

A Geographical Study on the Behavior Changes of Telemedicine Participants in Terms of Time and Space

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시공간 관점에서 본 원격진료 이용자 행태 변화에 관한 연구

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Abstract : This research aims to examine the behavior changes of telemedicine participants with regard to time-space reconfiguration and to address the implications of telemedicine in terms of extensibility and restrictions (ambilaterality). According to the results of this research, telemedicine can lead to behavior changes in telemedicine participants, particularly patients. However, it is difficult to anticipate the time-space reconfiguration of telemedicine participants drastically. In other words, although telemedicine minimizes patients' burden of accessibility to and utilization of medical institutions, it requires the patients to visit medical institutions at least once due to the restricted application of telemedicine related to technological problems, the characteristics of medical practice and mutual stakes among the medical institutions involved in telemedicine. And physicians (telemedicine providers as mediators between medical specialists and patients) and medical specialists (as the ultimate telemedicine providers) do not evidence considerable changes in their behaviors, except for offline meetings for information sharing and medical training. Because the present telemedicine system does not require simultaneity between physicians, patients and medical specialists. Furthermore, present telemedicine operation is absorbed into existing medical activities as a health care delivery method. These phenomena are due to 1) the interests among medical institutions and the limitation or generalization of telemedicine technologies to stimulate regional-based telemedicine operation and 2) the goal of face-to-face interactions between patients and doctors, which is to avoid misdiagnosis and side effects. Finally, medical activities related to telemedicine do not differ from general medical activities. The ambilaterality of telemedicine in terms of extensibility and the restriction of time-space reconfiguration is an unsettled problem in the ICT technologies of medical services.

Key Words : Telemedicine, time-space reconfiguration, extensibility and restriction of the ICT, technologies in medical services, Togane City

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요약 : 본 연구에서는 원격진료 이용자 행태를 시공간 재구조 관점에서 살펴보고, 원격진료의 양면적 성격, 즉 확장성과 제약성에 대해 고찰하였다. 연구 결과에 의하면, 원격진료의 도입은 직접적인 온라인 서비스의 수혜자인 환자의 행태 변화에 영향을 끼치나, 이는 원격진료 이전의 일반적 의료 행태와 확연한 차이를 보인 것은 아니다. 이와 더해, 의원급 병원의 의료진 및 원격진료 최종 서비스 제공자인 토가네현립병원의 의료진의 행태에는 거의 영향을 주지 않는 것으로 나타났다. 원격진료의 도입으로 인해 의료기관에로의 접근성 및 효용성의 향상에 도움이 된 것은 사실이나, 여전히 원격진료는 최소한 한번 이상의 직접 진료를 요구하고 있고, 인간의 생명과 직접적으로 연계됨에도 불구하고 불완전한 기술적 특성을 가지고 있으며, 원격진료 이용에 있어서의 의사-환자, 의사 사이의 합의 문제로 인해 시공간적 제약성을 내포하게 된다. 결과적으로, 당초 원격진료가 처음 고안되었을 당시 많은 이용자들에게 주었던 기대감(확장성)과 달리, 오늘날의 원격진료는 시공간을 초월한 개념이라기보다는 기술, 사회, 문화, 경제 등의 다양한 요인으로 인해 제약성을 내포한 형태로 발전하고 있다고 할 수 있다.

주요어 : 원격진료, 시공간 재구조, ICT기술의 확장성과 제약성, 의료 서비스에서의 기술, 토가네시

1. Introduction

Telemedicine is the transfer of electronic medical data for diagnosis, therapy and education from one location to another (American Telemedicine Association, 2010; Norris, 2002). In geography, telemedicine has been discussed as a contributor to lessening the costs and dangers of transporting patients and medical workers to external medical institutions and ameliorating inadequate physical or non-physical access to health care according to geographic service areas, medical specialties or diseases and target population groups (Abou-Shaaba and Naizy, 1991; Graham and Marvin, 1996; Reid, 1996; Bashshur, 1997; Capalbo and Heggem, 1999; Mitchell, 1999; Warf, 2000; Cutchin, 2002; Norris, 2002; Shannon et al., 2002; Mihara, 2004; Hayashi, 2005; Gilbert, Masucci, Homko and Bove, 2008). Ultimately, by connecting space that provides medical care (provider) and space that is served by medical care (receiver) via the telecommunication system, telemedicine may aid in delivering specialized care to medical care centers in

distant places, restructuring the time-space configuration of medical care opportunities and providing medical care services within a reasonable range of isolated individuals' time-space path (Mitchell, 1999; Shannon, 1997; World Health Organization, 2010).

Therefore, identifying the behavior changes of telemedicine participants will provide information concerning the efficiency and utility of telemedicine and considerations (particularly in regard to time and space) in practical telemedicine operation. The operation of telemedicine has been gradually extending. Although the geographical and relevant perspectives of the field of telemedicine are often noted, they are rarely studied. Thus, the current paper attempts to empirically outline an alternative reading of the degree to which telemedicine influences personal medical care activities (telemedicine users, including patients, physicians and medical specialists) and trajectories in terms of time-space reconfiguration. Furthermore, this research addresses the incompatibility of telemedicine, namely, the extensibility and restriction of time-space re-

configuration.

Generally, the time-space path shows the movement of an individual in the spatial-temporal environment with constraints placed on the individual in the most effective manner (Couclelis, 2009). Within this context, in-depth and open-ended interviews were conducted with telemedicine participants (patients, physicians and a medical specialist) from February to September 2011 (two separate investigations). The interviews were used to compare telemedicine users' behaviors before and after diagnosis via the telemedicine system. The telemedicine system provided by Togane Prefectural Hospital, which has been providing support to the chronically ill and elderly patients since 2002, was used as the subject of this research.

