Does Telecare have an Economic Effect when Used by Patients with Chronic Diseases in the Long Run?

Based on Nine-Year Data from Nishi-Aizu Town, Fukushima Prefecture, Japan

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***Abstract*— This study aims to demonstrate that telecare (e-Health) is one essential measure for coping with increases in medical expenditure related to chronic diseases such as heart failure, high blood pressure, diabetics, and stroke. To do so, the long-term effects of telecare use by residents of Nishi-aizu Town, Fukushima Prefecture, Japan, between 2002 and 2010 is examined by comparing medical expenditure and days of treatment between telecare users (treatment group) and non-users (control group) based on receipt data obtained from the National Health Insurance. Our previous studies used receipt data obtained for the years 2002 to 2006. This study expands the period of analysis for four more years with respect to respondents who were included in previous analyses. 90 users and 118 non-users were included in both analyses. Using rigorous statistical methods, including system Generalized Method of Moments (GMM), which deals with the endogeneity problem, this paper demonstrates that telecare users require fewer days of treatment and smaller medical expenditures than non-users with respect to chronic diseases, even in the long run. To date, there have been no studies examining the long-term economic effects of telemedicine use, and thus the current study presents a new facet of research in this field. In particular, the economic foundation for the sustainability of the telecare (e-Health) project will be supported by this study.**

Keywords- telecare; medical expenditure; days of treatment; System GMM; chronic diseases.

I. INTRODUCTION

Increasing medical costs and shortages of medical doctors in rural areas are issues that urgently need to be addressed in healthcare around the world. Medical expenditure in Japan has been steadily increasing, and in FY2012 amounted to JPY35.1 trillion (US$4,387 billion) with more than half (51.7%) of that being spent on the care of patients over the age of 65. In 2012, 24.2% of the Japanese population was over the age of 65, and this is expected to increase in the near future. Furthermore, the number of outpatient days in Japan is the largest among the OECD member countries at 13.4 days per person per year, compared with 4.0 (US), 5.9 (UK), 7.8 (Germany), and 6.9 (France) days per person per year (OECD Health Data). It is imperative to reduce the number of treatment days as well as overall medical expenditure in Japan. To cope with the serious healthcare situation in Japan, local governments have begun to implement telecare, or e-Health, which allows the local government to remotely monitor the health of elderly residents at home by transmitting health-related data, such as blood pressure, blood oxygen level, and ECG, to medical institutions via telecommunications networks. Telecare is thus expected to improve users' health, as our previous studies[1][2][3][4] demonstrated.

The present study selected Nishi-aizu Town as the project site. This town, located in Fukushima Prefecture, Japan, has nearly 20 years experience with telecare. The objective of the paper is to demonstrate that telecare use reduces not only medical expenditures but also days of treatment of patients with chronic diseases such as stroke, hypertension, heart failure, and diabetes, even over the long-term period of nine years. In addition, a rigorous statistical method, system Generalized Method of Moments (GMM), is used to statistically assess the causal relationship through which telecare use actually reduces medical expenditure and days of treatment. This relationship is not "seemingly correlated"[3][5][6]. In order to carry this out, field research was conducted in March 2012 to obtain two basic data for the statistical analysis; receipt data for 272 telecare users (treatment group) and 247 non-users (control group) for the period 2007 to 2010, and their responses to a questionnaire. This data included individuals who were included in our previous studies in the period 2002 to 2006, and thus data for 90 telecare users and 118 non-users for the whole period 2002 to 2010 were used in this study.

Another objective of this paper is to focus on medical expenditure and days of treatment of patients with particular chronic diseases such as stroke, hypertension, heart failure, and diabetes, since the increase in the number of chronic diseases is one of the major reasons for medical expenditure rises worldwide. Although the previous paper[7] compared these two outcomes for general users and nonusers for five- and nine-year data, this paper examines whether the same results hold particularly for patients with chronic diseases. The rationale for this research question is that the increase in medical expenditures is a common global issue and it is generally understood that the increase in chronic diseases is the major cause. Moreover, it is well known that chronic diseases can be prevented by lifestyle changes, for example. In this context, this study can provide one solution to these issues.

