노인을 위한 디지털헬스 서비스에 있어서 의사들의 수용과 확산 관련요인
- 혁신확산 이론을 중심으로 -

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The Factors Related to Physicians' Acceptance and Dissemination of Digital Health Services for Older Adults
- Applying the Dissemination of Innovation Theory -

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요 약

이 연구는 일차의료 의사들을 대상으로 노인환자를 위한 디지털헬스 서비스에 대한 수용도를 파악하고 서비스 확산에 필요한 정책 우선순위를 파악하고자 진행되었다. 조사전문기관에서 보유한 의사패널 중 개원의사 259명을 대상으로 온라인으로 진행하였으며 디지털헬스 사용경험, 서비스 수용도를 조사하고 혁신확산 이론을 적용하여 확산을 높이기 위해 고려되어야 할 우선순위를 파악하였다. 조사결과 전자의무기록 구축, 환자의 모니터링 시스템 개발에 높은 수용도를 가진 반면 원격의료에 대한 수용도는 가장 낮았다. 서비스 확산을 위해서는 서비스가 기존 노인환자 진료와 호환성을 가져야 하며, 작동이 간단하고 사용이 쉽게 설계되어야 하는데 우선 순위가 높았다. 또한 의사의 개인 혁신성이 서비스 수용에 영향을 주므로 의사 대상의 교육 훈련을 통해 혁신성을 높이는 노력이 필요하다.

ABSTRACT

Introducing the Korean New Deal program, which includes dissemination of telemedicine, required the consideration of the physicians' awareness and willingness to put the digital health services into practice. The current study aimed to understand the primary care physicians' intention to accept digital healthcare services and suggest policy priorities for their dissemination. To fulfill the study objectives, we surveyed 259 primary

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physicians and analyzed their awareness of digital healthcare services and factors that influenced the dissemination of the new technology. Results showed that physicians have a higher priority in assistant technology for monitoring of patients' medical data rather than health behavior data. Electronic health records systems had the highest priority among suggested digital healthcare services and telemedicine had the lowest priority. Also, increasing compatibility and reducing the complexity of digital healthcare technologies had a higher priority in terms of dissemination. Based on our result, we suggested taking into consideration physicians' priority in applying digital healthcare services. It is necessary to strengthen cooperation with enterprises and stakeholders in order to meet physicians' needs. Furthermore, continuous training and education of physicians are necessary for increasing the personal innovativeness of digital health.

Ⅰ. Introduction

The rapid development of information and communication technology (ICT) and the fourth industrial revolution has expanded the possibilities to provide remote healthcare services. Accordingly, the term "Digital Health" has become widespread in medical services. Digital health services include the following four areas: (1) telehealthcare, which includes telecare, and telehealth; (2) mHealth – various types of software, applications and wearable devices; (3) health analytics, which include data analytics, genomics, precision medicine; and (4) digitized health systems, which include electronic health records (EHRs)[1]. Digital healthcare services can provide various solutions for aging in place, and assist in providing remote health services to people with mobility difficulties[2].

The rapid increase in the older population and the associated raise in age-related diseases, such as non-communicable diseases, will lead to an increase in the burden on the healthcare system, as well as on the older adults and their caregivers[3]. In this sense, providing digital healthcare services for older adults is in high demand. So far, many positive effects of digital healthcare services for older adults have been introduced. For example, health monitoring, fall detector, remote controlled assistant services, etc.[4-6]. Studies on the utilization of digital health and digital healthcare services showed their association with an improvement in the management of patients' health status and provision of aging in place services more easily[7-9].

In 2020, the Korean government introduced a program to foster the digitalization of the economy called the "Korean New Deal" aiming to support the continuous development after the COVID-19 crisis. One of the components of the Korean New Deal program is telemedicine. However, the Korean Medical Association criticized the government's initiatives of introducing telemedicine[10], as telemedicine is only one area of digital health and the provision of several other services should be planned considering the fourth industrial revolution and continuous industrial development in the long term. Therefore, it is necessary to fully understand the perspectives of physicians who are responsible for the acceptance and implementation of new healthcare technologies and their development.

International studies provided different examples of the implementation of digital healthcare services into physicians' practices. Canadian studies on the enhanced use of EHRs described a positive relationship between the maturity level of the EHRs adaptation and improvement in patient care[11,12]. Additionally, a U.S. study reported the satisfaction of the stakeholders associated with enhanced telemedicine, emergency care for older adults, overall improvement in patient care, and availability of data[13].

