Applying Research Outcomes into Innovation and Technology for Better Health Care and Life Quality

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Abstract — The history of medicine can be traced back to the ancient human societies that related to the beliefs which provide explanations for birth, death, and disease. However, the concepts of diagnosis, prognosis, and medical examination were not formed until introduced by ancient Egyptians in Africa (1600 BC), Babylonians in Mideast (2200 BC) and Chinese in Asia (1600 BC). Preventive medicine was also developed in China at that time. During the Renaissance, knowledge of understanding anatomy and the invention of the microscope led to the 'germ theory of disease', the foundation of modern medicine. Now we are in the 21 century, standing on the summit of modern medicine era, which our ancestry had never dreamed of. Our life has already been extended from an average of 25 years in the Stone Age to around 70 years in the 'Modern Age' due to the help of modern medicine. However, we still face to many incurable diseases, such as cancer, AIDS, cardiovascular disease, psychiatric disease... etc., even our technologies in pharmacology, chemistry, physics, biology, medicine and engineering have tremendously improved than before. How to apply our research outcomes into innovation and technology for better health care and quality of life should be our mission and obligation.

Keywords — History, medicine, disease, technology

I. HISTORY OF MEDICINE

If the expectation of human civilization is to have healthily live with longer life, then there is no doubt that the most contributed aspect is the progress of medicine, especially the achievement of preventing the infectious diseases in the first half of the 20th century. The human life expectancy has been extended from the Stone Age of about 25 years to the 21 century's 70 years due to great improvement in medical diagnosis, treatment and the concept of prevention. There are several milestones of the investigations or inventions in the history that result in the modern medicine. Most of investigators won the Nobel prizes. Here I would like to state their contributions along the time line of the progress in medicine in history and the Nobel prizes award since 1901.

A. Microscope

In 1590, two Dutch lens grinders Hans and Zacharias Janssen make the first microscope by placing two lenses in a tube. The invention of microscope leads to discover and evidence the existence of bacteria which have very tiny size with unit in micrometer and can't be seen by eye

or simple glass magnifier. Some of them played major role of causing serious epidemic diseases or plagues in the Middle Age. Many ancient civilized cities such as Athens of Greek in BC 430 and Rome in 262 AC were almost destroyed by black plague. Nearly five thousands people died from it in a single day. In 1348 AC, the epidemic of black plague came back again and killed almost 1/4 to 3/4 population of Europe. The bacterium is now called Yersinia pestis which is a Gram-negative rod-shaped bacterium. It is a facultative anaerobe that can infect humans and other animals. In 1675, Anton van Leeuwenhoek uses a simple microscope with only one lens to look at blood, insects and many other objects. He was first to describe cells and bacteria, seen through his very small microscopes with, for his time, extremely good lenses. This results in the foundation of microbiology; In 1913, Richard Zsigmondy develops the immersion ultramicroscope and is able to study objects below the wavelength of light. He won The Nobel prize in chemistry 1925. In 1931, Ernst Ruska develops the electron microscope. The ability to use electrons in microscopy greatly improves the resolution and greatly expands the borders of exploration. He shares the Nobel prize in physics in 1986 with Gerd Binnig and Heinrich Rohrer who invent the scanning tunneling microscope that gives three-dimensional images of objects down to the atomic level. Although the last two were awarded in the category of physics, they all are frequently applied in the research of biological science.

B. Antitoxic serum and Vaccine

The invasion of bacteria to the body may cause serious disease such as the black plague mentioned above. However, some bacteria may not directly attack our body to cause illness but the released toxin can, such as diphtheria and tetanus. An antibody forms in the immune system in response to and capable of neutralizing a specific biological toxin. If serum contains antitoxins then it can be used to treat diseases caused by corresponding biological toxins, such as tetanus and diphtheria. Adolf Emil Behring was the discoverer of diphtheria antitoxin in 1890. He won the first Nobel Prize in Physiology or Medicine in 1901 for developing a serum therapy against diphtheria and tetanus. Paul Ehrlich won the same honor in 1908 because of developing a mass productive method of diphtheria antitoxin.

The history of vaccine and immunization should begin with the story of Edward Jenner. He performed the world's first vaccination in 1796. Unlike the diseases caused by bacteria, some of the diseases are caused by virus, which size is much smaller than the bacteria. Most range in size from 5 to 300 nanometers. In other words, it can't be observed under microscope. Cowpox is an example. More than 200 years ago, in one of the first demonstrations of vaccination, Edward Jenner inoculated a young English boy with cowpox material from a dairymaid and showed that the boy became resistant to smallpox. Jenner published a volume that swiftly became a classic text in the annals of medicine: Inquiry into the Causes and Effects of the Variolae Vaccine. His assertion "that the cow-pox protects the human constitution from the infection of smallpox" laid the foundation for modern vaccinology. Now there are many different kinds of vaccine to be used to prevent diseases, such as tuberculosis, yellow fever, poliomyelitis, ... etc.