2. Time-Space Reconfiguration and Telemedicine

In geography and related fields, studies on human behavior changes have demonstrated that telecommunication induces various time-space changes (Adams, 1995; Lenz and Nobis, 2007; Rotem-Mindali and Salomon, 2007; Nicolini, 2007; Schwanen and Kwan, 2008; Schwanen, Dijst and Kwan, 2008; Vilhelmson and Thulin, 2007; Couclelis, 2009). Researchers have recognized that an increase in the use of ICT may lead to changes in the location, timing and duration of people's activities and that the widespread use of ICT will likely be associated with new patterns of activity and travel in space and time (Nicolini, 2007). Because each consequence depends on the telecommunication technology's characteristics and user's utiliza-

tion characteristics, it is difficult to generalize each individual time-space change of various telecommunications (Couclelis, 2009). With this mind, it is reasonable to consider each telecommunication technology according to its technological characteristics.

Current research on telemedicine in the time-space reconfiguration remains in its early stage. There is currently only one monograph on the subject, authored by Shannon (1997). According to Shannon, telemedicine can bring the medical care services within a reasonable range of the isolated individual's time-space path by electronically transporting the specialist to a more accessible location via telecommunication. Furthermore, telemedicine can recast in a time-space configuration and influences on a fixed address and the path in space that is geographically fixed, including a specific temporal location, by electronically transforming medical care for both the primary providers (patients, physicians, hospitals or others) and medical specialists. The transformation is accomplished by electronically transporting the specialist to a more accessible location via telecommunication, resulting in significant travel-related savings for patients (Reid, 1996). With this mind, telemedicine has made great contributions to improved accessibility to and utilization of medical institutions. Moreover, it seems possible to transfer medical information among regions-and even among nations-without regard to geographical boundaries (Cutchin, 2002) and time constraints.

Although the complete switch from offline to online seems plausible and attractive, telemedicine technologies require further verification (Tanriverdi and Iacono, 1999; Norris, 2002). Furthermore, telemedicine has been primarily developed for

interrelationships among doctors based in medical institutions rather than mobile or personal telemedicine to prevent misdiagnosis in geographical considerations. Accordingly, it has been generally accepted that telemedicine is a complementary medical innovation (Reid, 1996). In many countries, it is stipulated that patients must see medical specialists at least once to avoid an erroneous diagnosis and need doctors or medical workers who can carry out telemedicine practices when utilizing telemedicine. In addition, there are time constraints in operating telemedicine around-the-clock. For example, telesurgery, which guides robotic arms to carry out remote surgical procedures, is accompanied by time differences among medical institutions, and accordingly, the practical operations of telesurgery are not mainstream technology (Norris, 2002). Furthermore, medical institutions that provide telemedicine cannot immediately respond to medical institutions that request telemedicine because in most cases, medical institutions regard telemedicine as subsidized medical care. Therefore, acceptable telemedicine is typically non-interactive telemedicine, such as reading medical images (tele-radiology or telepathology) or interactive telemedicine for a fixed time.

All things considered, the impact of telemedicine on the geography of medical care includes the reshaping of space and time (Cutchin, 2002). Furthermore, its operations bring new geographic processes into the provision of medical care, encompassing space-time issues of medical care delivery and access (Shannon, 1997). However, there are obstacles to overcoming time-space constraints and expanding telemedicine operations in terms of the technological application. Finally, although telemedicine eases accessibility to the utilization

of medical institutions in terms of time and space to some extent (extensibility), there are obstacles to overcoming burdens in the time-space dimensions (restriction). Furthermore, it is reasonable that telemedicine, as an ICT technology in the health care service, is considered within this framework (ambilaterality).

3. Data and Methods

Togane Prefectural Hospital comprises the major case study investigated in the current research. Togane City is approximately 60 kilometers from Tokyo and is located in the central part of Chiba prefecture (Togane City, 2012) (Figure 1). Although Chiba prefecture is the bed-town of Tokyo, there is a considerable gap in the utilization of and accessibility to medical facilities for a large area of the prefecture. In this sense, the areas within Chiba that are relatively far from Tokyo, such as Togane City, suffer from insufficient medical facilities, in particular, general hospitals. Furthermore, Togane City, which is on the periphery of Chiba prefecture, displays the characteristics of a typical rural area. Moreover, the population over 65, which experiences inconvenience in the use of medical facilities, has reached approximately 21.3% of the general population of Togane City.

In particular, there are many diabetics who must receive continuous medical treatment. With this in mind, local medical workers, particularly local physicians, have launched staged diabetes management (SDM) since the 1980s. SDM is a diabetes training program for non-specialists that aim to alleviate the concentration of patients in several core

medical institutions, such as general hospitals, and to disperse patients to local clinics that are close to their homes. Therefore, SDM can lessen the burden of general hospitals (e.g., improve the circulation of patients) and promote the stable income of local clinics. However, a suitable system for transferring patients' medical records between general hospitals and local clinics was lacking. In the 1990s, Togane Prefectural Hospital, which has led SDM as a core medical institution in Togane City, developed the telemedicine system to smoothly transmit patients' medical records among medical institutions, with regular offline meetings for SDM.

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The telemedicine system of Togane Prefectural Hospital transmits health care delivery in an online format through both in-person and virtual interactions among patients, physicians and medical

specialists. In other words, physicians provide the medical records of patients who require regular medical examination at clinical sites to medical specialists using this system. In addition, other medical treatment is conducted in clinical sites that are located close to patients' homes. To avoid misdiagnosis, patients are required to visit Togane Prefectural Hospital once per year. Furthermore, if the medical examination via the telemedicine system indicates that a patient displays serious symptoms, Togane Prefectural Hospital immediately assumes the complete responsibility of that patient. In addition, during the regular SDM meetings, Togane Prefectural Hospital trains physicians in SDM issues, such as complications, because most of the physicians are not diabetologists. Through this mechanism, the telemedicine system may prevent the overflow of patients in a particular medical institution as a tertiary care center in one diagnostic area and promote accessibility to and use of other medical institutions, especially local clinical sites (Figure 2).