In Korea, few studies on the acceptance of some types of digital healthcare were conducted in hospitals and clinics in the Seoul Metropolitan area [14,15]. Moon and colleagues reported a low awareness and experience of digital health among healthcare service providers such as physicians, nurses, and other medical certified specialists[16]. However, there is a lack of research in Korea

analyzing the primary care physicians' willingness to accept digital health and its policy. Furthermore, the studies conducted thus far did not present efforts to identify different dissemination strategies according to the target service, such as priority policies for the dissemination of digital health services for care of older adults. Therefore, this study aimed to provide an understanding of the physician's priority in the acceptance of innovations that are needed to develop a solution for the continuous dissemination of the digital healthcare services for older adults.

The specific goals of this study were as follows:
1. To identify digital healthcare awareness, service needs, and priorities of primary care physicians.
2. To identify the factors related to service needs.
3. To suggest policy strategies for prioritizing the dissemination of digital healthcare services for older adults.

Ⅱ. Methods

2.1 Study Design

A quantitative study was designed to explore awareness of digital healthcare services for older adults among physicians. Digital health includes a broad scope of services provided to the healthcare service consumers, services providers, and policymakers[17]. Digital health includes categories such as mobile health, telemedicine, health information technologies, big data, and ICT-based assistive technology[18]. In the current study, the term "digital healthcare services" comprises services of remote health monitoring, consultation, and decision-making. We analyzed the relationship between digital healthcare services for older adults and the experience of ICT-based services and personal innovativeness of physicians. The socio-demographic characteristics of the physicians were included as control variables. Additionally, the strategies for the dissemination of innovations in digital health were suggested using the survey of primary physicians.

2.2 Data collection and participant

A structured questionnaire was developed to collect data and analyze physicians' awareness of the necessary digital healthcare services for older adults. The survey was conducted by the Korea Data Network (KDN), a specialized research company. The first invitation to participate in the survey was sent to the 642 physicians included in the KDN's open panel of physicians. Initially, 88 physicians agreed to participate in the survey. Three more rebounds of invitations were sent using the snowballing method. Finally, a total of 259 responses to the online survey were received from the primary physicians (response rate, 40.3%). The survey was conducted between October 10 and November 23, 2019. Informed consent was obtained from all study participants. The study's protocol was approved by the Institutional Review Board of K University (KWNUIRB-2019-05-006-001).

2.3 Instruments

2.3.1 Digital healthcare services

Five services were included in the digital healthcare study analysis based on the classification proposed by Monitor Deloitte and current trends in the implementation solutions for older adults. The necessity of telemedicine and assistive technologies (as video-monitoring, remote health monitoring, electronic sensors, etc.) represented the telehealthcare dimension. Healthcare applications were selected to explore mHealth solutions and big data, AI for decision marking was chosen as the health analysis dimension, and EHRs represented digitized health systems[1,19]. A five-point Likert scale was applied to evaluate the physicians' opinion on the necessity of the implementation of each service, and their answers were coded as 1-very low necessity to 5 – very high necessity.

Physicians' impressions on the dissemination of digital healthcare services for older adults were evaluated by six criteria of the diffusion of innovation in health care services delivery and organization developed by Rogers[20-23]. Rogers explored the interaction between the individuals adopting innovation and the innovation itself[21]. The theory of its application to the public health and

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healthcare delivery included six main components (1) the relative advantages, (2) compatibility, (3) complexity, (4) trialability, (5) observability, and (6) perceived cost[21-24]. A 5-point Likert scale was used to evaluate the physicians' impressions on the dissemination of digital healthcare services for older adults, and the data was coded as 1 – strongly disagree to 5 – strongly agree. The participants were provided with six statements aiming to evaluate the aforementioned impressions, and the following operational definitions were used:

Relative advantages are evaluated by the perceived cost and effectiveness of the new technologies which are put in place of the current technologies or systems[22,23]. Physicians were presented with the following statement "The cost of ICT devices and services should be affordable" to evaluate the subjective level of the perceived relative advantages.

1. Compatibility is the level of the fit of innovation with the intended older adults' values, norms, and needs to accomplish the desired goal [22,23]. The statement "Developed ICT devices should provide convenient services for user" was used to evaluate the physicians' perceived compatibility level.

2. Complexity shows the level of physicians' perception of the easiness to adopt new technology and technologies' applicability to older adults [20,22]. Complexity was measured by asking the level of agreement with the following statement "ICT devices and services should match older adult patients' requirement."

3. Trialability is the extent to which the technologies will be committed to be full adopted by older adults[23,24]. Physicians were asked to express their opinion on the statement "Current developed ICT devices and services should be tried and improved".

4. Observability explores the physicians' view on how results will be seen, measured, and proven [21,23]. The statement "Improvement in treatment from using ICT devices and services should be proven" was asked to measure physicians' perception of the observability of technologies.

5. The attitude towards insurance policy was measured to understand the extent of potential readiness of the system to pay for innovation adaptation[22,23]. Physicians were asked to agree or disagree with the following statement "Developed ICT devices and services should be covered by insurance services."

