

Why China is currently underperforming in medical innovation and what China can do about it? – Part I

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The results of AME survey-002 came out with a surprise to authors' colleagues as well as the authors ourselves. Of the seven nominated important medical achievements in China mainland since *Xinhai Revolution*, only all-trans retinoic acid for acute promyelocytic leukemia treatment by Wang *et al.* [1988] was accomplished after the ending of *Great Proletarian Cultural Revolution*, which ended 38 years ago in 1976 (1). The results indicate China is currently underperforming in medical innovation.

As the timeline plot of AME survey 002 showed the important achievements were concentrated toward late 1960s and early 1970s (*Figure 1*). This immediately alerted us that these achievements coincided with some of the most important defense technology achievements of modern China, and the first major success of Longping Yuan's hybrid rice culture (*Figure 1*). This partially concur Murray's note: '*history has worked out, the ages rich in giants have also been rich in near-giants and the rest of the significant figures...*' (2).

According to Professor Guang-Zhao Zhou, ex-president of the Chinese Academy of Science, that productive period was characterized by (I) academic freedom, with senior scientists and young graduates engaging in open debate in the equal term; (II) very good team work and collaboration; (III) idealistic spirit of the participants (3). Of course, researchers at that time did not need to be constantly assessed by rankings and citations, so they were able to work on long-term projects. According to Charles Murray, being idealistic rather than motivated by material rewards and having freedom of action are important for individuals to excel in arts or sciences (2).

Professor Guang-Zhao Zhou commented in 2007 that

the academic atmosphere was becoming less democratic in China (3). This is not surprising. We human being, as one species of animal kingdom, also have the tendency that the small portion of the rich and powerful take their existing advantages to obtain even more wealth and more power, leading to concentration of wealth and power, while leaving the less privileged marginalized. This is a part of nature of biology.

China is certainly a wealthier society now. However, one interesting observation by Charles Murray is that wealth does not necessarily contribute to high achievements in sciences or in arts (2). As an example, the massive wealth bought to Spain from Latin America after Columbus discovered the *new* continent contributed to the chronic underperformance of Spain in sciences and arts relative to her European counterparties, which lasted to even today (2).

For more than a decade, China has been making great efforts to create '*globally first class universities and research institutes*'. However, with the massive monetary investment and exponential growth of citable publications, the actual achievement has widely been considered unsatisfactory (4-8), which to some extent agrees with the AME survey 002 results. If we look at the history perspective, Dong *et al.* (9) concluded that (I) the accumulation of scientific achievements over Chinese history is less than 1% of the world total; (II) the European area has been active in various scientific activities since 500 BC, and its scientific and technological achievements have always been outperforming China. Similar accounts have been shown by Charles Murray in his book '*Human Accomplishment: The Pursuit of Excellence in the Arts and Sciences, 800 B.C. to 1950*' (2).

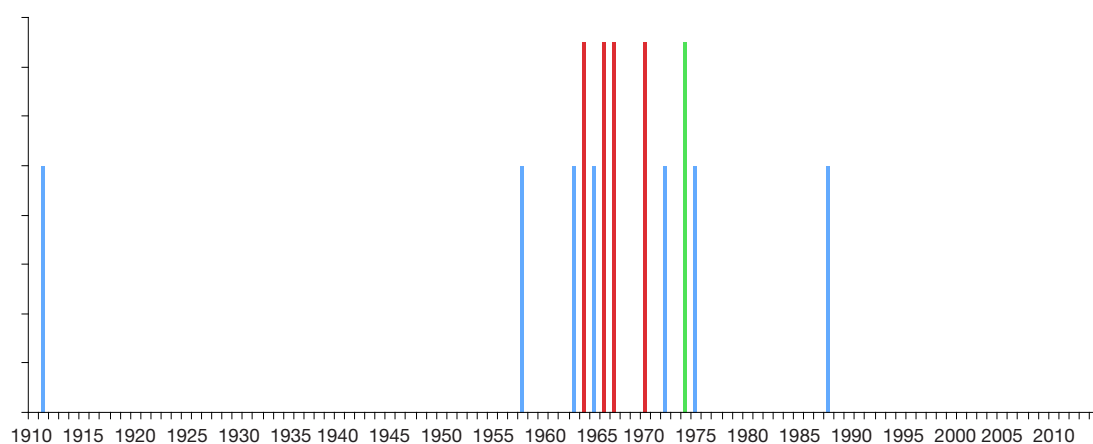


Figure 1 Concentration of major medical achievements toward later 1960s and early 1907s coincided with some technological successes in China. Y-axis is in artificial units. Blue-lines: top seven medical achievements in China mainland since *Xinbai Revolution* (1). (I) Wu's mask for plague prevention [1910]; (II) culture of *chlamydia trachomatis* in the yolk sac [1957]; (III) limb re-plantation [1963]; (IV) chemical of insulin [1965]; (V) Artemisine [1972]; (VI) arsenic trioxide (As_2O_3) [1974]; (VII) all-trans retinoic acid [1988]. Red-lines: (I) first successful test of nuclear bomb in China [1964]; (II) first successful test of nuclear-bomb carrying earth-to-earth missile in China [1966]; (III) first successful test of hydrogen bomb in China [1967]; (IV) first successful launching of satellite in China [1970]. Green-line: Longping Yuan's hybrid rice culture [1974].

Since China has never been a major contributor of science and technology for more than 2,800 years, intuitively we can assume it will be really hard for China to turn a portion of her universities and research institutes into world leading status in just one or two decades. To be fair, scientists in China universities and research institutes are not the only ones to be blamed. Chinese scientists may need to be given much more time for more meaningful outputs. Nature may have its own rules which we human being have not fully understood yet. By definition, most of us will turn out be ordinary persons in the end; high achievers are always rare (10). The same applies to university; by definition most of the universities in the world will be ordinary universities.

