The relationship between a cost reduction in medical expenses and utilizing smart health services, and a driving factor in Japan

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ABSTRACT

Continuing increasing in medical expences is a problem facing all countries. This paper considers using System Dynamics to understand how utilization of digital and ICT (Information and Communication Technology) impacts on medical expenses in Japan. From the research results, utilization of digital and ICT is expected to be a useful tool for solving problems in the healthcare field (medical treatment and the nursing field).These approaches, which utilize digital and ICT for this problem solving, are called "health Tech" or "digital health". The process of utilization of digital and ICT in problem solving in the healthcare field and using a system to collect data from the human body, analyzing them with data mining or machine learning methods and feeding back the analysis results to individuals as advice is called “smart health”

1. INTRODUCTION

Increases in medical expenses in recent years are one of the most important policy issues for all countries. Japan faces an accelerated decline in birthrate and a growing proportion of elderly people, and the continuing feasibility of the social security system, including medical nursing is currently being discussed. The approach which utilizes digital and ICT for problem solving in the healthcare field is called "health Tech" or "digital health". The process of utilization of digital and ICT in solving problems in the healthcare field, collection of data from people using sensors, analysis of this data using data mining or machine learning methods and the feeding back of the analysis results to the individual as advice is defined as smart health in this paper (Fig.1).

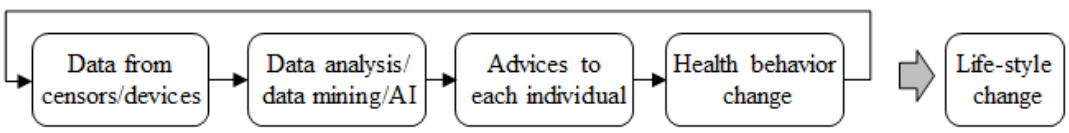

Fig. 1 Definition of smart health in this paper

There has long been high expectation of problem solving in the field of medical treatment for smart health, but there are few examples in Japan yet compared with how it has spread in Europe and the United States.

As a result, it has been problematic to promote smart health for initial practical use in Japan.

A study has shown that managing a major index for its disease like HbA1C in diabetes leads to cost reduction (Wagner et al, 2001) . A study has demonstrated that continuous e-learning through the Internet has proven to be a useful method in diabetes education (Shabestari and Roudsari, 2009). As seen above, there are study results that indicate that utilizing digital and ICT contributes to reduction in medical expenses.

There is a survey result that 1 person in 5 used wearable devices in the United States in 2015 (Forrester Research, 2015). In terms of technology, there are few differences between the United States and Japan. However, in the United States, the utilization of those technologies in practice is more advanced.

2. LITERATURE REVIEW

According to a report from the UK Department of Health, the cost of diabetes care in the UK is £5 million per day. Control of diabetes can significantly reduce this cost because the management of complication in diabetes accounts for the highest cost in diabetes care. Wagner et al (2001) show that this cost reduction is 7.5% per each percent reduction in HbA1C and another paper shows that structured education has been shown to be able to reduce 1.6% of HbA1C (Muhlhauser et al., 1983 and Sigurdardottir et al., 2007). A further report uses system dynamics modeling to predict the flow of patients in the educational system and the cost of their care. “Return on Investment” (RoI) can be used as an indicator of the cost benefit of web-based education. The analysis compared traditional and web-based education. Shabestari and Roudsari describe in the paper that prolonged e-learning through the Internet has proven to be a useful method of diabetes education (Shabestari and Roudsari, 2009). Homer et al. (2004) put a cost benefit analysis into effect on policy drafting for a chronic disease.

In Japan, there is a possibility that Information and Communication Technology (ICT) will be applied to medical treatment appropriately as a tool to solve problems in the healthcare field (including the nursing field to health and medical treatment). This can utilize social resources effectively and offer higher quality services (the Ministry of Health, Labour and Welfare and 2014). When the major pharmaceutical company Novartis collaborated with Microsoft, utilization of digital health was identified in 4 areas: (i) taking adherence improvement, (ii) promotion of behavioral modification, (iii) real time monitoring and (iv) realization of a digital therapy (Oshita, 2016a). Already,

there is real time monitoring and a practical case in the field of digital therapy in Japan. For example, Omron, a medical equipment manufacturer, acquires living body data using their devices and integrates data which are acquired by their sensors and other data which comes from other devices into one screen on a smartphone to show recorded data for each individual (www.Omron.com). There is a smart phone application "Luna Luna" as a successful case of digital health in Japan (www.MTI.co.jp). This service forwards the user's daily body temperature data onto the cloud. A characteristic of this service is that it provides a predicted ovulation day based on the user's data which are utilized as an original source through applications of a user's smart phone instead of an ovulation prediction of the OGINO system which is a widely recognized and established theory (www.MTI.co.jp).

