Global Healthcare: Advances and Challenges

By METIN AKAY
Guest Editor

TOSHIYO TAMURA
Guest Editor

DESCRIPTION: Recent scientific and technological developments and innovations have significantly improved the quality of life and saved lives in the developed world. But, these developments are not introduced to the developing and underdeveloped countries. We still face unprecedented healthcare challenges in the 21st century. The prevalence of major diseases today, from the global AIDS pandemic to antibiotic-resistant tuberculosis, cuts across the healthcare, political, economic, social, and biomedical disciplines: These diseases will continue affecting the world unless major measures are taken to develop comprehensive prevention and treatment programs. Thus, engineers and scientists are expected to play a critical role in developing novel and affordable healthcare technology and medications to solve global healthcare problems, especially in the developing and underdevelop countries. The objectives of this special issue are to discuss the global healthcare systems, financing, delivery and management. We also focus on the recent technological advances in healthcare and their use in diagnosing, treating, and preventing diseases, using novel technologies to develop new drugs, technology regulation, and ethical issues surrounding the use of novel technologies.

This special issue discusses the financing, delivery, and management of global healthcare systems, and also focuses on the recent technological advances in healthcare and their use in diagnosing, treating, and preventing diseases.

The first paper, titled "Microfluidics and Nanotechnology for Detection of Global Infectious Diseases" by Damhorst *et al.*, emphasizes the emergence of microfluidics and nanotechnologies and discusses the need for the tools of the submillimeter scale to overcome the shortcomings of the existing tools to meet the needs of people worldwide for simple, accessible diagnostic tests. It also discusses the urgent need for the commercialization and translation of micro- and nanotechnology-based diagnostics for HIV, TB, and malaria. Finally, the paper emphasizes the potential impact of these technologies in the lives of millions of people in the world's poorest regions that are disproportionately impacted by these life-treating infectious diseases.

The second paper, titled "Advances in nanotechnology and microfluidics for Human Papilloma Virus (HPV) diagnostics" by Tasoglu *et al.*, focuses on the existing assays and platforms employed for HPV diagnosis, and highlights recent advances in nanotechnology and microfluidics that potentially enable new approaches for HPV diagnosis. It emphasizes the limitations of the currently used methods for rapid and inexpensive testing in large population groups and developing countries since instrumentation and technology for real-time PCR amplification is not available. It also discusses the urgent need for innovative and inexpensive diagnostic methods and platforms based on the integration of merging nanotechnologies and sensing methodologies for HPV diagnosis in clinics.

The third paper, titled "Wearable Sensors For Healthier Pregnancies"

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by Penders *et al.*, evaluates wearable sensors as an enabling technology to motivate healthier lifestyle behaviors during pregnancy and reduce the risk of lifestyle-related pregnancy complications in both developing and developed countries. It also integrates wearable sensor technologies, behavior change and pregnancy monitoring to promote healthy pregnancies within the context of behavior change. It extensively reviews existing wearable sensor technology for the field of pregnancy monitoring and discusses the main challenges in designing wearable sensor systems and algorithms for lifestyle behavior monitoring during pregnancy. Finally, it presents the main opportunities at the intersection of wearable technology, behavior change and obstetrics to reduce pregnancy complications and improve outcomes.

The fourth paper, titled "Diagnostic Tools for Lab-on-Chip Applications Based on Coherent Imaging Microscopy" by Merola *et al.*, discusses the need and importance of the development of miniaturized devices able to provide fast and reliable testing for clinical diagnosis. It gives an in-depth review of the optofluidic imaging platform based on the integration of some powerful optical techniques to Lab-on-Chip (LoC) for rapid diagnosis with the main emphasis on the feasibility of a multi-purposeoptofluidic imaging platform. The proposed platform can be used to manipulate cells, measure biophysical parameters and provide long- term cost-effective healthcare solutions.

The fifth paper, titled "Biomedical Applications of Untethered Mobile Milli/Micro-Robots" by Sitti *et al.*, presents in-depth reviews of small-scale untethered mobile robots with applications in medicine to overcome difficulties with conventional medical devices that fall short without an invasive intervention. It furthermore discusses the minimally invasive applications of untethered mobile milli/micro-robots for treatments in clinics.

The sixth paper, titled "AMP-FLUID: Aggregation Magnified Post-Assay Fluorescence for Ultrasensitive Immunodetection on Digital Microfluidics" by Fan *et al.*, presents a novel digital microfluidic platform in which the discrete droplet confines beads, eliminating the problem of bead retention. It also decreases the distance to diffuse between the biomolecules in solution and the capture antibodies immobilized on the solid carrier to have a more rapid incubation and analysis to attain increased sensitivity. The proposed platform is highly likely to improve bead-based point-of-care (POC) diagnoses in developing countries.

