https://doi.org/10.1038/s41578-022-00509-x

Wear your health on your sleeve

Wearable electronics could enable us to optimize every aspect of our personal health and performance. They might also have important ramifications for clinical use and theranostics.

As scientists, we are all trained to rely on data to inform our work. It is seductive to think that we can quantify everything we do in our day-to-day lives. Wearable electronics give us a chance to do just that, and the idea of self-improvement through personal data mining has led to the emergence of a new concept: the quantification of the self.

Leading the charge for self-quantification, fitness trackers have been providing users with personalized data since their entry into the technology market. About one-fifth of Americans now own a smartwatch, and this number is only expected to rise. What technology companies have quickly realized, however, is the immense transformative potential of this technology in health care. Headlining the transition from fitness-focused devices to general health tracking, established players like Apple and Google are investing heavily in research and development. Several start-ups have joined, proposing devices with ever more sophisticated functions, from period pain management to brain activity tracking. The appeal is understandable; the possibility to self-diagnose and monitor — or even treat — most common ailments could dramatically unburden hospitals and improve patients' outcomes, with direct implications for personal and public health. In this month's Focus issue, we feature articles showcasing the potential of next-generation wearable electronic devices in medicine and beyond.

Although currently marketed wearable sensors can monitor physiological signals such as temperature changes and heart rate, they cannot reliably be used as alternatives in clinical settings yet. To shift to patient-centric health care, minimally invasive devices will need to be able to continuously measure several biochemical signals, as well as physiological signals. In this context, Can Dincer and co-workers discuss the building blocks of devices that can sample, among other things, biofluids, allowing access to richer health information.

To guarantee that this technology is widely adopted, wearable devices must be, first and foremost, seamlessly incorporated into our daily lives. An unobtrusive interface between human and device is key to continuous monitoring of health metrics. In that vein, there is a real interest in developing untethered systems that are self-charging, as discussed by Takao Someya and colleagues. Pei Cheng and co-authors also make the case specifically for organic photovoltaic power sources, which could be combined with other energy-harvesting devices.

Wearable devices that interface with internal organs and tissues push this concept even further, as reviewed by Sheng Xu and colleagues. This application is at a considerably less advanced stage than skin-interfacing electronics, owing to roadblocks such as safety considerations, complex signal acquisition and stability issues. However, if effectively implemented, these devices could potentially enable the long-term monitoring of a multitude of useful bio-signals inaccessible from the skin, such as biochemicals from the mucosa, as discussed specifically by Giovanni Traverso and co-authors.

As written by Zhitao Zhang, wearable light-emitting displays can also be made to be interactive, changing colour depending on certain stimuli. If triggered by specific cues, the emitted light can also be used for treatment; Dincer and co-authors mention a similar concept related to on-demand delivery of therapeutic agents where, for example, antibiotics could be administered if the pH of a wound reaches a certain value, symptomatic of an infection. This closed-loop strategy, allowing concomitant monitoring and treatment, may be the next frontier for wearable devices in medicine. Seung Hwan Ko and colleagues also put forward the idea of using wearables to provide enhanced telemedicine, which could contribute to the decentralization of health care.

Wearable electronic devices have implications beyond personalized medicine: the available output information is particularly compelling from a big data perspective. Such unprecedented access to large amounts of data could accelerate our understanding of many health conditions, leading to better diagnosis and treatment. We witnessed this prospect during the peak of the COVID-19 pandemic, when data pooled from smartwatches could detect the virus before symptom onset. However, as these technologies come to the market, concerns over health tracking and data privacy emerge. Going forward, transparency will be paramount to help people understand how their data will be used. Ultimately, wearables promise users more control over their health — this is indeed enticing, as long as this control extends to their generated data as well.

Published online: 27 October 2022