C. X-ray and imaging technology

The discovery of x-ray by Wilhelm C. Roentgen in 1895 opened a door for medical diagnosis. Although it has been over more than 100 years, this technology is still and frequently in use globally. There is no doubt that Roentgen was awarded Nobel prize in physics in 1901. In 1971, about seven decades later, the first x-ray

computer tomography (CT) has been built by Godfrey Hounsfield (1979 Nobel prize winner in Physiology or Medicine) for brain scan at Atkinson Moreley Hospital in London. Soon after that this technology is applied to whole body scan for diagnosis. The major contribution of this technology is to switch a 2D medical image (x-ray film) to a 3D configuration. In 2003, the Nobel Prize in Physiology or Medicine was awarded jointly to Paul C. Lauterbur and Sir Peter Mansfield "for their discoveries concerning magnetic resonance imaging". Although there are many different imaging modalities recently being developed for medical diagnosis, these two are still commonly used in hospital.

D. Physiological signal recoding

This is an aspect that reflects the function of tissue or organ in a fashion of electrical signal. The first evidence of electrical activity in the nervous system was observed by Luigi Galvani in the 1790s with his studies on dissected frogs. He discovered that you can induce a dead frog leg to twitch with a spark. In 18 century, human started to understand the phenomenon of electrical activity in body and found that the body can conduct current. In 19 century, Rudolph von Kolliker and Heinrich Muller found that heart could generate current when they took out a piece of muscle and its connected nerve from one animal and put the other end of the nerve on the heart of another animal, the muscle contracted. In 1878, a tiny electrode was developed to put on an animal heart to measure the current generated by the heart. In 1903, Willem Einthoven developed an equipment that can measure and recode small current when electrodes put on particular places on chest. This is the first noninvasive recoding of physiological signal, called electrocardiogram (ECG), in functional aspect of heart. In consequence, many protocols of measuring physiological signals at different sites of body were developed such as electroretinogram (ERG) for retina, electroencephalogram (EEG) for brain, and many others. Einthoven won the Nobel prize in Physiology or Medicine in 1924. More than one hundred years later, this technology is still in use for clinical diagnosis.

E. Antibiotics

Moving into the 20 century, it seems that many diseases can be prevented and controlled by vaccination and antitoxin serum therapy. However, there still have problems in medicine caused by infection that can't be solved. In 1928, Alexander Fleming found that one of cultured bacteria bottle was contaminated by green mould when he came back from a vacation. He noted that his cultured bacteria (staphylococcus) were swallowed up by these mould observed under microscope. This kind of green mould is called Penicillium which can be found on rotten orange or apple. In addition to this, he also found that Penicillium can have the same efficacy to the other types of bacteria. After purification, he named this new drug Penicillin. Mass production of Penicillin is carried out 10 years later by the help of two chemists Howard Florey and Ernest Chain. Penicillin provides great contribution to wounded soldiers in World War II. In 1945, Fleming, Florey and Chain won the Nobel prize in Physiology or Medicine.

II. CURRENT TECHNOLOGIES IN HEALTHCARE

A. The human genome project

Thanks to the progresses in current technologies such as electronics, computer science and engineering so that the permutation of DNA sequence can be completed within 13 years (1990-2003). Scientists believe that most of the human diseases are related to the genes. If the secret code of gene can be deciphered, then what sector of

genes that related to particular kinds of diseases can be found. This can probably lead to find a therapeutic way to cure the diseases.

B. Stem cell

Perhaps the most important potential application of human stem cells is the generation of cells and tissues that could be used for cell-based therapies. Today, donated organs and tissues are often used to replace ailing or destroyed tissue, but the need for transplantable tissues and organs far outweighs the available supply. Stem cells, directed to differentiate into specific cell types, offer the possibility of a renewable source of replacement cells and tissues to treat diseases including Alzheimer's diseases, spinal cord injury, stroke, burns, heart disease, diabetes, osteoarthritis, and rheumatoid arthritis.

C. Artificial tissue and organ

In last century, progresses in material science (include biomaterials), solid state and electronics (include bioelectronics) result in that many tissues or organ can be permanently or temperately replaced, such as intraocular lens replaces crystalline lens in eye for cataract surgery, cochlear implant for hearing impairment, artificial knee and artificial bone for severe fractures and disease, artificial skin for severe skin burn, ...etc. Currently, research of artificial retina has shown with great progress that a retina chip with 8x8 pixels resolution has successfully implanted in a blind patient, who is diagnosed retinitis pigmentosa (congenital retinal disease). This allows him to distinguish relative large objects such as door, wall and hallway so that he can walk with the help of a cane.

What we expected on the stem cell research is that it can differentiate to particular organ for organ transplant in the future. Before that, the technology of artificial organ or tissue can temperately take place of the functions of these tissue and organ. This is an idea and could come true.

III. THE ASPECTS OF HUMAN LIFE AND QUALITY OF LIFE IN THE FUTURE

The technologies in modern medicine have moved to the summit in the late 20 century, which has already extended human life from 25 years of the Stone Age to 70 years in the 20th Century, we still face to many unsolvable problems of disease such as cancer, AIDS, psychiatric disease, ... etc. Additionally, severe environmental pollution, unexpected weather change, declined grain yield, the pain factor increases compared to the Age without much help of medication. How to overcome these problems is a big challenge of human being in the 21th century in addition to prolong our life.