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3.3.1 The impact of STI on society

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Abstract

High-impact science, technology, and innovation have transformed the way society works. Although the connections of science and technology with society have increased, the implementation of the contributions of science and technology require a long time. In order to promote science, technology, and innovation that will benefit society, we must commit to investing in science and technology for the medium- and long-term as well as short-term, to address the challenges we face. However, it is far from self-evident that changes brought about by science, technology, and innovation contribute to society's well-being. Japanese are less aware that science and technology improve society than that they raise new ethical, legal, and social issues. This paper explores the impact of such science, technology, and innovation on society, using examples from fields of health and medicine.

Keywords

Social implementation, science and technology, technology transfer, health technology assessment, clinical application

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1 Japanese views of science and technology

Government and universities have periodically conducted surveys measuring Japanese attitudes toward science and technology, including nine Cabinet Office surveys on science, technology, and society since 1967 [1]; the NISTEP Internet survey (conducted by the National Institute of Science and Technology Policy under the direct control of the Ministry of Education, Culture, Sports, Science and Technology – MEXT) [2]; the National Character Survey conducted by the Institute of Statistical Mathematics every five years since 1953 [3]; and the World Values Survey (WVS) conducted by Inglehart at the University of Michigan [4]. Although Japan’s low response rates and tendencies to understate or avoid extreme answers complicate direct international comparisons, yet such survey research does provide insights into Japanese views of science and technology (Ryozo Yoshino et al., 2015), characterized by lowered expectations.

The first point that the surveys clarified was a dramatic shift in public attitudes during the 1970’s. Indeed, Japanese attitudes changed not only towards science and technology, but also towards values and life in general. As early as the 1973 survey, the opinion that “human beings should control nature for human happiness” declined, while “human beings should live in accord with nature” began to increase. Moreover, 50 percent of the respondents—a percentage continuing even today—agreed that “as science and technology develop, we become less human.” [1] In the 1970 Cabinet Office’s “Public Opinion Survey on People’s Lives” [5], roughly the same percentage of respondents said they wanted to focus on material wealth as of those who said they wanted to focus on spiritual wealth—but thereafter, the latter subsequently increased. Under pressure to deal with two oil crises and growing pollution problems, Japan began to reject the linear model of progress of the period of high economic growth (Kobayashi Shinichi, 2012), which had held that basic research based on the judgment of scientific and technological experts would lead to solutions to social problems.

Compared to other countries, Japan seems rather pessimistic, holding a relatively low estimate of how science and technology have improved the world. Asking respondents to rate on a ten-point scale whether the world were better or worse off as a result of science and technology, the 5th World Values Survey conducted from 2005 to 2009 found Japan second lowest out of 17 OECD countries surveyed (only Hungary was lower); and the 6th World Values Survey conducted from 2010 to 2014 found Japan second lowest out of 14 OECD countries surveyed (only Mexico being lower).

However, this tendency does not necessarily stem from any awareness of the negative effects of science and technology. (Kuriyama et al., 2011). In a public opinion poll asking whether the development of science and technology had more positive or negative aspects, only 40% of Japanese recognized negative aspects. Conversely, in countries such as the UK, Germany, and the Netherlands, which see science and technology as more likely to improve the world, more than 50 percent of respondents reported its negative aspects [6]. So not only awareness of negative factors like dangers and risks leads to distrust of science and technology. An analysis of the distrust of science and technology in the UK brought to light the desirability of social dialogues about the ethical, legal, and social issues of science and technology (Kobayashi, 2012). In Japan as well, enhanced opportunities for communication with and about science and technology may raise

Japanese awareness of their positive as well as negative aspects, improving future Japanese evaluations of science and technology.

2 Who wins or loses in the implementation of science and technology: Movement and endeavors in health and medicine

Academic and research institutions are expected to develop innovative technologies to benefit society, but the impacts of science and technology are not always beneficial. Indeed, novel technologies have ethical, legal, and social implications (ELSI) with the potential to benefit some of their target populations while disadvantaging others.

Take for example the social implementation of a new cancer drug originating in Japanese research. Together with Ono Pharmaceutical Co. Ltd., Dr. Tasuku Honjo and his colleagues at Kyoto University developed a new therapeutic drug, Nivolumab, which restores immune function against cancer cells (Ishida et al., 1992; McNutt, 2013; Topalian et al., 2012). It was approved by Japan in September 2014, ahead of the rest of the world, as a treatment for malignant melanomas; its scope subsequently expanded to include squamous non-small-cell lung cancer in December 2015 (Brahmer et al., 2015), significantly prolonging the survival of nearly 50,000 patients. In its interim results for September 2016, Ono's sales rose 94.7 percent over the same period in the previous year, with both sales and profits reaching record highs [7].