On the other hand, it is recognized that more than one technology and infrastructure are necessary to develop such services, and therefore that cooperation between more than one enterprise and academia makes it difficult to commercially realize these services. Thus the utilization of digital health in Japan is not enough, and although there are some successful cases, many enterprises don't reach commercialization.

In this paper, attention is paid to promotion of behavioral modification of smart health users. Based on the results of the existing research referred to earlier, it seems that the user's behavioral modification by utilization of smart health may contribute to a reduction of Japanese medical expenses.

This paper considers using System Dynamics to understand how utilization of smart health impacts on medical expenses in Japan.

3. MODEL STRUCTURE AND EVALUATION

This paper uses the estimated population of Japan from 2006 to 2015, the estimated value of the medical expenses from 2006 to 2013, the estimated population of Japan and the medical expenses until 2025 by the Japanese government and a research institute (the Ministry of Health, Labour and Welfare, 2016, the Ministry of Public Management, Home Affairs, Posts and Telecommunications, 2016 and National Institute of Population and Social Security Research, 2012, Prime Minister of Japan and His Cabinet, 2012).

A model was built from a perspective of the medical expenses which is related to the system of the public health insurance for the whole of Japan (Fig.2).

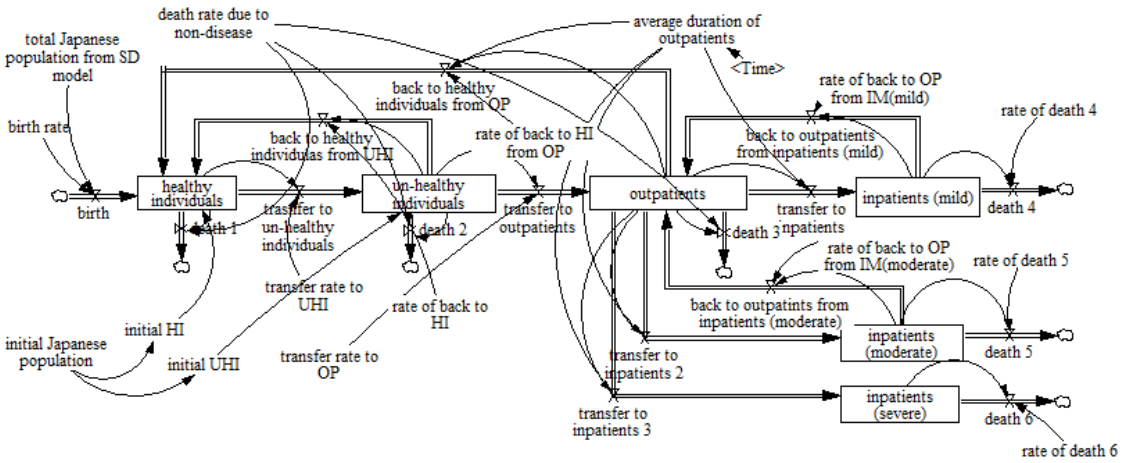

Fig. 2 SD model of patient journey in Japan

A number of routes were set up on this model;

a route where someone with a lifestyle related disease, but who is not an outpatient returns to normal health, a route where a person who is an outpatient returns to normal health and a route where someone who returns to being an outpatient. The definition of people with a lifestyle related disease but who are not outpatients is that they should be rightfully treated as outpatients, but they are not.

It is known that even those users who have begun to use wearable devices stop using them after a certain fixed period. The number of "digital health users" in 2006 was set at 10,000 people, which is an initial number in the model, because this time was an incubation period of smart phones and before the iPhone launch (2008) in Japan. More improvement of the precision of the SD model can be expected by defining these numbers for further discussions. This module is shown in Fig.3.

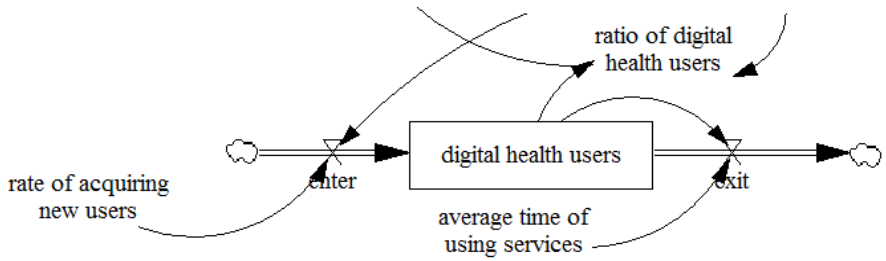

Fig.3 Module of smart health users

Japanese government predicted population figures and medical expenses from 2006 to 2025, and the simulation result from the SD model are shown in Fig.4 and Fig.5. The change in the values by the simulation was similar to the estimated value of the

population of Japan and the medical expenses.