Considering the mechanism of telemedicine, I conducted in-depth and open-ended interviews with 17 patients between February and March and between July and August 2011 on two separate occasions. Also, complementary investigations were conducted in 2012. The interviews were conducted in a roundabout way and with the support of physicians, who used the telemedicine system of Togane Prefectural Hospital, based on snowball sampling (Mack et al., 2005). The data for this research are based on 17 patient interviewees as the sample group in Togane City. The investigations covered interviewees (1) whose residential area is Togane City; (2) who were diagnosed via the telemedicine system in 2011; and (3) who understand the tele-

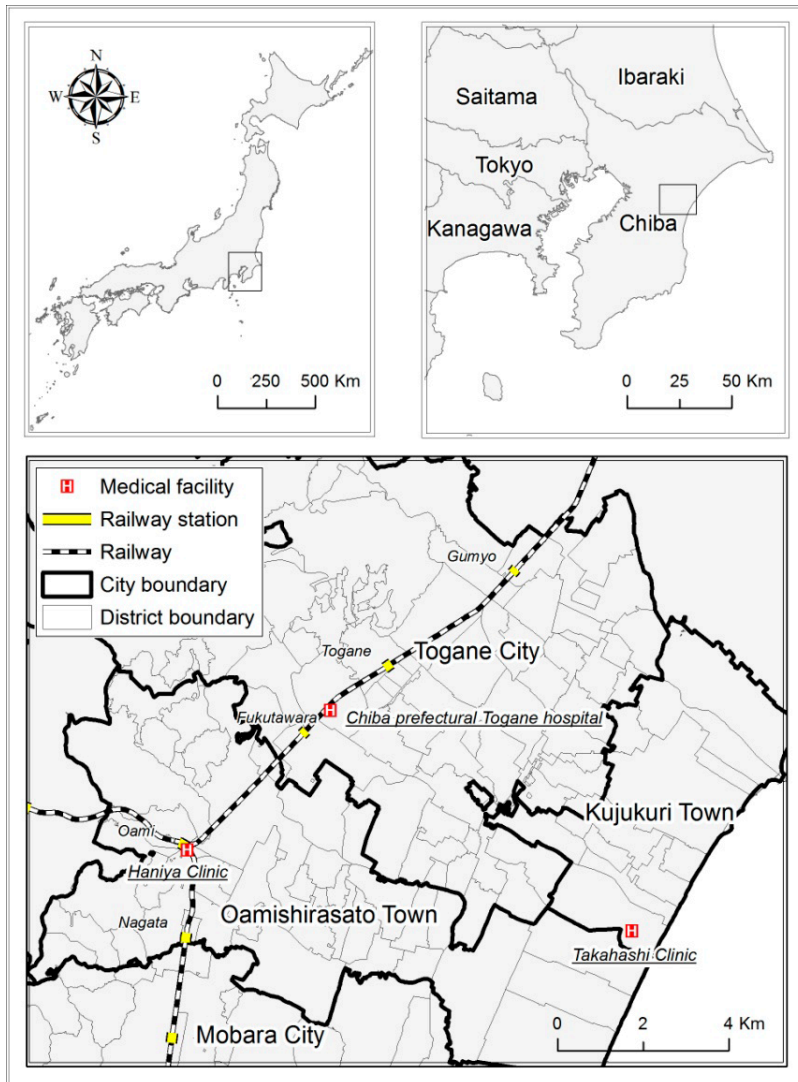


Figure 1. Location of Togane Prefectural Hospital and clinics

medicine system and its process between clinical sites and Togane Prefectural Hospital, including regular and personal visits to Togane Prefectural Hospital once per year. This study intended to include patient participants who could respond to in-depth and open-ended interviews based on the suggestion of the physicians. Furthermore,

interviews were also conducted with physicians at telemedicine-served sites (Takahashi clinic and Haniya clinic) and a medical specialist at Togane Prefectural Hospital, a telemedicine-serving site.

It is not yet feasible to make valid generalizations about the effectiveness of telemedicine across disparate health services, technological configurations

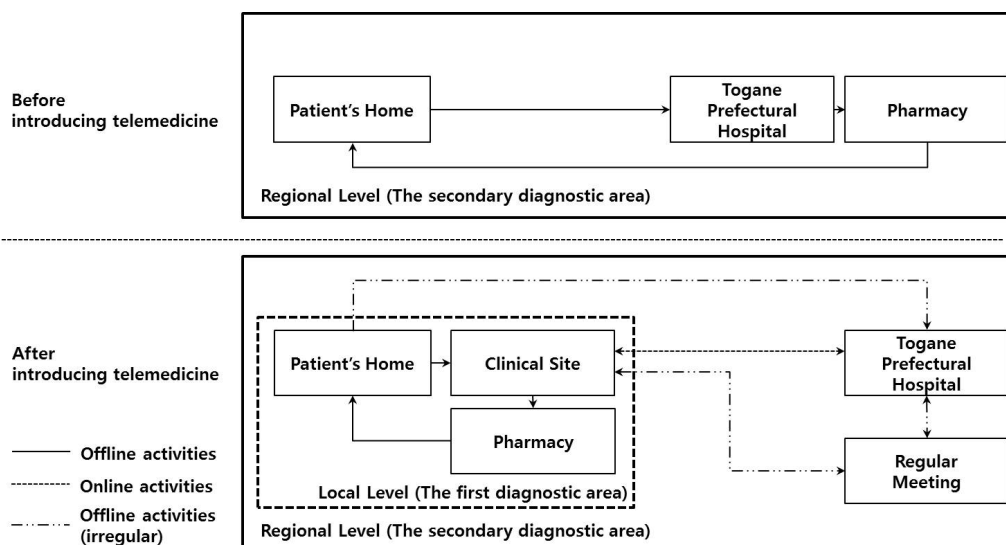


Figure 2. Mechanism of the telemedicine system served by Togane Prefectural Hospital (top: before introducing telemedicine, bottom: after introducing telemedicine)

