nature biotechnology

Wanted: biotech for an aging population

Digital medicine's extraordinary ability to communicate with patients, especially in under-served communities, could help reorient the biotech industry to better address aging and its associated diseases.

At BIO's annual meeting in San Diego last month, digital medicine featured prominently. Participants in the final *Scientific American* Worldview session discussed how these emerging technologies might change healthcare provision, foster biomedical research and spur new treatments in a graying world. Diseases associated with aging, such as Alzheimer, Parkinson and atherosclerosis, already gobble up >80% of healthcare budgets, and that proportion will only increase. There is little in the immediate biotech drug pipeline to prevent or slow progression in many age-associated disorders. So attention is turning to mobile technology as a means of gathering health data and enhancing therapy.

According to global figures from the United Nations, the over-60s represent one in eight people today but will be one in five by 2050 (around 2 billion people). By 2030, 25% and 17% of the population will be 60 or older in Europe/North America and Asia, respectively. The burden of disease increases concomitantly; >70% of people over 65 suffer from two or more chronic conditions. The *World Alzheimer Report* predicts that by 2050 over 131 million people will have dementia, nearly triple the 46.8 million people affected today.

Currently, there are no drugs that prevent, cure or even slow Alzheimer's progression. And the picture in other chronic diseases isn't much rosier. Of the 174 drugs approved by the US Food and Drug Administration's Center for Drug Evaluation and Research over the past five years, around 40% were for rare diseases and 26% for cancer. In contrast, only 5 (3%) of those 174 products were approved for neurodegenerative disease (0 products in 2014 and 2015), and none of those modified disease.

One reason for the slow progress in drug development is that unraveling the biology of these complex conditions is difficult. Researchers must tackle numerous molecular pathways and redundancies, with genetic modifiers that remain poorly understood, not to mention social/environmental, diet and lifestyle factors that contribute to disease risk and progression. Even when promising targets are found, financial and regulatory pressures conspire to make clinical development a logistical and financial challenge that is beyond the compass of virtually all but a handful of multinational pharmaceutical companies.

With its focus on immediate opportunities in rare disease and cancer, biotech has very little dry powder left to counter the demographic time bomb that healthcare systems face. Even if programs now underway can ameliorate disease, and that is far from certain, they would still take 10 years to progress through clinical development to reach the market. What can healthcare systems do in the meantime?

One answer must be digital medicine.

First, mobile technology, wearable sensors and in-home devices can improve the link between healthcare providers and caregivers and elderly patients. As smartphone technology becomes pervasive, patients can have better access to, and virtual visits from, health professionals. Improved links with patients will enable the remote collection of data: sensors to track sleep patterns; gait monitors to spot irregularities in walking to predict and prevent falls; wearable ECGs to flag irregular heart patterns; captured facial and voice recognition to help evaluate a patient's mental and cognitive capacities. Home monitoring can improve drug compliance and, hence, outcomes. Such approaches could keep patients out of hospitals longer, thereby saving health system costs.

Second, sensors and wearables are beginning to be incorporated into clinical trials to measure traits and behaviors, in addition to existing clinical markers and end points. For example, in one of its Parkinson trials, Pfizer is working with IBM to incorporate wearables and in-home sensors containing accelerometers, gyroscopes and magnetometers to record and interpret daily living activities. It will score these data against traditional clinical rating scales, hoping to reveal digital markers that complement traditional ones.

Finally, digital technologies will be increasingly adopted in longitudinal, observational studies in humans. Companies like Human Longevity and Arrivale are offering to track health data using a battery of tests, including some digital technologies. The hope is that by tracking the lives of individuals, including ostensibly 'well' people, over the course of years, new and earlier markers of disease progression will emerge. Those markers could enable biotech to develop treatments that target and correct disease earlier, enabling a move away from end-stage, last-ditch interventions. The idea of targeting earlier-stage disease is already being piloted—for example, Genentech/Roche's sponsored trials of crenezumab in prodromal Alzheimer patients. In the public sector, mobile health technologies such as ResearchKit are being used on a large-scale to monitor patients with Parkinson and rheumatoid arthritis, among other disorders.

Right now, digital healthcare is skewed to the affluent and well—the fit-rich. Paradoxically, early adopters of digital medicine—predominantly wealthy, white, who exercise, don't smoke and eat well—are those least likely to benefit. If digital medicine instead targeted underserved, underprivileged populations, much greater overall healthcare gains for the population as a whole could accrue. Furthermore, the fit-rich will take much longer to yield convincing data in support of early intervention. Scientifically and socially, it makes much more sense to conduct longitudinal studies in populations with elevated risk for early symptoms and overt disease, where biological signals will be stronger against the noise—in those with higher rates of smoking, pre-existing medical conditions, little exercise and a poor diet, for instance.

Mobile technology extends the reach of clinical trials and observational studies to individuals in remote or socially remote areas. Incentivizing research to focus on these populations would be a way to redress disparities both in health access and care. It could also ensure that potential early indicators of disease (and consequent treatments) are validated as quickly as possible. And just maybe, digital medicine could contribute to reducing, rather than contributing to, widening disparities in our societies.