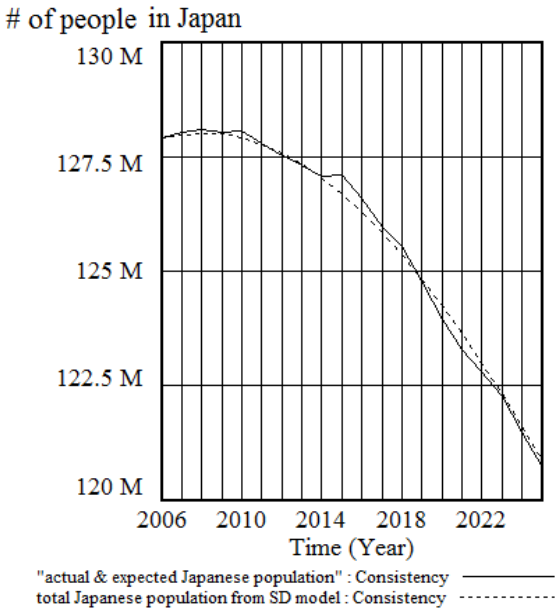

Fig.4 Consistency of number of people in Japan

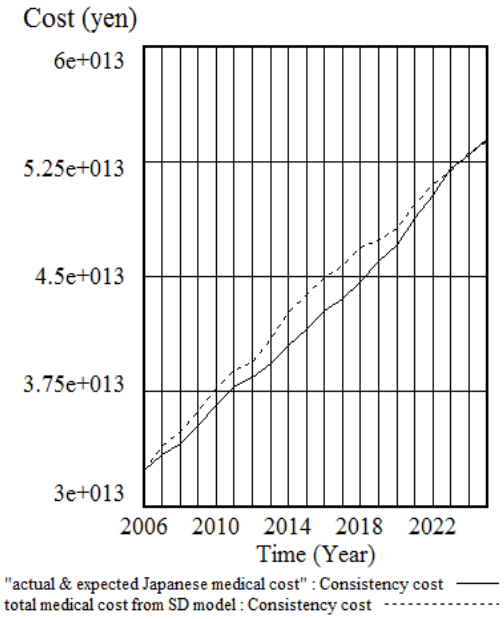

Fig. 5 Consistency of medical cost in Japan

4. SCENARIOS AND DISCUSSION

From the simulation results, it is shown that continued usage of smart health services promotes behavioral modification, and this leads to medical expense reduction.

From the model structural understanding and simulation, it is recognized that healthy people, people with lifestyle related diseases are smart health users. It is also expected that healthy people extend their healthy life span (Fig.6, 7,8,9,10 and 11).

The scenarios used for simulations are as follows. The scenarios which continuously new smart health users increase by 5%, 10% and 20% of the potential target users. The effect of the prevention was set to 10% of the users and the effect of improvement was set to 20% of the users. The period of the simulation was set to 2025 from 2006. The average period of using smart health services per user was set to 2 years.

The simulation results based on the scenario in which the number of smart health users increase by 5% are shown in Fig.6 and 7.

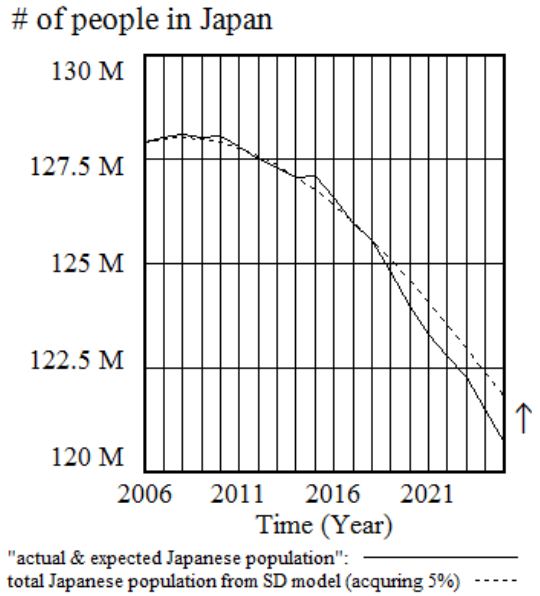

Fig. 6 Simulation result: number of people in Japan (increasing 5%)

