



Views & Comments

Informatics: The Frontier of Innovation in Health and Healthcare

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The purpose of public health and healthcare is to create healthier populations. The purpose of innovation in healthcare is to accelerate the transformation of the work processes and economic models required to improve health. The use of information technology and telecommunications, and especially of health informatics, is critically important to these goals. It is an inspiring and highly productive frontier for engineering, science, and human behavior, and is the most direct path to unleashing transformative and beneficial innovations in healthcare. I believe, however, that it is under-appreciated in terms of its potential.

Innovations such as these are often disruptive, and therefore require strong scientific, public, and private health support. In this article, I focus on four tectonic shifts in the nature of innovations in health informatics. I would encourage students, young faculty, and researchers to broaden their understanding of the range of opportunities in this field, and to consider these tectonic shifts as fundamental pillars for the application of informatics to discovery and large-scale transformation.

1. The transformative potential of the use of aggregated data

The first shift is from the construction and analysis of large retrospective databases to the use of aggregated data in near-real time to drive changes at the point of care. This shift includes not only the discovery of new knowledge, but also the ability to apply that knowledge directly and to rapidly impact care. Continuous and real-time or near-real-time analysis is a new tool for health innovation and directly informs us about the most effective ways to care for individuals and populations.

An excellent example is the Gunapati Venkata Krishna (GVK) Emergency Management and Research Institute (EMRI) in India, which has built a very innovative public-private partnership for free emergency services that now covers 750 million people in India. The partnership includes state governments, public hospital systems, and Google India, which co-developed the underlying technology systems with these public entities. How does this public-private partnership function? The joint private organization provides leadership, innovation, technology, research, training, and the capacity to execute for an ever-improving system. The government pays for the services and provides a toll-

free telephone number to the population. A map of India shows it to cover 17 states and 750 million people. The public-private partnership responds to 30 million emergencies and saves a million lives annually, deploying more than 9000 ambulances and handling over 20 thousand emergencies per day. This partnership is in real-time, and the technology platform that drives the evolution of medical services is highly sophisticated.

Approximately 40% of the emergencies that the GVK EMRI responds to are road traffic accidents (RTAs), according to the *EMRI Report on Forecasting RTAs* [1]. Therefore, the institute collaborates with hospitals near highways, and stations ambulances and other emergency vehicles on the roadways across from the geography where predictive analytics indicate that accidents are most likely to occur. Data also shows 60% of accidents to happen between 11 pm and 4 am, so the GVK EMRI strategically deploys ambulances and call center staff during these peak hours.

In addition, the report found 15% of the calls to be related to pregnancies. Maternal and child mortality are among the Global Grand Challenge goals for healthcare, and also figure prominently in the United Nations Millennium Development Goals. By deploying female emergency medical technicians (EMTs), the GVK EMRI has been able to improve outcomes by approximately 50%. This is indeed a tremendous benefit to health in both the remote rural regions and the crowded urban areas of India.

When comparing the GVK EMRI system with capabilities in the US, three critical differences can be seen. First, the system's application of sophisticated analytics to an ever-evolving, large-scale database drawing from a very large geographic area allows much more effective deployment of resources for emergency response. Second, real-time learning from the experience of millions of emergency requests for assistance, decisions about how to respond (i.e., with telephone advice, the dispatch of emergency vehicles, or direction to other resources with remote telemedicine or texting services), and follow-up information about outcomes from partner hospitals allows continuous improvement of the system's decision support analytics and the development of increasingly effective services. Finally, the private-public partnership model allows scarce public resources to provide services to a much greater population than would otherwise be possible, and supports a rapidly growing platform for innovation in technology and services.

2. The locus of innovation

The second tectonic shift is in the locus or target of innovation. For example, robots have been developed to provide company for older people in Japan; versions of these robots are now beginning to be used in the US and in other economies. They illustrate a much larger and very important point: that innovations in engineering must focus not only on the hospital or clinic, but also on the home; and must target not only medical diagnosis and treatment, but also the mental health and happiness of populations. We need engineering and informatics solutions to support the well-being of patients and individuals in their homes and communities.

Much of the burden of disease and the cost of poor health is concentrated in older people and in those with complex chronic diseases or advancing serious illnesses. Therefore, much of the early research on well-being has focused on the aged. In the last decade, researchers have begun to find that loneliness is a very common and strong indicator of a broader use of health services, even though it is not itself regarded as a mental health condition.