and settings (Grigsby et al., 2005). However, the criteria of telemedicine in terms of time and space were guided by evaluations from previous research that examined clients' and patients' perspectives on health improvements, medical effectiveness, satisfaction, health care services and decreased travel expenses, including accommodations, transportation and other expenses (Coughlan et al., 2006; Dávalos et al., 2009; Hicks et al., n.d., Garshnek and Hassell, 2000; Mair and Whitten, 2000; Whitten and Love, 2005). Taylor (2005) suggested criteria in the dimensions of user satisfaction (convenience, frequency and attitude of clinicians), medical outcomes (quality of care, cost-effectiveness and improved accessibility) and financial measures. In considering the characteristics of telemedicine in time-space reconfiguration, the current research is based on user satisfaction related to convenience and frequency and medical outcomes involved in

improved accessibility.

Based on these criteria, the results of this research were categorized as follows: 1) demographic characteristics, 2) behavior changes of telemedicine participants as a quantitative approach and 3) behavior changes of telemedicine participants as a qualitative approach. Finally, this research examined how the extensibility of the telecommunication technologies is mirrored in the medical field. Therefore, the first and second categories-in terms of patients and physicians & a medical specialist-above were associated with the behavior changes of telemedicine participants in terms of time and space, and the third category revealed the selection and determinants of telemedicine participants in the time-space prism (Figure 3).

The methods used in this research were divided into the following two parts in terms of patients, physicians and a medical specialist: 1) how patients

	Patients	Physicians and a Medical Specialist
General Questions	<ul style="list-style-type: none"> • Name • Occupation • Gender • Address • Type and history of disease • Opportunity for using the telemedicine system • Reason for designating clinical sites as telemedicine receiving sites • Degree of satisfaction with telemedicine and attendant activities (e.g., visiting Togane Prefectural Hospital once per year) 	<ul style="list-style-type: none"> • Name • Occupation • Gender • Address • Number of Beds • Number of patients visiting a clinical site • Informatization in a clinical site • Department • Period using the telemedicine system • Number of patients diagnosed by telemedicine • Opportunity for using telemedicine • Satisfaction with telemedicine • Benefits • Improvements • Expenses for telemedicine (e.g., for purchasing facilities, such as a computer) • Prevention for an emergency, when using telemedicine • Related to regular meetings for physicians (opportunity, satisfaction, and frequency of attending regular meetings)
Before Telemedicine	<ul style="list-style-type: none"> • Frequency of visiting Togane Prefectural Hospital per one month • Visiting day to Togane Prefectural Hospital • Transportation methods from home to Togane Prefectural Hospital • Time required to travel from home to Togane Prefectural Hospital • Waiting time to receive medical treatment • Time required to receive medical treatment • Medical expenses for general medical treatment • After finishing general medical treatment, patients' behaviors related to medical care • After finishing general medical treatment, patients' medical expenses related to medical care 	<ul style="list-style-type: none"> • Number of patients taking general medical treatment per day • Number of days spent on each patient
After Telemedicine	<ul style="list-style-type: none"> • Frequency of telemedicine usage per month • Visiting day to clinical sites as telemedicine receiving sites • Transportation methods from home to clinical sites as telemedicine receiving sites • Time required to travel from home to clinical sites as telemedicine receiving sites • Waiting time to receive medical treatment via telemedicine • Time required to receive medical treatment via telemedicine • Medical expenses for telemedicine • After finishing telemedicine, patients' behaviors related to medical care • After finishing telemedicine, patients' medical expenses related to medical care • Frequency of visiting Togane Prefectural Hospital as a telemedicine serving site once a year • Time required to travel from home to Togane Prefectural Hospital • Waiting time to receive medical treatment in Togane Prefectural Hospital • Time required to receive medical treatment in Togane Prefectural Hospital • Medical expenses for medical treatment in Togane Prefectural Hospital and transportation fee, including others 	<ul style="list-style-type: none"> • Number of patients diagnosed by telemedicine per day • Number of days spent on each patient as major telemedicine users • Time spent preparing the telemedicine between clinical sites to Togane Prefectural Hospital • Time spent inputting patients' medical records into the telemedicine system • Changing human activities for regular meetings for physicians (time spent on travelling and transportation methods from each clinical site to regular meetings' place) • Travel • Health care services and decreased number of patients diagnosed by telemedicine per one day • Number of days spent on each patient as major telemedicine users • Time consumption for preparing the telemedicine between clinical sites to Togane general hospital • Time for inputting patients' medical records to the telemedicine system • Changing human activities for regular meetings for physicians (taking time and transportation methods from each clinical site to regular meetings' place)
Criteria	<ol style="list-style-type: none"> 1) Health improvements 2) Medical effectiveness 3) Satisfaction 	

Figure 3. Interview questions (left: for patients; right: for physicians and a medical specialist)

access clinical sites as telemedicine receiving sites and are diagnosed by the telemedicine system, including the time-space prism related to general medical activities before and after telemedicine use; and 2) how physicians' and medical specialists' medical activities are influenced by telemedicine, including consultation time and ancillary activities (e.g., regular meetings). The former included such questions as general questions, time-space characteristics related to telemedicine (after using telemedicine) and time-space characteristics related to general medical treatment (before using telemedicine or regardless of the use of telemedicine). Such questions can contribute to the understanding of the mechanism of telemedicine and related medical activities. In addition, the latter is related to human activities in terms of physicians at clinical sites and a medical specialist at Togane Prefectural Hospital. Similar to the former questions, these questions were utilized for comparisons of before and after telemedicine use. The time-space characteristics related to telemedicine not only focus on the process of medical treatment but also consider the change in human activities during regular meetings, which are provided by Togane Prefectural Hospital to share professional medical knowledge among physicians and promote the reeducation of telemedicine.