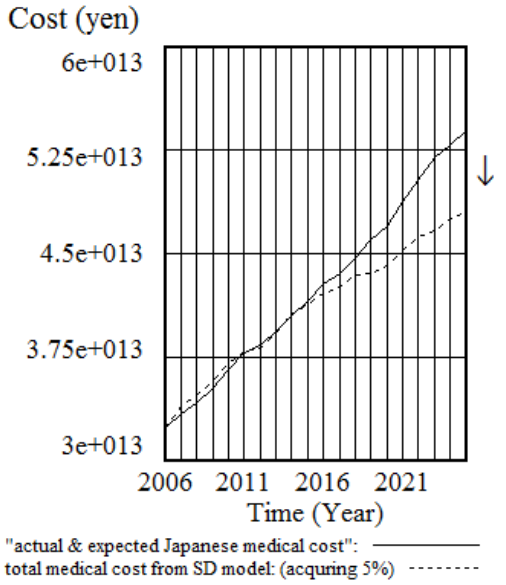

Fig. 7 Simulation result: estimated medical cost in Japan (increasing 5%)

The result based on the scenario which the smart health users increase. The results of the scenario by 20% are shown in Fig.10 and 11.

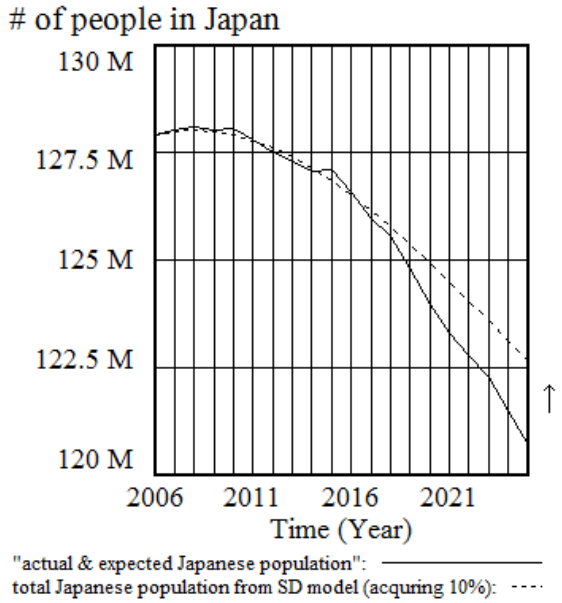

Fig.8 Simulation result: number of people in Japan (increasing 10%)

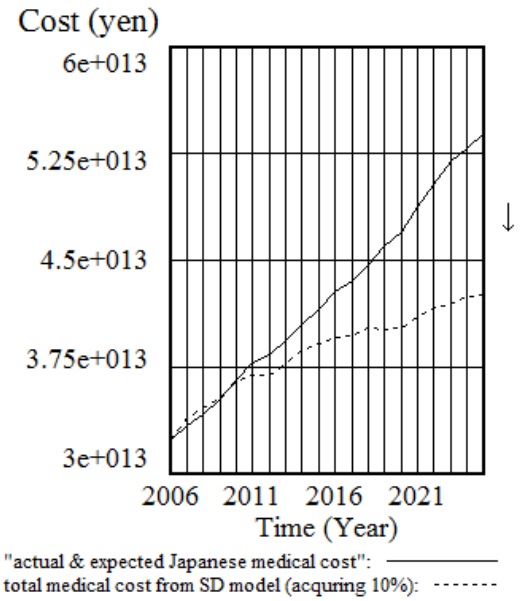

Fig.9 Simulation result: estimated medical cost in Japan (increasing 10%)

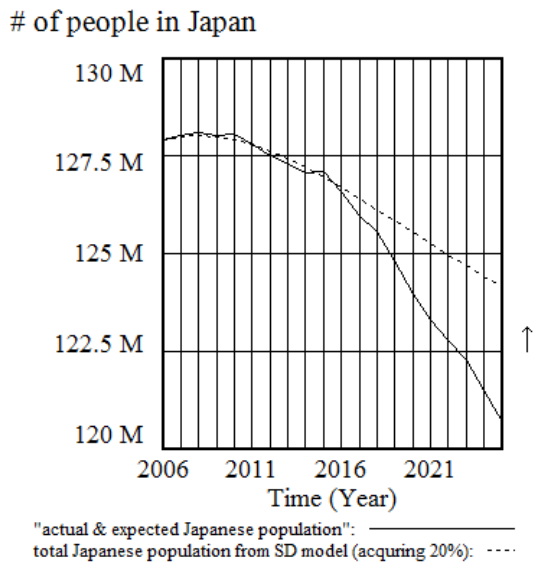

Fig.10 Simulation result: number of people in Japan (increasing 20%)