Well-being is a state of being that is experienced by an individual. It does not only refer to physical health, but also to whether the individual is lonely or supported by caring family or attendants, and to whether the individual is fulfilled—that is, has a sense of purpose. Only recently have researchers come to understand that a higher sense of purpose in life is longitudinally associated with a reduced risk of stroke, myocardial infarction, and sleep disturbances, as well as with fewer overall doctor visits and fewer overnight hospitalizations [2].

Today, medical informatics and computer science solutions are being developed to support people in their communities—to address loneliness, and even to help them develop a higher sense of purpose and connectivity to others. These measures can be as powerful in creating health and well-being as medical interventions such as pills or surgery.

Some of the most innovative solutions are very frugal; that is, they create solutions while requiring very few resources. Initially, scholars thought to look only to middle-income and lower-income regions of the world to source frugal innovations. The rural areas of India, as in the case of the GVK EMRI, and some of the excellent innovations in telemedicine in China are good examples of this. However, frugal innovations are everywhere now—for example, the UK has developed a very simple system involving a half-hour telephone call once a week to isolated and lonely adults, which is proving to be transformative and very inexpensive. The ultimate challenge we all share is to create sustainable healthcare systems that will be appropriate to each region and country. The Center for Health Market Innovations in Washington, DC, ACCESS Health International, the Imperial College London, and the Duke Institute for Health Innovation are among many institutes worldwide focusing on frugal innovations.

3. The source of innovation

The third tectonic shift is in the sources of innovation. Healthcare informatics is now a critical component of almost all wearable monitors and clinical devices. At the University of California, Los Angeles (UCLA), the Wireless Health Institute developed a very simple pedicycle for patients who are confined to bed. When patients are bedridden for as little as a few days, they are deconditioned. When they finally try to stand, they lack strength and balance and are at high risk for falls and injuries. At home, it will often take them weeks or months to recover the mobility and stability they need to return to a normal life.

The pedicycle is connected to a smart phone, so that patients can see how they are doing in their daily exercises. They use it several times a day in the hospital bed, and can also take it home. Use of the pedicycle reduces the average rehabilitation time by more than one-third. With this very simple device, a significant difference is achieved with less cost and time. The key is the immediate feedback to the patient, so that they can follow their own progress and be encouraged to continue using the pedicycle.

An additional source of innovation is the patients themselves. Three decades of research demonstrate that groups of patients sharing a chronic disease can assist each other to achieve remarkable improvements in the control of the disease within 8–10 weeks. In the case of arthritis, for example, peer support can reduce patients' need for pain medicine by 50%, and decrease by 20% the progress of the disease in terms of patients' limitations of activities of daily life. The power of peer support and of peer guides in community has been entirely ignored by much of the medical profession in the past. Today, however, telecommunications and remote support for self-management is a burgeoning field. Peer support among patients is an important area for scientific discovery and innovation in chronic disease.

4. Discovering new linkages between health status and social determinants of health

Finally, we face exciting opportunities as we discover new linkages between health status and social determinants of health. The roles of housing, education, food supplies, security, and the environment determine much of the health status of our communities. New research has demonstrated a direct link between a lack of adequate housing and intensive use of healthcare services, and has shown that the investment required to provide housing is very cost-effective, resulting in significant savings in healthcare costs and a return on investment within 12 months.

Similarly, simple nutritional support—meals for children, older people, and disabled patients—is another cost-effective investment. Education is associated with better health status in general, and patient education and health literacy are also increasingly effective and valuable in the management of chronic conditions. Because much of healthcare is shifting from a focus solely on the individual patient to a focus on populations, the role of informatics has become critical.

Informatics provides the science and the platform for a comprehensive understanding of the range of risks, including social determinants of health, within a population. Informatics provides the key to predicting the needs of individuals and populations, allocating resources, and testing innovations and adapting them for optimal efficacy.

As the task of building sustainable economies and societies has become more urgent, community and business leaders recognize that partnerships between the private sector and the public sector, and collaboration across sectors and agencies including housing, security, education, and the environment, can produce important solutions for health. The ability to aggregate and share data across these sectors; to borrow, co-develop, and adapt predictive capabilities; and to continuously test and improve innovations is one of the most important contributions of engineering to the future of health.

UCLA Health is a member of the Global Lab for Health at the Network for Excellence in Health Innovation (NEHI). We are grateful for the opportunity to participate in this Summit, and look forward to sharing our work on accelerating the adoption of high-value innovations that can radically improve value in healthcare.

References

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