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Another objective of this study is to compare the results from the same telecare project in Nishi-aizu obtained by our previous studies[1][2][3][4]. These studies cover the data for 199 telecare users (treatment) and 209 non-users (control) in the period 2002-2006. The results of this five-year period are summarized as follows: (i) telecare users had lower medical expenditures for chronic diseases than non-users; (ii) the longer the subjects used telecare, the lower the medical expenditures became; (iii) the longer the subjects used telecare, the larger the elasticity of the reduction of medical expenditures became; that is, the more years users utilized telecare, the greater the decrease in medical became for each additional year of use compared with those whose years of use were fewer; and (iv) the effect of the reduction of medical expenditures due to telecare is higher, especially for telecare users with chronic diseases.

The same hypotheses are applicable to treatment days. This paper thus compares the results for the five-year and nine-year research. This paper consists of the following sections. Section II describes the usage of the telecare system in Nishi-aizu, Section III outlines the materials and methods of the paper, Section IV indicates the results of the estimations, and in Section V we state our conclusions.

II. TELECARE USAGE IN NISHI-AIZU

Here we describe the background and history of the telecare system in Nishi-aizu.

A. Healthcare in Nishi-aizu

Nishi-aizu is located in the northwest corner of Fukushima Prefecture, Japan, and is an important point of transit to and from Niigata Prefecture and the nearby major city of Aizu-wakamatsu. The town is surrounded by mountains, which cover 86% of the prefecture, and the town center is located in a geographical basin. There are approximately 10,000 residents in 3,000 households, and in 2001, 35.9% of the population was over the age of 65. The town's main industry is agriculture, and rice is the main product. The climate is characterized by very high temperatures in summer and very low temperatures with heavy snow in winter. The severe winter conditions deprive the elderly residents of opportunities for sufficient physical exercise. Furthermore, due to a traditional diet of salty and protein-poor foods, the town's death rate was 1.7 times higher than the national average between 1983 and 1987, with relatively high rates of stomach cancer. The number of bedridden elderly people suffering from osteoporosis or arthritis is also higher than the national average[8].

B. Introduction of the telecare system in Nishi-aizu

The town introduced telecare in 1994 to reduce the incidence of chronic diseases such as cerebral infarction and stroke. Three hundred peripheral devices, called "Urara," manufactured by Nasa Corporation, were provided to residents with chronic diseases. The Urara device is connected to a host computer via a public switched telephone network. Health-related data such as the user's blood pressure, pulse rate, ECG, blood oxygen level, weight, and body temperature are transmitted to a server operated by the town. In 1996 and 1997, an additional 50 terminals were purchased with subsidies from the Japanese Ministry of Agriculture and Fisheries. In 2002/2003, an additional 187 terminals were purchased with the town budget. The town thus currently owns 587 terminals. These terminals use the CATV network for transmitting data. All the costs of operating the system are paid for by the local government. The Urara devices are distributed to the following three groups of patients: (i) elderly residents with diseases, (ii) elderly residents who have been referred by a doctor, (iii) other residents who are living alone or referred by a doctor[9].

C. Operation of the telecare system in Nishi-aizu

The Nishi-aizu Department of Health and Welfare oversees the administration of the telecare system. Six public health nurses check the health data transmitted by the Urara devices and use that data as part of their consultations with users. If these nurses observe unusual data, they ask a medical doctor from one of the clinics to visit the user in question. The health data for each user are summarized in a monthly report, which is then sent to the physician in charge. After the physician and a public health nurse add their comments, the report is sent to the user. When the user visits a doctor, they are asked to bring the report with them (see [9] for more details).

