Personalized medicine in China’s healthcare system

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“The immune system was traditionally seen as an army, a line of defense, but in reality it shows more resemblance to customs and homeland security services.”
Adapted from Scott Gilbert, Santa Fe, NM, USA, Feb 2013, stressing recent shifts in paradigms related to life-sciences and health.

Focus at the individual

The term ‘personalized medicine’ has infiltrated the medical vocabulary in recent times, along with a number of paradigm-shifting new insights in the biomedical sciences. This has been achieved thanks to the exponential growth of available medical data, combined with the development of analysis tools that enabled integration of different medical disciplines. The practical consequence of these novel insights is the ceased search for so-called therapeutic ‘Golden Bullets’ for symptomatic disease treatment, still very much alive in the early 2000s, and an increased appreciation of a complex disease etiology involving individual susceptibility due to genetics, life-style, development and environmental factors. The term itself is subject to various interpretations, and used in combination with or in the place of predictive, preventive and/or precision medicine. The latter term may replace personalized medicine in the future, as it better fits the data-driven revolution in medical sciences and the broader and deeper focus of health care providers seen today.

Systemic Approach

Personalized medicine is all about a systemic approach of disease. It demands interactive involvement of health care providers as well as academics. Ideally, not the disease, but the disease susceptibility is a focal point for healthcare providers. Integrated information about physiology, genetics, behavior, food intake etcetera can lead to an increased success in targeting disease, as well as preventing it.

Nanotechnology, molecular diagnostics and Big Data

Modern-day personalized medicine is driven by a steep progress in nanotechnology and the development of molecular techniques in the -Omics areas. Nanofibres are being constructed in a manner that they can target specific tissue, for example in order to visualize tumors or to target drug delivery. Nucleotide sequencing technologies now enable swift genetic analyses, and mass-spectrometry is applied to pinpoint physiological markers in an increasingly detailed manner. Importantly, datasets are digital and can easily be shared with any stakeholder. In molecular-diagnostics pipelines, the analysis of complex datasets may become the main bottleneck, rather then the availability of data. A successful transition towards personalized medicine requires advances in data access, data analysis and multi-disciplinary collaboration tools.

Response of stakeholders

In the global arena, the US anticipation towards personalized medicine has been most prominent. The publication ‘Towards Precision Medicine’ (National research Council, 2011) has become a reference for healthcare stakeholders worldwide. In the EU, different groups aim to put personalized medicine on the public agenda, for instance the European Alliance for Personalised Medicine and the European Personalised Medicine Association. Globally, the adaptation leads to a diminishing border between the public and commercial domains. Commercial molecular and data analysis facilities are
Increasingly involved in medical decision-making, and share the responsibility towards patients.

**Health managers in adapted business models**

An enhanced integration of healthcare providers and academics will benefit patient’s perspectives. On top of this, more and more people will be actively contributing to the healthcare sector. Ideally, when a disease is avoided by preventive measures, an individual will never become a patient. Personalized medicine may turn patients into managers of their own health. Physiological markers and molecular data becomes a commercial asset, and this may shift the healthcare business models in the future. Ethical aspects will be challenged due to an increasing public availability of personal health data.

**Personalized Medicine in China**

The global Eureka moment with respect to personalized medicine must have been a surprise to at least some of the traditional Chinese medicine (TCM) practitioners and academics. Regardless of the efficiency of TCM, not being included as an evidence-based medicine practice, the philosophy behind it resembles the one behind personalized medicine to a high degree. They focus towards the individual, earlier life events, and prevention rather than treatment. Personalized medicine may provide modern-day China the opportunity to merge western and TCM practices. Until now the governmental involvement in stimulating such or other advances seemed limited. However, support from officials has been given to international collaborative initiatives, such as the Sino-Dutch centre for preventive and personalized medicine. The focus on developing and implementing personalized medicine is not apparent. Without a clear policy, numerous institutions and industries have nevertheless put personalized medicine on their operational agenda. Most efforts are spent on disease-related issues that affect the Chinese society most, such as ageing, metabolic diseases and liver disease. The following sections show an intersection of current activities that involve personalized medicine.

**Current status**

**Research**

Chinese investigators are contributing to the development of personalized medicine in the global arena. One focus is on exploiting the possibilities of nano-technology, for detection, imaging and treatment purposes. For instance, within a Sino-US consortium a platform has been generated to design nanoparticles, which can help to track, visualize and treat tumors. Furthermore, stem cell therapy is a hot topic in the present-day Chinese research community. Potential therapies for individualized treatment programs could include genetically engineered stem cells and regenerative medicine.