2.3.2 Personal Innovativeness

Personal Innovativeness was evaluated with four following items "If I heard about new information technology, I would find a way to experience it," "I tend to use new information technology first among my acquaintances," "Generally, I don't hesitate to try new information technology," "I like to use new information technology." A 5-point Likert scale was applied to evaluate personal innovativeness. The mean score of the four questions was calculated.

2.3.3 Socio-demographic characteristics

Socio-demographic data of survey participants, such as sex, age, specialization, and location of workplace, were collected. Sex was coded 0 for 'male' and 1 for 'female'; age was divided into three groups (younger physicians: 34 years and younger, middle-aged physicians: 35 to 45 years, and senior physicians: 46 years and older). The specializations of physicians were diverse, and three main groups were labeled as internal medicine, family medicine, and others. Meanwhile, the workplace location of physicians was also divided into three groups: Seoul Metropolitan City, urban areas, and rural areas. The urban area category included the administrative metropolitan cities other than Seoul, and areas with a population larger than 150 thousand (Si), the rural area category referred to areas where the population was less than 150 thousand (Gun).

2.4 Data analysis

The socio-demographic characteristics of study participants were analyzed, and the reliability of the research tools was checked. Reliability analysis of personal innovativeness was performed resulting in a Cronbach's α of 0.9. Descriptive statistics and

multiple regression analyses were performed to identify the relationships between the digital healthcare services for older adults and the diffusion of innovations, the experience of using ICT-based healthcare services and personal innovativeness. Socio-demographic characteristics were used as control variables. Data analysis was performed using IBM SPSS Statistics 24.0 (IBM Corp.).

Ⅲ. Results

3.1 Descriptive statistics

The socio-demographic characteristics and descriptive statistics of independent variables are presented in Table 1. The prevalence of men was higher than women (76.8% vs 23.2%), physicians' age distribution was 28.6% – 34 years and less,

Table 1. Characteristics of the physicians

| Variable		Frequency	%/ Mean (±SD)
Sex	Male	199	76.8
	Female	60	23.2
Age	34 years and less	74	28.6
	35 – 45	92	35.5
	46 years and older	93	35.9
Specialization	Internal medicine	117	45.2
	Family medicine	59	22.8
	Other	83	32
Location of workplace	Seoul Metropolitan City	128	49.4
	Urban area	95	36.7
	Rural	36	13.9
Experience of ICT-based services	No	192	74.1
	Yes	67	25.9
EHRs		50	74.6
Telemedicine		7	10.5
ICT-based assistive technology: video-monitoring, remote health monitoring, electronic sensors		18	26.9
Health applications		26	38.8
Big Data and AI for decision making		2	2.9
Personal Innovativeness		259	3.5 (±0.8)

Note: 67 physicians experienced ICT-based services.

35.5% – 35 years to 45 years, and 35.9% were 46 years and older. Forty-five-point-two percent of participants were internal medicine physicians, 22.8% were family medicine physicians, and 32% qualified as "others." Forty-nine-point-four percent of respondents provided services in healthcare facilities located in Seoul Metropolitan City, 36.7% in urban areas, and only 13.9% of participants were employed in rural healthcare facilities. About two-thirds of the participants had no experience using ICT-based services in practice (74.1%). Among the physicians who experienced using ICT-based services the most frequently used services were EHRs (74.6%) followed by healthcare applications (38.8%). The score of physicians' personal innovativeness was 3.5 which slightly above the mean.

3.2 Awareness of digital healthcare services

Figure 1 presents the distribution of physicians' perceptions of the most necessary digital healthcare services for patients. Respondents indicated a high demand for EHRs among the five digital healthcare services (78.8%). This was followed by ICT-based assistive technology, healthcare applications, and big data and AI for decision marking. Only 19.3% of primary physicians perceived telemedicine as a necessary digital healthcare service.

Analysis of the perceived necessity of the information obtained from patients showed that physicians have a higher demand for information
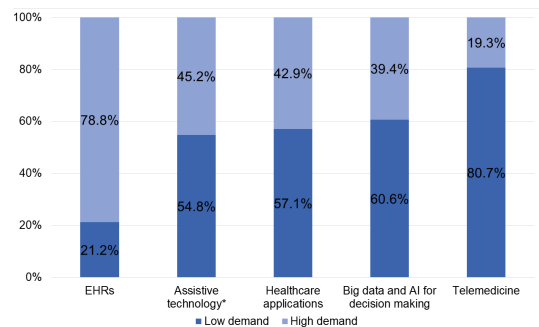
Note: *ICT-based assistive technology includes video-monitoring, remote health monitoring, electronic sensors, etc.