4. Behavior Changes Of Telemedicine Participants

1) Demographics of Telemedicine Participants

The patients' demographics (n=17) and the information on clinical sites (as telemedicine receiving sites) are as follows. Most of the patients were female (11, 64.7%) and unemployed (12, 70.6%). As previously mentioned, Togane City is in a rural area in Japan; therefore, the patients' age, gender and occupation are characteristic of the society and community. Furthermore, the patients had a relatively long medical history, at least since the 1980s and 1990s. The telemedicine system was primarily used due to the suggestion of physicians in clinical sites or medical specialists in Togane Prefectural Hospital. Togane Prefectural Hospital employed a strategic approach to promote the regional health care system. Most of the patients were satisfied with receiving medical treatment in clinical sites as the telemedicine receiving sites rather than Togane Prefectural Hospital. In addition, the patients selected the clinical sites based on the suggestion of Togane Prefectural Hospital. Most of the patients were aware of the need to visit Togane Prefectural Hospital once per year for a regular medical checkup (Table 1).

Two clinical sites were involved in the interview. These sites are internal medicine clinics and diagnose approximately 50 patients via the telemedicine system. The telemedicine system is primarily employed at the suggestion of Togane Prefectural Hospital and the request from the medical association in Togane City. The two clinical sites are

Table 1. Patients' demographics (n=17) in Togane City and their opinions on telemedicine

The information on interviewees	Sum
Gender	17
1) Male	6 (35.3%)
2) Female	11 (64.7%)
Occupation	17
1) Unemployment	12 (70.6%)
2) Farmer	2 (11.8%)
3) Housewife	2 (11.8%)
4) Part-time job	1 (5.9%)
Medical history	17
1) 1980s	3 (17.6%)
2) 1990s	5 (29.4%)
3) 2000s	7 (41.2%)
4) No answer	2 (11.8%)
Opportunity to use the telemedicine system	17
1) Suggestion of physicians in clinical sites or medical specialists in Togane Prefectural Hospital	11 (64.7%)
2) Bad accessibility to and utilization of Togane Prefectural Hospital	1 (5.9%)
3) Other (e.g., after attending a telemedicine information session for residences or for health care)	5 (29.4%)
Satisfaction with the use of clinical sites as the telemedicine receiving sites rather than Togane Prefectural Hospital	17
1) Great satisfaction	3 (17.6%)
2) Satisfaction	12 (70.6%)
3) Middle	1 (5.9%)
4) Needs improvement (e.g., more information on his or her health care condition)	1 (5.9%)
Reasons for the selection of clinical sites	17
1) Suggestion of Togane Prefectural Hospital	9 (52.9%)
2) Close proximity	3 (17.6%)
3) Clinical sites where physicians visit regularly regardless of telemedicine	3 (17.6%)
4) Other (e.g., after attending a telemedicine information session for residents)	2 (11.8%)
Necessity of visiting Togane Prefectural Hospital once per year for a regular medical checkup	17
1) Necessary	16 (94.1%)
2) Unnecessary (e.g., inconvenience)	1 (5.9%)

Source: results of interviews

satisfied with this system. As previously mentioned, physicians attend regular SDM meetings, which are held by the members of the medical association in

Togane City and are supported by Togane Prefectural Hospital. The attendance of the meeting for SDM provided the physicians with a considerable

Table 2. Information on clinical sites as telemedicine receiving sites

Name of clinical sites	Information
Haniya clinical site	<ul style="list-style-type: none"> • General Information <ul style="list-style-type: none"> - Number of patients visiting a clinical site : 60/day on average - Informatization in a clinical site : Electronic Medical Record (EMR) - Department : Internal medicine • Related to telemedicine <ul style="list-style-type: none"> - Period using the telemedicine system : Since 2001 - Number of patients diagnosed by telemedicine : Approximately 50 (2/day) - Opportunity : Suggestion of Togane Prefectural Hospital - Satisfaction with telemedicine : High - Benefits : Prevention of serious sickness in advance - Improvements : Advertisement of telemedicine to increase patients' efficient use of this system
Takahashi clinic site	<ul style="list-style-type: none"> • General Information <ul style="list-style-type: none"> - Number of patients visiting a clinical site : 50/day on average - Informatization in a clinical site : Electronic Medical Record (EMR) - Department : Internal medicine • Related to telemedicine <ul style="list-style-type: none"> - Period using the telemedicine system : Since 2003 - Number of patients diagnosed by telemedicine : Approximately 50 (0-3/day) - Opportunity : Request from the medical association in Togane City - Satisfaction with telemedicine : High - Benefits : Improvement of patients' accessibility to and use of medical institutions - Improvements : Coping with serious disease that occurs suddenly, such as complications

Source: results of interviews

opportunity. The physicians in the clinical sites stated that the prevention of serious sickness in advance and improvement of patients' accessibility to

and use of medical institutions are benefits of using the telemedicine system. They indicated that the following two factors may promote the present tele-

medicine system's effectiveness: first, advertisement of telemedicine to increase patients' efficient use of the system, and second, coping with serious disease that occurs suddenly, such as complications (Table 2).

Togane Prefectural Hospital, as a core telemedicine provider, began this service in the 1990s, supported by Nippon Telegraph and Telephone Corporation (NTT). Approximately 700 people are listed as patients diagnosed by the telemedicine system. In addition, 7 clinical sites are involved in this telemedicine network as secondary telemedicine receivers. Before managing telemedicine, Togane Prefectural Hospital promoted regular SDM meetings with the medical association of Togane City because of the seriousness and increase in diabetes. SDM is a diabetic care program that provides diabetes training to doctors. At the same time, Togane Prefectural Hospital required the decentralization of many patients. The director of Togane Prefectural Hospital applied the telemedicine system to the network for SDM; this challenge has been passed down through the generations and continues to exist today. The director of Togane Prefectural Hospital is satisfied with this system due to the simplicity of using the system and the resulting convenience for the elderly. Furthermore, in addition to this system, another telemedicine system (teleradiology) is utilized by Togane Prefectural Hospital to stabilize the regional health care system. Accordingly, it is reasonable that the telemedicine system in Togane Prefectural Hospital is utilized in various directions in the regional medical system.