The telecare system is operated as part of the town's "Project for Promoting Total Care," and the underlying principle is close collaboration between the health, medical, and welfare activities in the town. Regional Care Meetings are an important example of this collaboration. More than 20 people attend each meeting, which consists of doctors, nurses, public health nurses, town office staff, care-takers of the elderly, and lifestyle advisers. At these meetings, medical care for individual telecare users, such as necessary medical examinations, specific health advice, and general healthcare issues, are discussed in detail, the telecare health data playing a central role. To improve the residents' motivation for using the telecare system, the town office organizes telecare users' meetings five times a year. At the meetings, users can exchange their experiences and views of using the system. In fact, our in-depth interviews conducted with public nurses working in Nishi-aizu revealed that the number of patients with chronic diseases visiting doctors decreased with increasing telecare use.

The introduction of the telecare system should not be considered the sole factor promoting better regional healthcare; rather, it should be seen as the framework that assists all the departments and personnel involved to deliver more effective health care.

III. MATERIALS AND METHODS

Here we outline the materials and methods used in this paper.

A. Sample selection

Here two kinds of data for analysis, namely receipt data and responses of questionnaire are explained. In our previous study, the receipt data for 199 users and 209 non-users collected between 2002 and 2006 was obtained from the National Health Insurance. The receipts for each month are kept at the Nishi-aizu town office, and include a range of information. In the current study, the following data were used: (i) name of patient, (ii) birth date, (iii) regular outpatient treatment or hospitalized

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patient treatment, (iv) name(s) of major disease(s), (v) date of initial treatment, (vi) number of days of treatment was needed, and (vii) the medical treatment "points" (one point is equivalent to JPY10).

Next the receipt data for the years 2007 to 2010 was collected. To ensure that the patients included in the previous studies were also included in the current study, we first checked whether they responded to the questionnaire survey (whether the person had deceased or not, etc.); about half of the subjects failed to respond, which resulted in a lack of samples. We therefore selected 565 new subjects from among the telecare users. The questionnaire used in this study was the same as that used in our previous studies. The questionnaire asks for information on characteristics such as sex, age, and the individuals' use of the telecare system, which is data not included in the receipt data. Non-users were selected by stratified sampling from the list of subscribers to the National Health Insurance, which amounted to 1035 non-users. The respondents are summarized in Table I, which shows that 272 users and 247 non-users were selected as valid respondents for this study; 91 users and 118 non-users were included in both the previous study and the current study. We then collected the data mentioned above (regarding the construction of data, see [9] in more detail.).

TABLE I. RESPONDENTS TO MAIL QUESTIONNAIRE

		No. of residents sent questionnaire	No. of valid respondents (No. of valid respondents between 2002 and 2009)
2007 Survey	Users	412	199
	Non-users	450	209
	Total	862	408
2012 Survey	Users	565	272 (91)
	Non-users	1035	247 (118)
	Total	1600	519 (209)

B. Summary of mail survey

The percentages of users and non-users by gender is shown in Table II. The percentage of males (57.1%) is higher than that of females (42.9%).

TABLE II. GENDER

	Users (%)	Non-users (%)	Total (%)
Male	52 (57.1)	72 (61)	124 (59.3)
Female	39 (42.9)	46 (39)	85 (40.7)
Total	91	118	209

Table III shows average ages of samples and since the same persons are compared average age of 2012 sample is five years older than that of 2007.

TABLE III. AVERAGE AGE OF RESPONDENTS

	N	Average age (2007)	Average age (2012)
Users	91	70.67	75.67
Non-users	118	70.76	75.76

The telecare system in Nishi-aizu was implemented to help in the management of chronic diseases such as heart disease, hypertension, diabetes, and stroke. Table IV shows the number of patients with these four diseases that were treated within the study period. Hypertension was the most common of these four diseases, followed by heart disease.

Table V summarizes the number of years of individual telecare use. Users that had used the telecare system for more than 10 years accounted for 25.6% of the total number of users, which is the largest percentage, and this makes examination of the long-term effect of the system possible. The number of respondents who replied that they did not use the telecare system accounted for 30% of the respondents, which is larger than expected. It is possible that they responded that they did not use the system since they became too old, even though they had a telecare device in their homes.