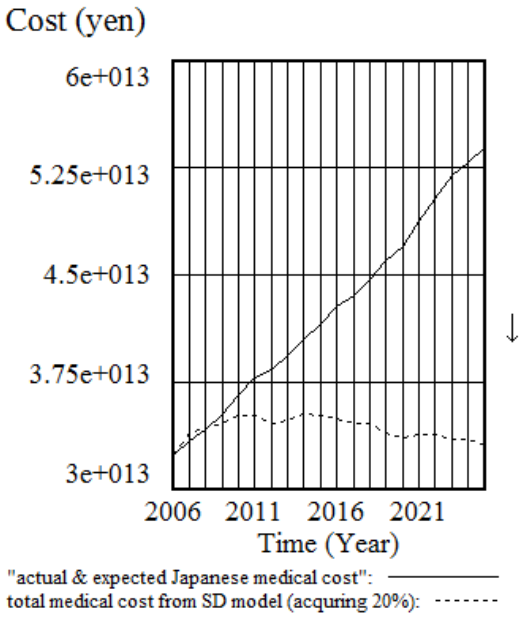

Fig.11 Simulation result: estimated medical cost in Japan (increasing 20%)

Approximately 11.5 trillion yen (about 115 billion dollars) may be reduced in medical expenses with an acquisition rate of 10%. The effect appears about 5 years after 2006.

It was shown that approximately 21 trillion yen (about 210 billion dollars) may be reduced by 2025. The effect appears about 3 years after 2006 with an acquisition rate of 20%.

These simulation results show that utilization of smart health would be effective in reduction of medical expenses and it is imperative that the user continues to use the service to promote behavioral modification by utilization of smart health and to reduce medical expenses. The percentage of smart health users in the three scenarios mentioned above is indicated in Fig.12. This indicates the ratio of the smart health users. This ratio is dependent on the setting of the user acquisition rate by the variable in Fig.3; "rate of acquiring new users". The increased tendency continued for approximately 6 years after the beginning of 2006, and the number of smart health users remains steady after that.

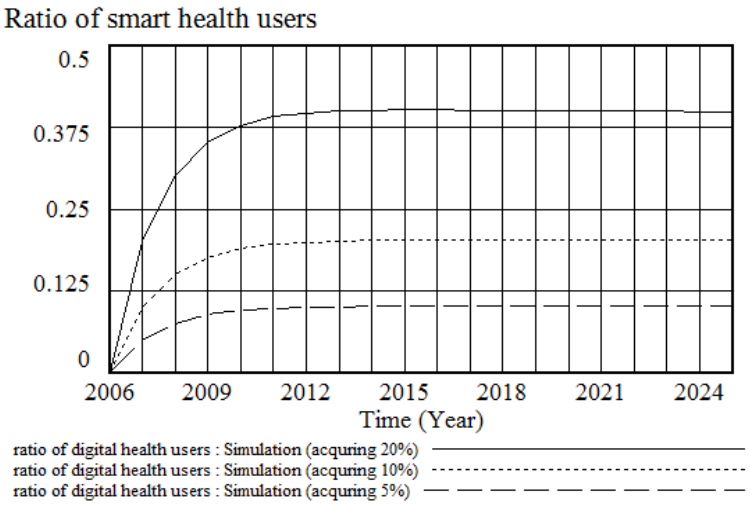

Fig.12 Ratio of smart health users in Japan except inpatients

5. CONCLUSION

The contribution of digital health is known to contribute to reduction in medical expenses from existing research. In this paper, smart health is especially focused on behavioral modification. It is expected that utilization of smart health leads to a reduction in medical expenses. This research also makes it clear that constant acquisition of new users is the key point to maintain this effect.

One characteristic of smart health is the user's behavioral modification. It is expected that healthy people extend the period in which they can stay healthy, and people with lifestyle related diseases but who are not outpatients and outpatients can improve their health status. As a result, utilizing smart health could be a possible solution to societal problems such as increasing medical expenses. However, it may be necessary to achieve consensus on building the evidence, and it would be necessary to discuss a measurable index which may be a standard to discuss validity of product or service of smart health in further research.

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