The seventh paper, titled "Advances in Smartphone-Based Point-of-Care Diagnostics" by Xu *et al.*, focuses on the state-of-the-art advances in smartphone-based point-of-care (POC) diagnostics with main emphasis on smartphone-based POC diagnostic technologies to detect and collect the desired signals both *in vivo* tests and *in vitro* tests. Because smartphones are widely available and affordable, they will be very essential tools for POC diagnostics in both developing and developed countries.

The eighth paper, titled "Demonstration of a Remote Optical Measurement Configuration that Correlates with Breathing, Heart Rate, Pulse Pressure, Blood Coagulation and Blood Oxygenation" by Ozana *et al.*, describes the use of an optical remote system for the estimation of five vital biomedical signals including heart rate, breathing, pulse pressure, blood coagulation, and oxygen saturation in swine from a distance of approximately 40 m. The proposed platform, which is a low cost and compact, integrated multifunctional system, can be used to overcome the global healthcare challenges, especially those relevant to developing countries.

The ninth paper, titled "Engineering a Global Response to Infectious Diseases" by Fitch, proposes a more robust, adaptable and scalable infrastructure to improve the capability to respond to infectious diseases that are a major cause of death and economic impact worldwide. The paper discusses advanced technologies to improve current approaches to infectious disease management and engineering challenges to accelerate the application of science to infectious disease planning and response at the global scale. Finally, the paper emphasizes the importance of ethical issues needed to leverage traditional infrastructure for infectious disease response and nurturing a global culture of responsibility in both healthcare and technical applications.

We believe that this special issue helps increase the public awareness and stimulate discussions on healthcare knowledge, and the development of long-term cost-effective healthcare solutions. It also stimulates discussions on new healthcare technologies and advocating for policies and resources to provide people with access to the solutions of health problems. Finally, it helps us strengthen partnerships among governments, healthcare industry, and international research institutes. ■

ABOUT THE GUEST EDITORS

Metin Akay is currently the founding chair of the new Biomedical Engineering Department and the John S. Dunn professor of biomedical engineering at the University of Houston. He received his B.S. and M.S. in Electrical Engineering from the Bogazici University, Istanbul, Turkey in 1981 and 1984, respectively and a Ph.D. degree from Rutgers University in 1990.

He is the founding editor-in-chief of the Biomedical Engineering Book Series published by the Wiley and IEEE Press and the Wiley Encyclopedia of Biomedical Engineering. He is also the editor of the Neural Engineering Handbook published by Wiley/IEEE Press and the first steering committee chair of the IEEE Trans on Computational Biology and Bioinformatics. He established the Annual International Summer School on Biocomplexity and Biodesign from Gene to System sponsored by the NSF and the IEEE EMBS and was the founding chair of the IEEE EMBS Special Topic Conference on Neural Engineering. He is also the chair of the IEEE EMBS Neuroengineering Technical Committee. He was the program chair of the International IEEE EMBS 2001 and the co-chair of the Annual International IEEE EMBS 2006 and the program co-chair of the Annual International IEEE EMBS 2011 conference held in Boston.

Dr. Akay is a recipient of the IEEE EMBS Early Career and Service awards as well an IEEE Third Millenium Medal and is a fellow of IEEE, the Institute of Physics (IOP), the American Institute of Medical Biological Engineering (AIMBE) and the American Association for the Advancement of Science (AAAS). His Neural Engineering and Informatics Lab is interested in developing an intelligent wearable system for monitoring motor functions in Post-Stroke Hemiplegic Patients and detecting coronary artery disease. In addition, his lab is currently investigating the effect of nicotine on the dynamics of ventral tegmental area (VTA) dopamine neural networks as well as the detection of coronary occlusions.

Toshiyo Tamura received Ph.D. from Tokyo Medical and Dental University in 1980. He is currently a Distinguished Professor, School of Biomedical Engineering, Osaka Electro-Communication University, Japan. He also holds several adjunct positions in universities in Japan and Singapore.

His research interests include biomedical instrumentation, biosignal processing, telemedicine telecare, home care technology and rehabilitation engineering. His research has resulted in over 100 English reviewed articles. He has served as a chair of IEEE/EMBS Tokyo Chapter in 1996–2000, and the Asian Pacific representative for the EMBS from 2000 to 2004. He was a-president of Japanese Society of Medical Electronics and Biological Engineering in 2010–2012 and a president of Japanese Society of Life Support Technology in 2009–2011.