TABLE IV. SELECTED DISEASES TREATED BETWEEN 2002 AND 2010

	Users (%)		Non-users (%)		Total (%)	
	2002–2006	2007–2010	2002–2006	2007–2010	2002–2006	2007–2010
Heart disease	19 (0.21)	19 (0.21)	15 (0.13)	15 (0.13)	34 (0.16)	34 (0.16)
Hypertension	49 (0.54)	51 (0.56)	40 (0.34)	57 (0.48)	89 (0.43)	108 (0.52)
Diabetes	8 (0.09)	11 (0.12)	9 (0.08)	14 (0.12)	17 (0.08)	25 (0.12)
Stroke	5 (0.06)	8 (0.09)	7 (0.06)	9 (0.08)	12 (0.06)	17 (0.08)

TABLE V. YEARS USING TELECARE

	2007 (%)	2012 (%)
Less than 1 year	2 (2.2)	0 (0)
1–3 years	15 (16.5)	8 (8.8)
3–5 years	19 (20.9)	8 (8.8)
5–7 years	21 (23.1)	11 (12.1)
7–10 years	16 (17.6)	13 (14.3)
>10 years	18 (19.8)	23 (25.3)
Do not use	2 (2.2)	27 (29.7)
Not answered	0 (0)	1 (1.1)
Total	91	

TABLE VI. FREQUENCY OF USE

	2007 (%)	2012 (%)
Almost every day	41 (45.1)	27 (29.7)
3–4 times a week	22 (24.2)	15 (16.5)
1–2 times a week	10 (11)	7 (7.7)
1–2 times a month	11 (12.1)	7 (7.7)
Rarely use	6 (6.6)	24 (26.4)
Not answered	1 (1.1)	11 (12.1)
Total	91	

Table VI summarizes frequency of telecare use. More than half of the respondents reported that they used the telecare system at least once a week to communicate with a nurse or to

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alert medical staff of distress or discomfort. This high frequency of use is possibly due to the town office's efforts in holding public meetings to educate users in the use of the system, as already mentioned. One fourth of respondents answered that they rarely use the telecare system, which corresponds with the number of users who answered that they do not use the system (Table V).

D. Method of estimation

The outcome variables of days of treatment and medical expenditure are not stable over the study period, and it is difficult to assess whether there are any differences between users and non-users over the study period. Rigorous statistical analyses are therefore necessary. We thus employed a regression analysis to assess whether telecare use reduces days of treatment and/or medical expenditure. Studies in this field face a number of important methodological issues. First, there is the problem of endogenous explanatory variables. One method of solving this is by using system GMM, which allows treatment of not only endogenous explanatory variables but also of the dynamic relationships among the variables that arise due to the chronic time-lagged effect of chronic diseases on patients. Moreover, system GMM is able to deal with the reverse correlation between outpatient medical expenditure and telecare use. In this context, we attempted to demonstrate causality between telecare use and decreased medical expenditures, or, in other words, to show that the relationship is not seemingly correlated. A number of previous studies have successfully attempted to handle endogeneity problems in telemedicine and telecare evaluation[3][5][6].

IV. RESULTS

Here we set out the results of our estimations.

A. Model for estimation

In the estimation, the dependent variables were (1) days of treatment of outpatients, all diseases, (2) medical expenditure for outpatients, all diseases, (3) days of treatment of outpatients, chronic diseases, and (4) medical expenditure for outpatients, chronic diseases. The explanatory variables were telecare use (if users, 1; otherwise, 0), age, income, and the presence of any of the four main chronic diseases such as heart disease, hypertension, diabetes, and stroke (if treated, 1; otherwise, 0). In addition, other factors were added as instrumental variables, such as dummy variables for sex or year dummies. System GMM estimators developed by Arellano–Bond, Arellano–Bover, and Blundell–Bond are general estimators for coping with data that have "small T, large N" panels. System GMM can be used in models in which the independent variables are not strictly exogenous, namely, those correlated with past and possibly current realizations of the error. System GMM can also be used to treat data with heteroskedasticity. The Arellano–Bond test for AR (2) (second stage autocorrelation), the test of weak instruments, and the Hansen test for over-identifying restrictions were used.