However, the effects of this medical breakthrough on society have not been uniformly positive. Nivolumab costs approximately JPY 35 million (a quarter of a million US dollars) per person per year. If all eligible Japanese patients used Nivolumab, the annual cost of the drug would approach JPY 1.75 trillion [8]. Japan's medical care system caps patients' payments for high-cost medicines, so public insurance and taxes cover almost the entire amount. This new medicine is a godsend for one group with a specific disease has become a financial threat to Japan's entire health insurance system, which supports countless other patients and citizens. In response, the Ministry of Health, Labour, and Welfare (MHLW) decided to significantly reduce NHI prices by 50 percent in February 2017, without waiting until 2018 for the usual NHI price revisions [9]. On the other hand, such off-regulation revisions may also undermine the predictability of pharmaceutical companies' operations and discourage them from investing in innovation for the benefit of future patients. As with Nivolumab, increasingly sophisticated and expensive medical technologies increase national healthcare costs by hundreds of billions to a trillion yen each year [10], challenging the sustainability of Japan's universal healthcare system (Nishigori et al., 2015).

In addition to economic issues, all new medical technologies risk adversely affecting their target populations. Life science innovations like the clinical application of iPS pluripotent stem cells raise ethical, legal, and social issues as well. The implementers of science, technology, and innovation need to clearly recognize that the effects of new developments are not uniformly beneficial, but may also raise ELSI among certain groups or society as a whole.

Technology assessment supports social decision-making by predicting these social impacts at a relatively early stage of technological development (Shiroyama et al., 2013). Health Technology Assessment (HTA)

is one such attempt in the medical field, typically using comparative utility analysis to evaluate cost-effectiveness, that is, how much an increase in costs can improve life expectancy and quality of life (McCabe et al., 2008; Nishigori et al., 2015). Comparative utility analysis—already widely used in other countries and about to be introduced in Japan to evaluate the cost-effectiveness of high-cost medical technologies such as Nivolumab [11]—will enable society to make better use of its limited resources and to more fairly evaluate valuable technologies. Such evaluations are expected to further encourage breakthrough innovations.

HTA needs to involve not only health care professionals but also patients and the general public (Menon and Stafinski, 2011). Individual patients and citizens, not healthcare professionals, should judge whether the effects of a new medical technology are positive or negative. The UK excels in HTA by actively involving patients and citizens under the Patient and Public Involvement Policy, which views patients as experts in living with illness rather than as medical laypersons [12, 13].

According to Japan’s Fifth Science and Technology Basic Plan, the relations between society and science, technology, and innovation should be expanded from traditional motives of research and profit to those of “co-creation” among diverse stakeholders. If the government would promote and standardize activities such as HTA, that predict, evaluate, and judge the impact of science and technology from multiple perspectives, then stakeholders could interact and collaborate with one another, thereby “co-creating” science, technology, and innovation in Japan.

3 How can science and technology contribute to society: Perspectives from medical research

Although the natural sciences formerly developed in isolation from social practice, today science and technology policy can no longer ignore their relationship with society, particularly because much OECD government R&D expenditure contributes to socioeconomic objectives, such as national defense, health, and environmental protection (Iwahashi, 2016). In 1999, the World Conference on Science adopted a Declaration on Science and the Use of Scientific Knowledge as a mandate for the twenty-first century. Its fourth chapter, “Science in and for Society,” declares that scientific research and the knowledge it generates must be used for the welfare of humanity, human dignity, and respect for the global environment [14].

Japan’s Fourth Science and Technology Basic Plan (2011), advocated “policies developed in cooperation with society” [15]; facing increasingly complex domestic and international challenges, Japan’s Fifth Science and Technology Basic Plan (2016) included “addressing economic and social challenges” as one of its four pillars [16]. Japan’s 2015 White Paper on Science and Technology introduces the roles played by the government alongside the changes in people’s lives brought about by scientific and technological advances over the past decade, presenting eight cases ranging from photocatalytic technology in exterior house coatings to the world’s first fully farmed bluefin tuna and drugs for hypercholesterolemia, many of which took several decades from research germination to implementation [17].

It is well-known that basic medical research requires substantial investment of time and resources to reach clinical application. Indeed, an earlier study found that of the articles published in the top five science journals between 1979 and 1983, twenty-seven had reached their clinical application stage after ten years (Contopoulos-Ioannidis et al., 2003). We examined articles published in the eight leading journals between 1989 and 1993, as the emergence of new research areas and problems may have changed the rate and time required for reaching the clinical application stage. Compared to previous studies, we found that the rate of clinical application decreased while the time to clinical application increased (Hanaki et al., 2016), suggesting that publication in major journals is not adequate grounds by which to assess the applicability of scientific research. We concluded that research funding should be allocated based on the value and content of each study itself, rather than merely on the reputation of the journal in which it was published.

In the future, developed countries like Japan face issues resulting from socioeconomic changes that urgently demand solutions, ranging from demographic changes due to declining birthrates and ageing populations to issues of resource shortages and environmental crises [18]. While we assiduously hope that science, technology, and innovation can solve these problems and contribute to society, at the same time, we need to support basic research that may not immediately entail practical application in the short term, but which may beget future innovation in the long term. In this respect, care must be taken when allocating limited research funds.

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