**Public health: Shanghai CDC**

The Shanghai Center for Disease Control (SH-CDC) is engaged in public health. Among its key tasks are policy recommendations for the Shanghai municipality. It performs surveillance of infectious, chronic and occupational disease. The Chinese Ministry of Health has requested from the SH-CDC to obtain patient materials to develop biomarkers for tuberculosis and cancer. China’s population has 5 million known TB
patients, and the incidence is over 1 million per year. The SH-CDC is actively involved in vaccine development and personalized medicine. In the latter project, patients that present themselves are followed intensively. When a patient enters the first day, a standard treatment is offered to him or her. Bacteria are cloned and checked for the response to treatment. Treatment is adjusted if the bacteria seem non-responsive. A large subset of treated patients develops liver damage. Therefore, epidemiological studies have been initiated to subcategorize patients according to treatment, responsiveness and assay outcome, amongst others. Blood is collected for genome sequencing, in order to find regions that associate with the liver disease. Genomic data is also used to study the treatment impact and drug resistance from the host. Tools will be developed for TB treatment in a more effective manner. The industry will be involved to consolidate developments and design treatment plans.

**BGI**

The BGI, formerly known as the Beijing Genomics Institute, is one of the most visible life-science giants in China today. Its sequencing capacity is the largest of any company worldwide, and is expected to increase with the recent acquisition of Complete Genomics. Its ambitions are diverse and surely involve the personalized medicine era. The BGI is in the process of developing prenatal screening techniques (by selecting circulating nucleated embryonic cells in the mother and perform targeted sequencing), and similar techniques that lead to early detection and characterization of tumors.

**Capital Bio**

Capital Bio, headquartered in Beijing, provides the hybridization platforms and chips for genetic counseling, neonatal screenings and other diseases, that are related to genetic mutations or gene expression variation. They serve the global market, and are now strongly involved in developing molecular test for the domestic market as well. A recent development is the kit for testing hearing loss, which guides in defining the risk for newborns to develop hearing loss prior to auditory testing is possible. It allows a pre-collection of individuals at risk, and may lead to timely prevention for a subset of these.

**Shanghai Biomedical Laboratory**

The Shanghai Biomedical Laboratory operates in China and has a small market share in Japan and Indonesia. It is an independent lab, that bridges pharmaceutical industries and clinicians. It offers molecular testing and interpretation of the results. As such, they guide the doctor in the diagnostic process and share responsibility for the patient with the doctor.

According to this company, the pharmaceutical developments drive developments in personalized medicine and with it, molecular diagnostics techniques. Namely, in order to get approval from any FDA-like organization, a specific diagnostic tool should be provided for every newly developed drug. On top of this, efficiency is requested for novel drugs and genetic evidence for treatment. Companies such as the Shanghai Biomedical Laboratory can perform the individual molecular testing, and have access to a huge amount of physiological and molecular data. This requires a heavy investment in terms of bio-informatic analysis. They welcome foreign partners to collaborate and can share anonymised data for the development of tools and techniques.
Big Data revolution
Clearly, the personalized medicine revolution is a data-intensive effort. Advances in information technology are essential for its success. Compared to molecular technology, information technology is cheaper. With a good education system with a strong focus to natural sciences and mathematics, it can be expected that the most significant contributions to personalized medicine comes from academic laboratories and the development of computational and analytical tools in China.

Who drives the revolution if patients cannot pay?
Doctors are the extension of the patient, provide a diagnosis at the intake, but may not be aware of the potential of personalized medicine. They may be the ‘users’ of personalized medicine, but do not have the means to pay for it. In China, awareness is therefore a main issue, and if there is awareness, funding is another one. Most individuals pay the diagnostic tools personally, as these costs are not covered. It can be expected that the implementation and further development in personalized medicine will halt, if insurance companies, or governmental programs, will not cover these expenses in the near future.

Opportunities in China
Personalized medicine motivate individuals into managing their own health. It is expected that high-tech companies in the life-science sector can provide tools and infrastructure. The Chinese healthcare system is rapidly integrating all available patient data. Individual (patient) data will more and more be collected at home. Therefore the opportunities for e-health solutions are substantial.
From a broader perspective, China becomes more open to health professionals from abroad, who now are allowed to establish and manage private hospitals. Private hospitals may, to a certain extent, import health solutions from abroad. Clearly the informatics sector in the Netherlands may also have opportunities in China. The Netherlands Bio-informatics Centre could support its members to invest in tools for the Chinese market, in which information processing becomes one of the main bottlenecks. The three million genomes project, that has been announced by the BGI, clearly displays the data-driven ambitions of the Chinese life-science community and the expected focus on new cloud solutions and algorithms.
Last, experienced policy makers from abroad may contribute in reforming the Chinese health insurance policy, in order to make the latest treatment and prevention solutions available for the entire population.

Further reading
3. Opportunities in China’s pharmaceuticals market. Deloitte, 2011
6. Personalized Medicine, the path forward. McKinsey, 2013