



Technology and Health

An Interview with Professor Benny Zee

Why do you devote yourself in this academic area?

The initial research of this academic area dated back to 2008 when one of my PhD students started working on her thesis entitled: "Image Analysis of Retinal Vascular Network Geometry and its Relationship to Cardiovascular Complications". Since diabetic retinopathy (DR) is a risk factor for stroke, our research team have also developed methodology for the detection of DR, macular edema (ME) and age-related macular degeneration (AMD). We felt that although there are a lot of valuable information in the retina, they would not be useful for community health applications unless the whole process is fully automatic. We have solved a few major technical issues and submitted a US patent on 2012 and was eventually granted in 2014. Later we have also obtained China and Taiwan patents in 2017. We have shown that Automatic Retinal Image Analysis (ARIA) technique can be applied in stroke risk assessment for health promotion and education purposes in the community. We were excited to realize how much information we can get from the vasculature of the retina and later confirmed by another PhD student on her thesis showing that both stroke and coronary heart disease can be detected using retinal images. Based on these findings, we were encouraged to evaluate other vascular-related indications beyond that of cardiovascular disease. Another PhD student demonstrated that diabetic neuropathy and diabetic kidney disease can also be detected using retinal image. This series of investigations led me to realize that innovation and technology using biostatistics methods incorporating AI and machine-learning approaches is valuable to the development of digital public health, and worth devote myself in this academic area.

What do we know about this topic? For example, how is the development in Hong Kong, Asia and Global?

Retinal imaging is a commonly used technology for eye examination by ophthalmologist and physician for assessing eye diseases such as diabetic retinopathy (DR). Scientists have found associations between various retinal characteristics and cardiovascular diseases. However, other studies have not been able to get accurate risk estimate for cardiovascular diseases based on these characteristics and also encounter problems with time consuming and tedious manual measurements of the characteristics during practical application. We have resolved both these difficulties using our proprietary ARIA analytical methods incorporating machine-learning approach.

From a public health point of view, we knew that global burden of stroke is huge. Countries such as Public Health England of the United Kingdom (UK) have recognized the urgency to integrate digital innovation and technology to improve health and reduce inequalities, and they have started to explore "digital strategy" to enhance the effectiveness of health promotion and disease prevention way before disease symptoms occur similar to the Chinese Medicine concept of "治未病". For example, in the article "How digital health care can

help prevent chronic diseases like diabetes" by Harvard University. They studied Omada Health, a digital therapeutics firm focused on preventing obesity-related chronic conditions, provides an example of how digital health interventions can be used to mitigate the overwhelming burden of chronic diseases in the United States. This trend is not only happening in UK and United States, but also in China where many big companies are active in the digital health care market. However, the development in Hong Kong is relatively slow. We feel that we have a mission and responsibility to take the lead actively in this area of research in Hong Kong.

How your current research / project contributing to the advancement of this topic?

In addition to ARIA-stroke risk we are now working on various other indications. For example, we have recently published a paper entitled "Retinal image analytics detects white matter hyperintensities in healthy adults". It has been shown that retinal images can be used to estimate cerebral small vessel disease based on age-related white matter hyperintensities (WMH) using brain magnetic resonance imaging (MRI) as gold standard. We would be able to estimate age-related WMH grading (0-1 vs. 2-3) for assessing the risk of cerebral small vessel disease (SVD), with sensitivity and specificity of 93% and 98% respectively. Individuals with cerebral SVD have higher risk of cognitive decline, stroke and dementia. We will offer this fast, non-invasive, and relatively inexpensive test to the community as a tool for health promotion and introduce lifestyle intervention to improve cognitive health. In the next stage, we are planning to work with organizations in the community to encourage lifestyle changes for those with high risk of SVD, especially in the 3rd world countries where resources and expensive treatments are limited. We are planning to partner with wellness centres, social service community centres, Chinese Medicine clinics, Tai Chi organizations, gymnasium training classes, yoga classes, diet programs and supplements centres.

What is the controversy of this topic?

In Hong Kong, health promotion and disease prevention is not traditionally emphasized by the local medical system, despite the fact that Chinese culture considers family support, healthy diet, exercise such as Tai Chi are important components of healthy lifestyle. In contrast, UK such as Public Health England, NHS Wales Informatics Services (NWIS) and the Life Sciences Hub Wales supported by Welsh Government's "Efficiency Through Technology Programme" created the Digital Health Ecosystem Wales (DHEW) network, are a few examples how active other countries are promoting the concept of digital public health and embracing innovation and technology in the development. Hong Kong is supposed to be in a best position to pursue digital public health, as we exposed to both East and West cultures and knowledge. We are also leading in many areas of innovation and technology, the problem is whether Government, industry, and academic institutions are willing to work together.



What is the biggest frustration or challenges in the area?

I don't think I have a lot of frustration, but it is "painful" every time I have to give advice to my students on their career choice. I wish my best students stay in our CUHK research group or join our entrepreneurship adventure in Hong Kong, but at the same time I have to be honest that a more stable job that offers good opportunity to grow in their career with less uncertainty is probably preferable to them. When I have to give advice rationally, it is painful, but we have to be honest and do the right thing. My early students are now working in Hospital Authority as Specialist in Ophthalmology, Assistant Professors in Sun Yat-sen University, Administrator in Shenzhen University, and Biostatisticians in big Pharmaceutical Companies. In addition to the graduate program, our School also trained bachelor and master degree graduates, which I feel I can offer them excellent learning experience and challenging jobs in research or as an entrepreneur in Hong Kong as well as in other parts of the world. We aim not only to be successful in innovation and technology development for digital public health, we also aim to make big social impact to our society.

What is the future, prospects and implication of the area? (e.g.: Career Path)

Digital technology is going to change the future of public health. With innovation and technology development in digital public health application, health care cost will be decreased and efficiency will be increased. The scope of digital public health is extremely wide. Using ARIA as an example, early detection of risk of SVD and stroke may encourage healthy lifestyle and promote early prevention of chronic diseases. This is just one of many potential inventions, and if we combine other technologies such as medical informatics, wearables, AI systems, application of epigenetics information, etc. we would be able to achieve even larger benefits with the ability to reduce burden of diseases to the society and improve individuals' quality of life. What we need to do is to help train our students to think outside of the box, and embrace this "innovation and technology evolution" in shaping our future in the area of public health. The world is getting smaller because of the advancement of technology, and that means our students would have a higher chance to make a global impact to improve health and reduce health inequalities.