B. Estimation results, all diseases

Tables VII and VIII show the results of the estimation using system GMM. The coefficient of telecare use is negatively significant for days of treatment ($p<0.10$) and medical expenditure ($p<0.05$). These findings imply that telecare contributed to reductions in days of treatment and medical expenditure. However, the Arellano–Bond test for AR (2) for the model of medical expenditures (see Table VIII) showed that there was autocorrelation under the 1% significance level. This means that serial correlation of the error terms cannot be denied, and accordingly, the estimates still have small biases. The test of weak instruments showed that instruments and endogenous variables used are correlated significantly, which indicates exemption from a problem of weak instruments. Furthermore, the Hansen test for over-identifying restrictions showed that the instrumental variables were properly chosen. This means that the model specification was adequate and that the parameters were significant and robust. In addition, age is positively significant for both days of treatment and medical expenditure ($p< 0.01$), which is natural considering that days of treatment and medical expenditure increase with age. Finally, the coefficients of three chronic diseases (heart disease, hypertension, and diabetes) are positively significant for both days of treatment and medical expenditure. According to the estimations, telecare use reduces days of treatment for all diseases by 7.9 days per user per year, and medical expenditures for all diseases by approximately JPY 106,904 per user per year. However, the latter may contain biases due to serial correlation, and therefore the result may not be reliable.

TABLE VII. RESULT OF SYSTEM GMM (1): DAYS OF TREATMENT (OUTPATIENTS, ALL DISEASES)

	Coefficient	SD	*t* value	*p* value	
Telecare use	–7.889	4.081	–1.93	0.053	*
Age	0.125	0.022	5.66	0.000	***
Income	–0.003	0.007	–0.43	0.664	
Heart disease	16.031	8.880	1.81	0.071	*
Hypertension	15.688	1.962	8.00	0.000	***
Diabetes	11.809	5.199	2.27	0.023	**
Stroke	–3.657	8.395	–0.44	0.663	
Number of observations				1820	
Arellano–Bond test for AR (2) (*p* value)				0.109	
Test of weak instruments (*p* value)				< 0.01	
Hansen test for over-identifying restrictions (*p* value)				0.144	

Note: ***, **, and * indicate levels of significance of 1%, 5%, and 10%, respectively.

C. Estimation results, chronic diseases

The same models were applied for patients with chronic diseases. The other variables were the same as in the previous estimations. Tables IX and X summarize the results of these estimations. Both the Arellano–Bond test for autocorrelations, the test of weak instruments, and the Hansen test for over-identifying restrictions were satisfied, since they were not significant ($p =0.692$). Thus, the instrumental variables were selected appropriately. The coefficients for telecare use were negatively significant for both days of treatment ($p<0.05$) and medical expenditure ($p<0.05$). Age was again positively significant for both outcomes ($p<0.01$). In contrast to the previous estimation, only hypertension was positively significant for days of treatment ($p<0.01$) and medical

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expenditure ($p<0.01$). This means that hypertension is a major contributing factor to days of treatment and medical expenditures. The coefficients indicate that telecare use reduces days of treatment for chronic diseases by 4.2 days per user per year, and medical expenditure for chronic diseases by JPY 64,944 per user per year.

