, and effective training is required before their application. The entire user community should be properly educated about the use of smartphones as well as the medicinal apps.

A study was conducted to access the efficacy of breast apps, based on current available evidence and involvement of medical professional (5). The study showed the lack of evidence concerning direct involvement of health expert with relevant field expertise in designing these medical apps flooding the markets. There were inconsistencies in quality, with thousands of them claiming to improve health status without scientific backgrounds. Lack of controlling body to monitor these apps was obvious. Without the definitive consensus and quality control, there is significant health concern regarding the use. The need for a solid scientific framework and
regulation before they reach to consumer is indeed a challenge. Although with immense potential, these challenges have definitely limited the maximal use of smartphones in medical field.

There are reported cases of adverse health complications with the excessive use of smartphones. These include transient monocular vision loss (25). Most of the people tend to use phones at a close distance for reading. These excessive close-range exposures have been linked with developments of acute acquired comitant esotropia (AACE) in adolescents (26). Patients had significant improvements after refraining from smartphones or limiting the use.

Discussion:

S-tech is the future of modern medicine. They are not only the means of communication but also a powerful handheld multi-tasking personal device. Within less than a decade they are able to occupy almost entire mobile technology and carry immense possibility for their growth. They have become a necessity in modern lifestyle, slowly replacing personal computers. Newer companies are coming every year with more powerful devices, and smartphones business is widely open for rapid developments. The obsession is not only limited to young peoples, as it was the case few years back, it has penetrated deep into the core of society with strong roots.

S-tech has opened a new opportunity in healthcare system. It has been adopted for use in different stages of practices by many clinicians. The shift to s-tech has provided an effective platform for health institution and professional for innovation of newer medicinal apps that is user friendly and customized to satisfy specific needs. It is also providing an opportunity for the
patients, to efficiently communicate with health care providers and monitor their status. Smartphones is also an effective device for physicians and trainees, with internet sealing the large void in medical education. They can act as a virtual library, and many hospitals and medical universities advocate the use for learning and reference purposes. E-books and online library has become a cornerstone for fulfilling the needs for quality educational needs through smartphones.

The unprecedented use of smartphones comes with the price. Smartphone dependence can lead to multiple avoidable side effects. They will directly interfere with work efficiency and decrease the performance output. Excessive use will directly interfere with visual sensitivity and decrease in retinal visual perception. There is also an exaggerated risk with the use while driving. Text-driving is a dreadful complication of its dependence. The overall adverse effect and events are more profound in older drivers with high texting behavior (27). Response reflex is impaired and lane excursions are usual. There must be an absolute no texting while driving regardless of age. Google glass with head mount display and speech recognition, although not the better option had less risk as compared to traditional smartphones texting (28). It is advisable not to use smartphones while driving to reduce the smartphones associated road accident.

Mobile apps are the cornerstone of s-tech. Most of the health related apps have a very a low level of health care professional involvement, and at times can be misleading (29). Evidence for the current available apps in the market is lacking and there are no proven studies to establish the efficacy. With an increasing global trend of s-tech in medicine, there is an obvious need to establish a more systematic and scientific approach to validate them (Fig-1). The necessity for
appropriate apps to fulfill the health needs for general population is immense. Mobile apps and s-tech should be combined with evidence based medicine for maximal benefit to the target groups.

Figure-1: The effective framework for selection and design of smartphones technology (s-tech) to crater specific population health needs.

**Conclusion:**

Smartphone has a widespread use in medicine. S-tech has opened a wide area of exploration with its user friendly interface, multi-tasking, and portability. The potential use of s-tech in health education, personal health monitoring, tele-medicine, drug compliance monitoring and data collection is rapidly revolutionizing modern medicine. There is an urgent need to crater the specific needs of target population to fulfill the desired health with exponential increase in medical apps. It is pertinent that there should be further research to establish and validate these apps based on a scientific and evidence based medicine.
References:


23. Lane SJ, Heddle NM, Arnold E, Walker I. A review of randomized controlled trials comparing the effectiveness of hand held computers with paper methods for data collection.


