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Opinion

Opinion: Population Health, New Technology, and Innovation: The Future is Here, But Does it Benefit Everyone?

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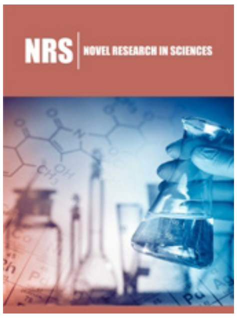

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Opinion

Advances in research and innovation are spurring clinical treatment and population health management. However, significant disparities exist in access to innovative technologies and health outcomes by race, age, and geographic location. Efforts should be made to use new technologies equitably to enhance the health and well-being of the most vulnerable in order to provide for a sustainable future for all. The recent Nobel Prizes clearly illustrate the advent of a new scientific revolution leaving in its wake the development of new technologies and innovations. Alain Aspect, John Clauser, and Anton Zeilinger shared the Nobel Prize in physics for their work to advance applications of quantum physics to real life issues including the generation of new computing capabilities [1]. The Nobel Prize in Chemistry went jointly to Carolyn Bertozzi, Morten Meldal, and K Barry Sharpless for the development of click chemistry and biorthogonal chemistry which harness the potential to radically transform the pharmaceutical industry and the speed at which new drugs and diagnostic tools are developed [2]. Finally, Svante Paabo was awarded the Nobel Prize in physiology or medicine for his work on sequencing DNA from ancient remains [3]. The CRISPR and the new gene editing capabilities are eloquent illustrations of the practical applications of these new advances. Though much is still unknown, the human genome is no longer a tierra incognita and complex molecular processes are better understood. By all measures, the ongoing technological revolution will deeply impact social and cultural development as well as the length and quality of life in the decades to come.

As a result of these new advances in the various disciplines of the sciences, new approaches to health and disease are emerging at unprecedented rates. It took the better part of a century to sequence the genome of the 1918 pandemic influenza virus but only a few weeks to publish the sequence of SARS-CoV-2 [4,5]. Similarly, the pace of vaccine discovery and development has increased exponentially. Approximately 80 years separated the identification of Mycobacterium tuberculosis, the pathogen responsible for TB, one of the world's leading causes of the death, and the development of the BKG vaccine [6]. For Covid-19, the time between the identification of the pathogen and the first vaccine was less than 6 months! Consequently, the health field is being radically transformed through the creation of new disciplines of research and practice. A few examples include health geomatics, nanosurgery and nanomedicine, precision medicine, mobile health and telemedicine, and quantum leadership in healthcare, the internet of things applied to health. Progress in the health field is bidirectional. First, at the meta level, new capabilities allow the analysis of big data and the ability to detect trends in disease from vast populations. The second direction of the technological revolution in health moves toward the infinitely small, to the dimension of the quarks, unveiling intimate molecular processes. Health scientists, serving either at individual or population levels must grapple with that bidirectional complexity to create a values-based synergy that improves health outcomes. Molecular epidemiology, for example, is a step in that direction through investigating how molecular traits and functions lead to disease distribution at the population level and what specific mechanistic approaches should be used for more refined and effective treatments.

This dawning of the future of medicine and healthcare systems shines its bright rays unevenly on select population groups. For groups of higher socioeconomic status, the advances of the new scientific revolution are quickly translating into benefits in terms of new treatment options and, ultimately, better health outcomes at the population level. For others less affluent it appears that technological advances are inversely correlated to need. For example, although malnutrition remains a leading factor of childhood mortality globally, field epidemiologists for nutritional studies still measure anthropometric variables of children in the Global South with outdated tools, error-prone practices and unacceptable delays. They still have low-tech instruments, manually record the data, and spend significant time analyzing these data using software developed over a decade ago. This process frequently takes at least 3 to 4 months, and by that time, the nutritional profile of the targeted children has often shifted, especially in the most vulnerable children under the age of 5 years. Those who were moderately malnourished may have progressed to more severe conditions, and those who were severely malnourished may have died. At a time when the photon has fewer and fewer secrets and 3-D printing is largely available around the world, why is it still difficult to develop an automated anthropometric instrument that will detect individual malnourished children and, also compute the local prevalence instantaneously to trigger immediate action on the field? Such a holistic practice would allow the merging of big data at the population level with treatment of the individual.

Another illustration of this disparity is the case of malaria. Estimates from the WHO suggest that there were approximately 241 million cases of malaria worldwide in 2021 with an estimated death toll of 619,000 individuals [7]. Nearly 1,700 people died from malaria every day, and children under the age of 5 accounted for about 80% of that mortality. The African Region accounted for 95% of cases and 96% of deaths. The new malaria vaccine, RTS S/as01, though welcomed with (measured) enthusiasm, has been in development since 1987! Though its effectiveness is applauded, the WHO report warns that it only reduces life-threatening cases of severe malaria. We are still miles away from control and eradication of a disease that has for millennia been the scourge of mankind. To date Malaria remains a leading cause of morbidity, mortality, and economic burden for over one fifth of the world's population. It would seem logical to expect that quantum physics, click and biorthogonal chemistries, and ventures in the human genome converge to address the world's most persistent challenges that every day claim the lives of the weakest.

Even in affluent nations, the second quantum revolution, changes in chemistry processes, exploration into the human genome, and the subsequent digitalization of health and disease only benefit a few. As in previous technological revolutions, there are winners and there are losers. Data from the United States NIH Surveillance, Epidemiology and End Results program (SEER) suggest that the annual incidence of prostate cancer is two times higher in African American males than in their Caucasian counterparts [8]. Studies suggest that this demographic group also develops a more aggressive form of the disease due to genomic variations that are not well understood (or should we say not well explored). A more equitable approach to population health would require authorities to devote the resources and attention required to reduce preventable differences in disease course and health outcomes and improve access to the benefits of technology for all groups. The disparities in access to and uptake of innovation do not only strike along economic and ethnic lines. They also impact populations along the age groups. Health systems and policy makers will have to analyze current policies and practices in light of a globally aging demographic. An increasing proportion of aged individuals face structural challenges as they live in environments that have been designed for healthy, productive young adults! As a result, fall risks and other impacts of balance deficits, age-related impaired visual and/or auditory capabilities remain poorly addressed, and new concepts such as aging in place or healthy aging have yet to be embraced by the technology revolution.

In balance of the promised benefits, the ongoing scientific revolution has the potential to change the way we practice medicine and conduct population health interventions. The possibility of achieving Marc Lalonde's dream to add years to our lives and life into our years has come a step closer [9]. However, mankind can no longer afford to leave population groups behind as we journey toward greater technological innovations. It is a moral and ethical imperative, but it is also a sustainability necessity. In this interconnected world of quantic era, as seen recently with the Covid-19, the disease of one group can quickly become the disease of all and put the entire civilization to a halt.

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