2) Behavior Changes of Telemedicine Participants in Terms of Time and Space

According to the results of time-space reconfiguration as a quantitative approach, the effectiveness of telemedicine was identified in all dimensions (Table 3). In other words, the starting and ending times of medical activities were quicker, the time consumption for hospital visits (from home to clinical sites), waiting, diagnosis and other activities, such as visiting pharmacies and shopping, decreased. Finally, the total time required for medical activities decreased from 222 min to 89.8 min, particularly due to the decrease in waiting time. The number of hospital visits increased from 6.9 to 9.6 per year. In addition, before utilizing telemedicine, the car was the patients' major transportation method. However, following the implementation of telemedicine, the major transportation methods of patients diversified, such as car, walking and bicycle. Furthermore, the car method was primarily substituted by the easy or convenient transportation methods of walking and bicycle. Accordingly, most of the patients were not accompanied to the clinical sites by their family members (for driving). In addition, medical fees decreased by approximately 1,200 yen (approximately 15 USD), and the linear distance from patients' homes to medical institutions decreased considerably.

3) Behavior Changes of Telemedicine Participants in Extensibility and Restriction

Although the quantitative approach provided information on effective telemedicine utilization, a

Table 3. Information on clinical sites as telemedicine receiving sites

Medical Activities		Value (Before)	Value (After)	▲/▽
Time consumption	Starting time	11:33	10:54	–
	Number of hospital visits (number/year)	6.9	9.6	▲
	Time spent travelling from home to medical institutions (min)	23.5	13.2	▽
	Time spent travelling from home to medical institutions (min)*	103.8	52.7	▽
	Waiting time (min)	140	42.2	▽
	Time spent for diagnosis (min)	24.1	9.1	▽
	Other (min)	57.9	38.5	▽
	Ending time	15:15	12:23.8	–
	Total time consumption (min)	222	89.8	▽
Major transportation methods		Car	Car, Walking, Bicycle	–
Number of companions (people)		6	3	▽
Medical fees (Yen)		7,775	6,507.3	▽
Linear distance		6.6 km	2.9 km	▽

Note: * is expressed by two categories. The first row represents time spent travelling from home to medical institutions regardless of the means of transportation. The second time (expressed by ()) indicates the conversion results of the time spent travelling from home to medical institutions according to transportation (e.g., walk-1, cycle-3, bus-4 and car-5).

close examination of the interviews with telemedicine participants provided a different view. In other words, it seems that the quantitative results of this research are related to the extensibility of telemedicine, while the qualitative results connote the other side of telemedicine, namely, the restrictions of telemedicine utilization.

(1) Patients

According to the results of patient interviews, it is axiomatic that telemedicine allows for the selection of convenient appointment times (in most cases, preferring diagnosis in the morning (Patient 1)); reduces unnecessary time consumption, such as waiting time for diagnosis or medical fees (Patient 14); and guarantees easy access to clinical sites (Patient

6). As mentioned previously, telemedicine assures the convenient utilization of and easy accessibility to clinical sites compared to general medical activities. Accordingly, this result is associated with the number of hospital visits from 6.9 to 9.6 per year.

“... I prefer to have a checkup via telemedicine in the morning...” (Patient 1, female)

“... As you know, I am the aged. So I am worried about my health condition and need to see a doctor directly as much as possible. At Togane Prefectural Hospital, I must spend a lot of time and medical expense and it was difficult to see a doctor sufficiently. Even though the time consumption for diagnosis in the present clinical site is shorter than Togane Prefectural

Hospital's one, I can ask my health condition to a physician frequently and feel relieved... (Patient 14, male)

"... Before using the telemedicine system, I must go with my husband and he drove me down to Togane Prefectural Hospital in most cases. Now I am walking or cycling to a clinical site alone. So it is difficult to feel the inconvenience of hospital visits recently....." (Patient 6, female)

Patient 16 indicated decreases in the completed health examination, high medical fees and time consumption compared to Togane Prefectural Hospital and the reliable relationship with a physician in a clinical site regardless of telemedicine. When patients selected to receive checkups for diabetes at clinical sites rather than Togane Prefectural Hospital, they were referred by physicians at close sites who played a crucial role as their family doctors. Therefore, a ready-formed human relationship between patients and physicians was connected to medical activities via telemedicine. With this mind, although the time consumption of diagnosis via telemedicine was shorter than that of the general diagnosis, patients were satisfied with medical treatment in clinical sites and understood their health condition due to frequent checkups and updated diagnoses.

"... Comparing Togane Prefectural Hospital with the present clinical site, the most favorite point of telemedicine is the decrease of the complicated health examination. And I can ask my health condition, which are not only diabetes but other diseases, to a physician as my family doctor who are understanding my situation comprehensively..." (Patient 16, female)

Despite these convenience factors, some obstacles restricted the use of telemedicine. The physicians, who were trained by Togane Prefectural Hospital, did not have medical knowledge of diabetes. Accordingly, some patients were doubtful of the safety of telemedicine and the measurement of emergency, when patients suddenly take a turn for the worse. Therefore, patients visited Togane Prefectural Hospital once per year. Accordingly, some patients did not experience the convenience of telemedicine or a difference between medical activities before telemedicine and medical activities after telemedicine (Patient 17). These points-checkups by non-professional doctors on diabetes, absence of confident measurements and compulsory visit of Togane Prefectural Hospital-dominated the restrictions of telemedicine.

