Editorial Note on Bio, Medical, and Health Informatics

READERS of IEEE TRANSACTIONS ON INFORMATION TECHNOLOGY IN BIOMEDICINE (TITB) may have already noticed that two special sections of distinctive themes have been included in each of the three issues published in 2010. For the first issue in 2010, we have a section on "*Data Mining in Bioinformatics and Biomedicine*" as well as a section on "*Wireless Health*"; for the March issue, we have "*Affective and Pervasive Computing for Healthcare*" and "*Personal Health Systems*"; as for this issue, we have included two sections on "*New and Emerging Technologies in Bioinformatics and Bioengineering*" and "*Smart Wearable Devices for Human Health and Protection*," respectively. The arrangement of these special sections is intended to bring out an important message regarding the TRANSACTIONS: TITB intends to open up its platform for high quality, basic and application papers that mark the advancements in informatics within the wide spectrum of biological, medical, and health issues.

Bioinformatics, fuelled initially by the Human Genome Project, have vastly expanded from its primary study on genomics and genetics (particularly involving large-scale DNA sequencing) to entail the establishment of theories, creation and advancement of databases, algorithms, and statistical techniques to solve formal and practical problems arising from the management and analysis of biological data [1]. These studies at the molecular scale form a solid ground for researchers to understand the biological processes.

On the other hand, medical informatics starts of as an area that develops information systems to support the infrastructure of medicine. Some notable development includes computerized patient records, picture archiving and communication systems (PACS), and hospital information systems (HIS). The second generation of systems and tools developed in this field aimed at supporting physicians and practitioners with decision-making, education, and other professional activities [2].

As clinical or healthcare practice continuously evolves, technologies required for supporting the decision-making also change correspondingly. Recently, the U.S. National Institute of Health described the future health model as a 4-P's paradigm, i.e., *p*ersonalized, *p*redictive, *p*reemptive, and *p*articipatory [3]. Based on the model, a 6-P's paradigm is proposed and defined as p-Health [4], which has two triangles that, respectively, describe "*what kind of healthcare decisions should be made*" and "*how healthcare decisions should be made*" (see Fig. 1). Regarding disease-oriented measures, prevention will serve as the fundamental element in this model. Preventive care will include both population and individualized approaches, initially outlined in Rose's classical seminal paper [5]. Development of predictive risk models for and preemptive treatments to specific diseases are complementary notions derived from the preventive concept. Regarding the decision-making procedure, individualization will be the core. The personalization concept aims to use health information related to an individual acquired up-to-date, including genomic information, personal and family medical history, images of tissue and organs, blood test results, behaviors, etc. with models of the biological systems and physiological process to support the selection of an optimal and effective healthcare approach for the individual. Pervasive care, in contrast to the current hospital-based medicine, aims to deliver health services beyond hospitals and into individual's daily lives, thus allowing care decisions to be made wherever and whenever necessary. More importantly, it supports individualization by providing means to acquire personal health information that are impossible to obtain inside hospitals. It also leads to participatory care by overcoming geographical barriers to facilitate the interaction and sharing of information between individuals and relevant practitioners.

Under the p-Health model, collection of health information has to begin as early as possible, which can be starting at birth or even before birth. Types of information have to span multiple spatial scales of the human body, down from the genetic and molecular level and up to body system level. Information of different modality has to be captured by a variety of acquisition tools, e.g., sensing and imaging devices, and under different situations, e.g., during day-to-day activities as well as irregular clinical visits. The set of information will eventually help to solve health issues arouse at different levels, from personal to global. *Health informatics* is therefore defined as the highly intermultidisciplinary area that deals with the multiscale and multimodality set of data, information, or knowledge at different levels, including the acquisition, processing, storage, transmission, and retrieval of them, for understanding the mechanisms underlying biological, physiological, and pathological processes to support healthcare decision-making and implementation [6], [7]. Fig. 2 shows a block diagram of the multiscale, multilevel, and multimodality health information system.

Listed as one of the 14 Grand Challenges for Engineering in the 21st century by the U.S. National Academy of Engineering, health informatics is foreseen as a field that can greatly enhance the quality and efficiency of medical care and the response to widespread public health emergencies by redesigning care practice and integrating local, regional, national, and global health informatics network [8]. Bio, medical, and health informatics all involve the following five common core research areas related to information technologies: processing, storage, transmission, acquisition, and retrieval, which are collectively named P-STAR for the three kinds of informatics. Health informatics