TABLE VIII. RESULT OF SYSTEM GMM (2): MEDICAL EXPENDITURE (OUTPATIENTS, ALL DISEASES)

	Coefficient	SD	*t* value	*p* value	
Telecare use	–10690.36	5232.40	–2.04	0.041	**
Age	134.54	30.15	4.46	0.000	***
Income	–5.82	7.61	–0.76	0.444	
Heart disease	31937.81	10053.93	3.18	0.001	***
Hypertension	17968.45	2278.68	7.89	0.000	***
Diabetes	13425.88	6351.97	2.11	0.035	**
Stroke	–20272.70	13779.70	–1.47	0.141	
Number of observations				1820	
Arellano–Bond test for AR (2) (*p* value)				0.005	
Test of weak instruments (*p* value)				< 0.010	
Hansen test for over-identifying restrictions (*p* value)				0.563	

Note: ***, **, and * indicate levels of significance of 1%, 5%, and 10%, respectively.

TABLE IX. RESULT OF SYSTEM GMM (3): DAYS OF TREATMENT (OUTPATIENTS, CHRONIC DISEASES)

	Coefficient	SD	*t* value	*p* value	
Telecare use	–4.223	1.957	–2.16	0.031	**
Age	0.053	0.012	4.50	0.000	***
Income	0.002	0.004	0.47	0.637	
Heart disease	1.761	3.873	0.45	0.649	
Hypertension	9.061	1.111	8.16	0.000	***
Diabetes	3.370	2.471	1.36	0.173	
Stroke	–3.856	4.621	–0.83	0.404	
Number of observations				1820	
Arellano–Bond test for AR (2) (*p* value)				0.415	
Test of weak instruments (*p* value)				< 0.01	
Hansen test for over-identifying restrictions (*p* value)				0.231	

Note: ***, **, and * indicate levels of significance of 1%, 5%, and 10%, respectively.

TABLE X. RESULT OF SYSTEM GMM (4): MEDICAL EXPENDITURE (OUTPATIENTS, CHRONIC DISEASES)

	Coefficient	SD	*t* value	*p* value	
Telecare use	–6494.41	3215.58	–2.02	0.043	**
Age	70.83	19.37	3.66	0.000	***
Income	–3.11	8.25	–0.38	0.707	
Heart disease	6885.39	4903.83	1.40	0.160	
Hypertension	9714.75	1466.91	6.62	0.000	***
Diabetes	5606.42	4452.80	1.26	0.208	
Stroke	–6857.28	6447.90	–1.06	0.288	
Number of observations				1820	
Arellano–Bond test for AR (2) (*p* value)				0.165	
Test of weak instruments (*p* value)				< 0.01	
Hansen test for over-identifying restrictions (*p* value)				0.692	

Note: ***, **, and * indicate levels of significance of 1%, 5%, and 10%, respectively.

D. Comparison with the results of five year data

Table XI summarizes the results from our previous study of the five-year period between 2002 and 2006[1][2][3]. The results obtained in the current study are larger than those reported previously, which means that telecare use produces both long-term and short-term effects. Therefore, the longer patients use telecare, the larger the reductions in days of treatment and medical expenditure.

The analysis of the nine-year period only demonstrated the result (i); telecare users had a lower medical expenditure on chronic diseases than non-users. Regarding the result (ii); the longer the subjects use telecare, the lower medical expenditures become, [10] demonstrated this result by using the difference-in-difference propensity score matching (DID-PSM) method, which enables examination of the time trend effect. In particular, for patients with chronic diseases, medical expenditures over 10 years are reduced by JPY21,194.6 (US$235,5) ($p<0.05$), and treatment days by 1.73 days ($p<0.05$) per year per user. These are smaller than the results obtained in this paper. Other results obtained in the five-year data are unable to show reductions mainly due to the small number of subjects in the 2012 research. In addition, further rigorous statistical inference is required.

TABLE XI. PREVIOUS RESULTS FROM FIVE-YEAR DATA

	OLS[1]	System GMM[2]	PSM[3]
Medical expenditure	JPY 15,302 (US$ 191.28)	-	JPY 25,538–39,936 (US$ 319.23–499.20)
Days of treatment	1.6 days	2.0 days	2.6–4.0 days

Note: [1]Akematsu and Tsuji (2009), [2]Minetaki, Akematsu, and Tsuji (2011), [3]Akematsu and Tsuji (2012).