"... Even though the telemedicine system provides usability or convenience to us absolutely, we should have a checkup by non-professional doctors in diabetes finally. So visiting Togane Prefectural Hospital more than once directly is necessary to us. Finally, in some parts, it is difficult to say that telemedicine can't assure complete convenience..." (Patient 17, male)

(2) Physicians

The telemedicine system aims to promote patients' utilization of and accessibility to medical institutions. Therefore, physicians do not have the burden of moving to other places or spending certain amount of time with patients, except for attending regular meetings for medical knowledge training. All of the physicians who were involved in this interview regarded the regular meetings supported by Togane Prefectural Hospital and Togane Medical Association as instructive medical activi-

ties for stable regional health care (Physicians 1 and 2). When physicians attended regular meetings, they shared considerable medical information and exchanged patient information; therefore, they considered the meetings to be an accomplishment in the use of telemedicine.

“... Even though I attend the regular meeting provided by Togane Prefectural Hospital for the training of telemedicine from time to time, it is very useful for me that I can meet other doctors or medical specialists; so I can share a lot of medical information, particularly not my specialty, and it is a valuable opportunity...” (Physician 1, male)

“... Despite the attendance of the regular meeting, the increase of patients is the merit of telemedicine. In addition, this regular meeting is involved in not only telemedicine, but understanding the regional health care system; so I think that this regular meeting is a cooperative activity for physicians...” (Physician 2, male)

In their medical activities, the only time consumption for diagnosis via telemedicine was defined by patients without any physical movement. However, even this activity did not influence the behavior changes of telemedicine participants because the present telemedicine system is based on non-real-time services. Therefore, it seems that the operation of telemedicine was a general medical activity (Physician 2).

“... The present telemedicine system is based on non-real-time services. So there is no obstacle to use it in terms of time. Finally, the use of this system depends on patients' visit...” (Physician 2, male)

Similar to patients' opinions, physicians indicated the lack of measurements for medical emergency as an obstacle of telemedicine at the present stage (Physician 1). Accordingly, it is inevitable that telemedicine does not extend the range of diagnosis and is based on a regional-based boundary (within Togane City) in light of patients' life zones.

“... Practically, it is difficult to extend over the range of the regional health care system because of medical emergency...” (Physician 1, male)

(3) A Medical Specialist

For the medical specialist in Togane Prefectural Hospital, it was difficult to identify behavior changes in terms of time and space, except for the hosting of regular meetings (1-A Medical Specialist). The first condition necessary for operating telemedicine is associated with the promotion of regional health care, in particular, from the perspective of a major regional health care provider (Togane Prefectural Hospital). In particular, considering the Japanese health care system, which sets a premium on the provision of stable medical services, hosting regular meetings is regarded as a responsibility of regional medical workers.

“... Even though I manage the regular meeting for physicians, the stability of the regional health care system, including the provision of convenience for patients, is urgent most of all and telemedicine is considered within this perspective. I have never felt the management of holding the regular meeting in a distant place as troublesome. Especially, the regional-based telemedicine system or regional-based health care is a core part of the Japanese health care system...” (1-A Medical Specialist, male)

According to the interview results, Togane Prefectural Hospital plays a crucial role in operating telemedicine, including the range of the telemedicine services in terms of time and space. Therefore, the provision of telemedicine is mirrored in the mutual understanding of medical institutions related to profitability and the understanding of doctors or medical staff members, including patients, associated with safety and compatibility. With this mind, although telemedicine can be accessed from any location and used at any time, this medical and technological innovation is intrinsically restricted (2-A Medical Specialist).

“... Actually, I would like to extend the range of the telemedicine service in terms of time and space, but there are some limitations practically such as the mutual understanding of medical institutions related to profitability, the understanding of doctors or medical staffs, including patients, associated with safety and compatibility, etc. The present system served by our hospital is the simple telemedicine system and is focusing on a special disease group (diabetes)...” (2-Medical Specialist, male)

The quantitative results of this research indicate the extensibility of telemedicine, whereas the qualitative results indicate its limitations. Therefore, although telemedicine can somewhat overcome the burden of accessibility to and utilization of medical institutions, there are some restrictions, such as the selection of the proper time for diagnosis and the unlimited extension of telemedicine service boundaries. In addition, this virtual reconfiguration of the medical care landscape does not eliminate the problems associated with the geographical distribution of medical care. Rather, a new and more complex

geography is created (Shannon, 1997), or the medical activities via telemedicine are absorbed into the general activities.

5. Discussion and Conclusion: the Two Facets of Telemedicine, Extensibility and Restriction

Figure 4 presents the time-space characteristics of telemedicine participants before and after the introduction of telemedicine. The following results were demonstrated following the initiation of telemedicine: 1) patients' decreased time-space requirements to visit or be diagnosed by a medical institution and 2) the time-space requirements for the physicians and the medical specialist to attend regular meetings. However, it is difficult to ascertain the considerable behavior changes of telemedicine participants in the offline and online dimensions. Namely, although telemedicine is convenient for patients, it is difficult to determine the difference between face-to-face diagnosis and telemedicine in terms of human activities for diagnosis (time arrangement). The medical activities with regard to telemedicine appear to be incorporated into the general medical activities. Accordingly, the medical behaviors caused by telemedicine are quite similar to general medical behaviors, except for the decreased burden in terms of time and space, particularly for patients. This phenomenon results from the double-sided characteristics of telemedicine: extensibility and restriction.