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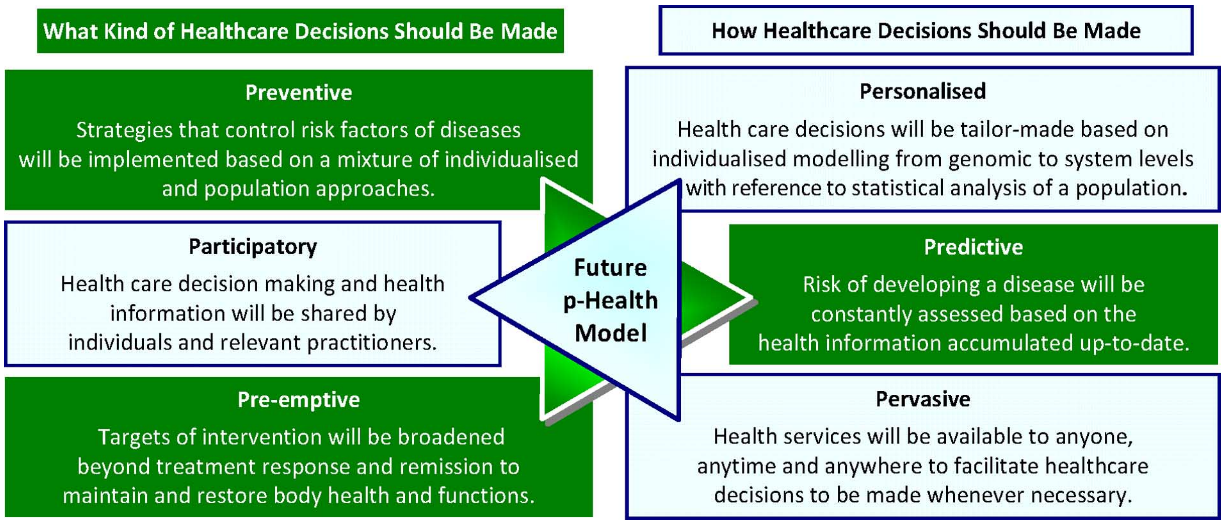

Fig. 1. Future p-Health model: A 6-P's paradigm.

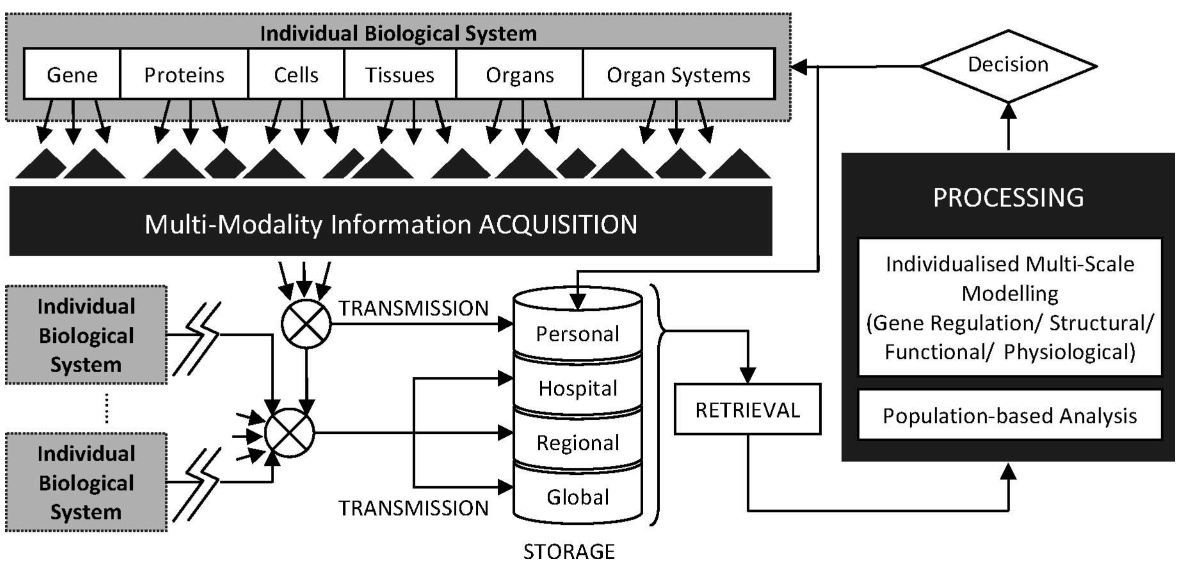

Fig. 2. P-STAR of information in the multiscale, multilevel, and multimodality health information system.

includes part of the technologies advancing in bioinformatics and medical informatics. For example, computational methods for identifying microRNA genes and assessing their expression levels, which are typical tools developed in bioinformatics, are found to be useful for illuminating the role of microRNAs in the development of cancer in health informatics [9]. Medical and health informatics share many technologies in common and are sometimes even used interchangeably. Studies on topics such as the interoperability of medical/health records [10] and modelling of physiological systems/signals [11] are important to both medical and health informatics; however, since data required for dealing with health issues span over wider temporal and spatial scales, as well as involve more modalities, different technologies and tools will have to be developed to solve the same or similar problems arise in medical and health informatics.

Although health informatics shares common technologies with bio and medical informatics, it also requires works that are not covered in the other two areas, particularly regarding health-information acquisition and processing before the emergence of disease symptoms. Tools that allow health information to be acquired outside the hospitals help to prevent the widespread of a virus in the community. The development of wearable devices that can be networked around the body area facilitates the continuous monitoring of health conditions to ensure transient information to be picked up for disease prediction [12]. Highlighted in the front cover of this issue is advancement in this area, where long-term on-body acquisition of vital signs during daily activities is made possible by an earring sensor and wireless earpiece [13]. On the other hand, processing and fusing multiscale and multimodality health information obtained from genetic to system levels are also nontrivial. A recent study showed that combining genetic variation that was associated with incident of a disease does not necessary improves the discrimination or classification of predicted risk achieved with traditional risk factors [14]. The integration and harmonization of biological and traditional medical information, therefore, post new challenges to health informatics.

One year after our publication of the *Editorial Note on Health Informatics*, it is delighted to see that TITB has continuously received an increasing number of high-quality papers in this area. By this Editorial, we look forward for more original contributions to TITB in all three areas of bio, medical, and health informatics. It is envisaged that the advancements in these three fields will help lowering the cost of health care while enhancing the quality and efficiency of health services.

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