V. CONCLUSTIONS

This study aims ato providinge one clue tofor solveing athe global issue of the increase in patients with chronic diseases and suggests itthat the solution is telecare. The economic effect of telecare obtained here is not limited to an example in Japan alone. The research of the effect of telemedicine in other countries with macro data, representative macro approaches include those of [11] and [12], which used national cross-sectional data or panel data from OECD countries, respectively. Representative micro approaches include the following four papers. Evaluating 19 cases in Australia, [13] found that the cost-effectiveness of both telehealth and telemedicine improved considerably when they were part of an integrated use of telecommunications and information technology; [14] showed that advancements in e-Health transformed health care delivery and achieved such positive results as improving clinical decision making, increasing efficiency, and strengthening communication between physicians and patients; [15] found that an interactive telephonic support system which included coaching, education, and reinforcement modules reduced total costs for hospitalizations and emergency room visits by $5,271 per user per year; and [16] reported an average visit cost of $48.27 for a face-to-face home visit versus $22.10 for a

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virtual visit. Moreover, [17] conducted a systematic search of the literature and concluded that information technologies were effective in improving the quality and efficiency of care.

Regarding the studies that used micro data, there are similar projects with telecare in other countries. Scientific results have been obtained and it is possible to compare our results with those of other projects. Results obtained in other countries consist of the Kent Development Pilot in the UK and the VHA CCHT project in the US. The former studied the effect of telehealth on the number of inpatient days, general practitioners (GP), acute care, and others by experimental observation with statistical analysis[18]. This study compared outcomes at baseline and after six months with a focus on patients with COPD, heart disease, and diabetes. The authors concluded that telecare use resulted in a decrease in the number of home visits and GP surgery per participant, Accident and Emergency (A&E) visits of 0.5days, and inpatient treatment days of 1.5days. The results of the VHA CCHT project in the US are similar to those of the Kent study, that is, the number of inpatient treatment days was reduced by 25%, and the number of hospital admissions by 19%[19]. Thus the results of international projects were estimated mainly in terms of inpatient treatment days, not expenditures, and for all diseases, not only chronic diseases. This paper aimed to obtain results which are directly comparable with other studies. According to our results, the Nishi-aizu project shows a larger reduction in inpatient treatment days than the Kent project (3.3 vs. 1.5 days). On the other hand, the reduction of bed days is calculated as approximately 16.12% in this paper, which is smaller than that of the VHA project (25%).

The results obtained in this study show the importance of telemedicine. Japanese local governments implementing this system currently do not charge users for the service. The system is funded from tax money raised from local residents. For the initial investment for the in-home devices, servers, and network, local governments receive subsidies from the central government. The Nishi-aizu local government received funds from three different ministries. However, due to the current adverse economic situation in Japan, local governments can no longer rely on such subsidies, implying that the sustainability of telecare or e-Health is an issue that urgently needs to be addressed[8]. From a financial point of view, a new framework is required. Reimbursement through the medical insurance system, for example, is one possibility for increasing the use of telecare systems. Here, we provide an important basis for evidence-based public health policies.

It should be noted for further research that chronic conditions tend not to occur singly, and many patients have more than one at the same time. For example, patients with high blood pressure or diabetes are also likely to suffer from heart disease. This multiplicity of conditions hampers analysis. This paper examines single chronic diseases, and does not include multiplicity. In addition, neither does this study analyze how telecare improves these outcomes. In the telecare system introduced in Section II, telecare users become more concerned about their health condition when reviewing the data returned to them by the town health office, and make personal efforts to improve their health indicators. This assists in the prevention of chronic diseases. Although these psychological effects cannot be denied, more studies are required on the medical mechanisms by which telecare imparts positive impacts on health. These are remaining issues for future study.

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