The results of the interviews as a qualitative approach indicated that visible and physical aspects (e.g., improved accessibility and reduced time and

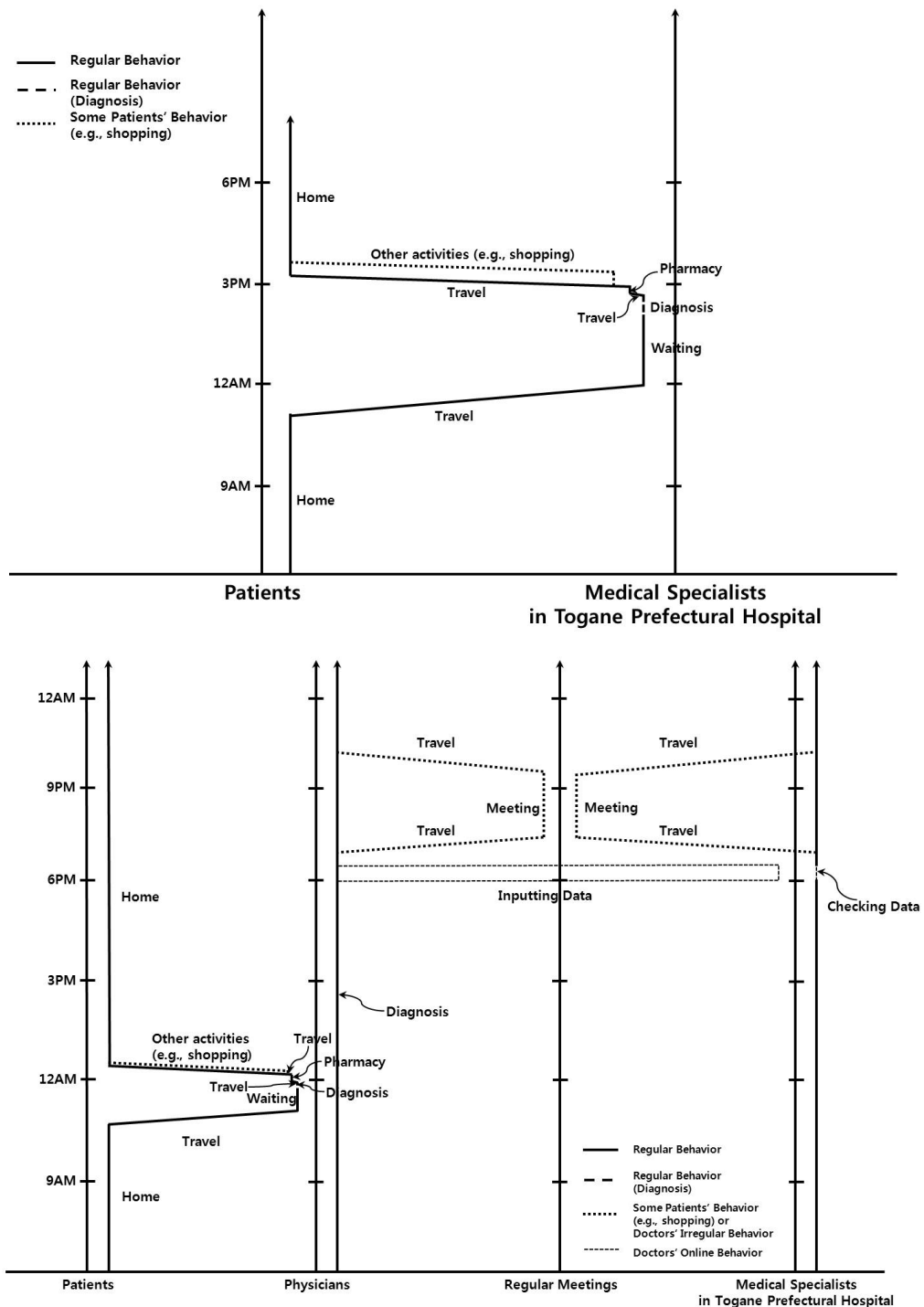


Figure 4. Average time-space characteristics of telemedicine participants (top: before introducing telemedicine, bottom: after introducing telemedicine)

medical expenses) were factors of extensibility. Furthermore, invisible and psychological dimensions, such as anxious attitudes and mutual stakes with regard to profits, including mutual trust based on human networks, restrict telemedicine (Figure 5).

According to previous research studies on telecommunication in terms of time and space, geographical and innovative phenomena involve the convergence of time and space. Therefore, the friction between distance and time limitations may be overcome by such extensibility (Adams, 1995). However, the results of the current research provide a different view. Accordingly, the boundary of telemedicine applications cannot extend without restriction and is based on the regional health care system (e.g., the secondary or third diagnostic area with regard to a local level); in addition, the service time of telemedicine is limited. Furthermore, it is difficult to identify the drastic extension of time and space in telemedicine.

These characteristics are caused by the following

factors. The previous telemedicine system emphasized the simultaneity between patients and doctors or among doctors; however, the present telemedicine system aims to control the health care system or the method of preventive medicine that does not require the physical presence of telemedicine participants. Accordingly, face-to-face diagnosis is required, but only local travel is required for telemedicine participants. The most important fact is that the extensibility of telemedicine depends on the integration among medical institutions; however, the lack of mutual understanding among medical institutions, outcome problems, the riskiness of sharing personal information and other problems limit its extension, as mentioned earlier. Especially, human networks associated with mutual trust, which is built by one diagnostic area, are involved in telemedicine; accordingly, telemedicine application is preserved by human networks' boundary (generally, at the second or the third level). With this in mind, telemedicine is not only regarded as

		Extensibility	Restriction
Physicians and a Medical specialist	Patients	<ul style="list-style-type: none"> • Improved accessibility to medical institutions • Convenience regarding the selection of appointment times • Saving time and medical expenses 	<ul style="list-style-type: none"> • Reduced reliability of medical activities via the telemedicine system
		<ul style="list-style-type: none"> • Increased number of patients • Sharing the newest medical knowledge through regular offline meetings 	<ul style="list-style-type: none"> • Mutual understanding of telemedicine participants (associated with profits)

Figure 5. Extensibility and restriction of telemedicine participants

the provision of medical service as a health care delivery system or referral system but is also discussed within regionalization with regard to the level of telemedicine technologies, futuristic utilizations and the equal distribution of medical profits caused by telemedicine (Park, 2011). Overall, the practical issues of telemedicine application must be considered within the contexts of both extensibility and restriction and will be addressed based on the consent of telemedicine participants in terms of time and space.

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