Most people will agree that woman weight-lifting should be abolished as a competitive sport in China long time ago. Few people are interested in and watch this sport; and it is unhealthy and can cause frequent injuries to the participants. China may give up football as well. The Chinese national foot team, collectively, has failed expectation again and again. We must come to the term that Chinese are not good at football after all. Football is not a part of Chinese tradition, and Chinese people can be happier playing table tennis and badminton. For science and technology, China of course needs to continue to improve her defense capabilities, and also support companies like *Huawei*. However, do we really need *globally*

first class universities defined by the current Anglo-Saxon ranking systems [the Germans and the French apparently have different systems (11,12)]? At current stage we think it is desirable, but not essential, though definitely we need good educators. To achieve and maintain these *first class universities* will cost lots of not-well-spent money. There is no need for China to repeat the expensive and monotonous show of 2008 Beijing Olympics game. Of note, the top two countries on happiness index list Denmark and Norway do not have globally first class universities by the common rankings. The USA has a highest number of globally first class universities and research institutes, while ranked only 18th in happiness index. Costa Rica has higher happiness index than USA (13).

Research management and the ways to cultivate innovation are rather sophisticated, much more difficult than managing manufacturing. If we look at our East Asia neighbors, not only Japanese and South Korean pharmaceutical and biotech companies are not prominent, as the authors happen to be in the field of medical imaging so we talk about magnetic resonance imaging (MRI), in MRI devices Japanese companies are still far fallen behind the big three, i.e., *GE*, *Siemens*, and *Philips*, though Toshiba has a large R&D operation in USA (*Toshiba America Medical System*). South Korean MRI companies are not quite visible yet. One Japanese MRI scientist recently told one author

(YX Wáng) that he really admires that *GE*, *Siemens*, and *Philips* being able to introduce waves and waves of new MRI technologies continuously into the market.

As opposed to the cold war time, it is a relatively peaceful world around China now. As long as the many clever scientists in *Harvard*, *MIT*, *Stanford*, *Cambridge*, and *ETH* work 12 hours a day and 6 days a week (or even more), and the large number of clever chemists and engineers in *Pfizer*, *Novartis*, *Siemens*, *Philips*, *Airbus*, and *Boeing* are well motivated, then we will be fine. We will not be left out. Most of their discoveries and inventions will benefit Chinese people as well in the end. Instead of fierce head-to-head competition, Chinese scientists can now be more relaxed. Chinese scientists can be more focused on long-term projects those are really interesting to themselves, or those are really useful to the society. In the end, the primary aim of scientific and technological endeavors is to benefit ordinary people, and to make sure the disadvantaged are protected.

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Appendix

Considerations on validity of the AME survey 002

The results of AME survey-002 came out with a surprise to the authors. The first immediate reaction from the authors is that will the results be reliable? Was there no major achievement in the last 25 years? Right after the survey, the authors contacted many friends and colleagues, however, all the contacts replied that they could not name a major medical innovation in China in the last 25 years. When we looked at the survey data again, we could see that the distribution of our participants was balanced. The number of participant is also similar to several previous DXY.cn surveys [Quant Imaging Med Surg 2015;5(1):174-81; and <http://vote.dxy.cn/report/dxy/id/59649>]. It is highly

unlikely that a major innovation with wide application has been missed. The age information was not collected during the survey; however, based on the professional grade distribution of the participants, we estimate that median age of participants would be their early 30 s (also similar to AME survey 001). As a rough guide of academic activities, votes of AME survey 002 excluding nominations in reference (1) are shown in *Figure S1*. We can take the assumption that recent achievement would be better known to the participants. Therefore despite all the limitations and potential bias, including the possible residual effect of mass propaganda before the ending of *Great Proletarian Cultural Revolution*, it is unlikely AME survey 002 missed a major medical innovation in China in recent decades.

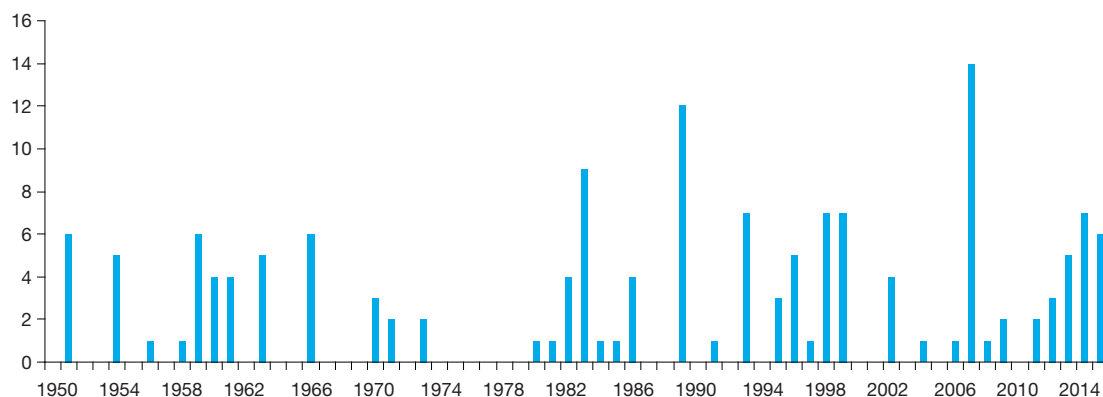


Figure S1 Nominations in AME survey 002 across timeline. Y-axis is the votes of each item \times number of voted item over years. All other practical as well as theoretical items nominated are included though a few of them were not clinically validated and some of them were not original in China. The seven major medical achievements and acupuncture anesthesia (reference 1) and *Yunnan Baiyao* (1902, by Huangzhang Qu) are not included in this graph.