In the relatively short time span of eight years, smartphones have had a profound impact on our everyday lives, but have yet to display any substantial impact in the field of healthcare and medicine. This article aims to explore the ways in which smartphones and the Internet of medical things can improve medicine, both today and in the future.

Smartphone Technologies
Today, wearable technologies or devices that attach directly to a smartphone can be used to measure an ever-growing set of personal biomarkers, including blood pressure, heart rate, respiratory rate, and blood oxygen concentration. These devices have enabled patients, for the first time, to personally capture, measure, and track their own vital signs and other such information; individuals can easily acquire and store this information via their smartphone. Furthermore, these technologies have enabled real-time data streaming, superseding the traditional “snapshot” view of vital sign measurement that often took place only when patients encountered a healthcare provider.

In addition to facilitating basic vital sign acquisition, smartphones also serve as a hub for many advanced medical diagnostic platforms, including inexpensive handheld ultrasound technologies such as the Lumify (Philips Healthcare), a smartphone add-on that performs—at a fraction of the cost—the majority of functions that an existing ultrasound platform also provides. Access to advanced imaging technologies, such as handheld ultrasound, provides point-of-care, hospital-level diagnostics to the patient; just as importantly, this is done with interpretation capabilities that can be performed either remotely by a trained specialist or by using the algorithmic processes that are already in place for investigations such as ECG.

Beyond a detailed picture of what is happening from a moment-to-moment perspective inside the body, smartphone sensors will provide in-depth insight into our personal environment, including air quality measurements, pollen count, ambient radiation and ultraviolet light, preservatives in our food, and pollution particulate counts. Just as the collective information acquired from millions of smartphones in cars worldwide allows for the accurate estimation of travel times on Google Maps, so too will the environmental information captured from smartphones allow for the assessment of individualized decisions regarding environmental exposure risks.

Smartphones further offer a unique opportunity to immediately access medical records and all diagnostic testing that an individual has performed or undertaken throughout his or her lifetime. Services such as Picnic Health, which aggregates all historical medical records—including labs and scans, irrespective of provider—are serving not only to eliminate the frustrations of accessing medical records from outside institutions, but also to avoid the duplication of medical testing, the extra costs, and the often harmful radiation exposure that accompanies it.

Not only will medical records be accessible on smartphones, but so too will your physician. Telemedicine is growing in popularity; it serves a substantial and yet
unmet need of healthcare provision for conditions that do not require an in-person consultation or for rural areas where the duration of travel to a physician’s office is prohibitively long. Patients using telemedicine services will be equipped with a suite of smartphone medical diagnostics, ranging from eye and ear examinations with camera-enabled scopes, to assessing skin lesions for dermatological examinations, to checking vital signs. Point-of-care smartphone testing is already capable of detecting many infectious diseases, thereby often eliminating the need for patients to travel and reducing the risk of pathogen spread. Regarding point of care, it is now possible in many cities in the US to summon a doctor to one’s home via a smartphone using a variety of Uber-like apps.

The Smartphone of the Future

Although such progress is remarkable, it is simply scratching the surface of what smartphone technologies will be capable of delivering for future healthcare. The “medicalized” smartphone of the future will have an impressive array of healthcare features (Figure 1). Currently, smartphones can measure basic blood chemistry such as blood glucose, but in the near future, they will have the potential to perform blood testing that was previously exclusively available only in hospital settings. No longer will patients be forced to travel—often great distances—to have blood drawn; they’ll have the option to do so from the comfort of their own homes, and will be furthermore provided with instant feedback concerning their results.

Beyond assessing basic blood chemistries, smartphones will also enable point-of-care genomic sequencing, capable of performing rapid pathogen detection, rather than needing the samples to be laboriously cultured in a hospital facility. Identifying such pathogens and assessing their unique antibiotic sensitivities will thereby enable precise antibiotic treatments and will help patients avoid unnecessary and potentially harmful drug treatments. Even when a particular drug is suggested, the likelihood of it resulting in an adverse event will be reduced, because the drug will be cross-referenced against the patient’s personal complete genome sequence, which the smartphone will access in the cloud. Upon identification of the pathogen’s unique genomic signature, its range of antibiotic sensitivities, and the drug choice least likely to result in an adverse event, the medicine will likely be ordered via smartphone and delivered to the patient by an autonomous drone.

Apart from lab testing, a variety of additional diagnostic testing services will be available on smartphones, including breath analysis for the screening of lung cancer and other conditions with an aerosolized signature. Breath analysis has been linked to several lung and inflammatory disease states, and such noninvasive modalities of disease tracking will likely become commonplace in the future. Facial gesture recognition software and voice analytics services (like those already provided by platforms such as Beyond Verbal) will enable the quantification of continuous mood states in order to assess and diagnose underlying mental health disorders or responses to treatment. Aggregating such mood parameters with other contextualized data can provide valuable estimations of a person’s emotional state, and whether any intervention is required or—if already in place—is progressing as expected.

Awareness of an individual’s mood is critical in and of itself; when extended to entire populations, however, incredible insights can be made as to the resultant effects of policy changes and healthcare...
There is no doubt that to achieve the fullest potential of individualized medicine using smartphone technologies, substantial challenges must be overcome. These would include data privacy concerns, appropriate accountability for acting upon the information gathered, and the analytics services that need to be developed to enable such opportunities. Further issues include hardware concerns related to adequate battery life and biohazard safety, which must also be addressed. However, in less than a decade, there has been explosive growth in the capabilities of smartphone technologies, supported by a remarkable digital infrastructure with cloud and supercomputing, pervasive connectivity, and ever-increasing bandwidth. The next step involves artificial intelligence and deep learning on each individual’s multi-layered medical data, which no human could process in real time. Then, smartphone medicine will go to the next level, with the virtual medical coach, who hopefully will help us better manage and even preempt some diseases in the future.

Reference

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