Fig. 1. Physicians' demand for utilization of digital healthcare services for older patients

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Table 2. Multivariate analysis of the perceived demand for digital healthcare services among primary level physicians

Variable		Standardized beta				
		EHRs	Telemedicine	ICT-based assistive technology	Healthcare applications	Big Data and AI for decision making
Experience with ICT-based services		.019	-.067	-.037	-.104	.013
Personal Innovativeness		**.313*****	**.283*****	**.349*****	**.38*****	**.401*****
Sex (ref=male)	Female	.112	.101	-.008	.074	.007
Age (ref=45 years and older)	34 years and less	-.032	-.059	-.015	-.037	-.02
	35-45 years	-.023	-.099	-.098	-.02	.04
Specialization (ref= Internal medicine)	Family medicine	.103	-.01	.011	.076	.068
	Other	-.033	-.02	-.03	-.001	.047
Location of workplace (ref=Rural areas)	Seoul Metropolitan City	.061	-.058	.126	-.016	-.022
	Urban areas	-.057	.021	.073	-.001	**-.119***
R Square change***		**.129**	**.109**	**.15**	**.176**	**.196**

* p < .05, ** p < .01, *** p < .001

related to health conditions than daily life activities (Figure 2). The highest priority was given to an emergency (fall) button, followed systolic blood pressure, medicine intake, diastolic blood pressure, heart rate, and body temperature. Information on the daily physical activities, meal intake, sleep duration, and wake-up times were in lower demand. Therefore, physicians seem to be more interested in receiving information that directly helps manage the health status of older patients rather than information about their lifestyle influencing their health condition.

The results of a multiple linear regression analysis of the five types of digital healthcare services showed a relationship between personal innovativeness and workplace location among the socio-demographic characteristics (Table 2). Additionally, the results partially confirmed the physicians' perceived necessity of digital healthcare services. Among the five types of services, telemedicine had the lowest coefficient of the relationship with personal innovativeness. However, big data and AI for decision marking, healthcare applications, and ICT-based assistive technology showed higher coefficients (β=.401, β=.38, β=.349 p<.001 respectively) than EHRs (β=.313, p<.001). Among socio-demographic variables only dig data and AI decision marking services demonstrated a negative relationship with the physicians' workplace location of urban areas other than Seoul (β=-.119, p<.01). The higher the physicians' levels of personal innovativeness, the more interest they showed in using advanced digital healthcare services such as big data and AI for decision marking; however, they
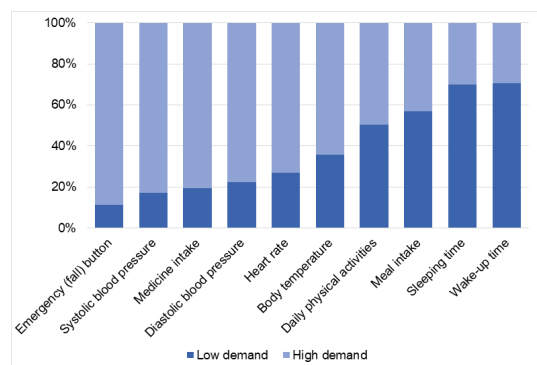

Fig. 2. Physicians' perceived necessity for patient information by type

also showed less interest in providing telemedicine services.

3.3 Physicians' priorities in disseminating digital healthcare services for older adults

Figure 3 presents the level of physicians' perceived priority in disseminating digital healthcare services for older adults. The indicators were above the mean for all six dimensions. The dimensions perceived as the most important were compatibility and complexity of digital healthcare services, with the average scores higher than 4.0. Coverage of the digital healthcare services by national health insurance (insurance policy) and proof of current available and continuous development (trialability) of the digital healthcare services had a lower perceived demand.

The findings showed that the physicians pay more attention to achieving the results in the improvement of healthcare status and easiness of technology adaptation. While the insurance policy and current proven trialability of technologies were less important to physicians.
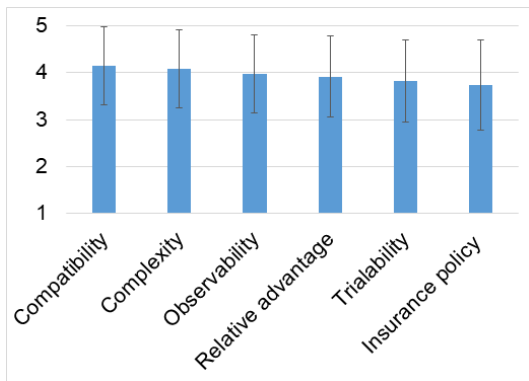

Fig. 3. Physicians' priorities in a policy to disseminate digital healthcare for older adults

Ⅳ. Discussion

The main objective of the study was to analyze attitudes towards acceptance of digital healthcare services for older adults, and to explore subjective factors that influenced the dissemination of innovations among Korean primary physicians. Five

digital services were selected for this study and represented the four dimensions proposed by Monitor Deloitte[1]. Those services support the management of the patient condition and decision making. The findings highlighted physicians' priorities regarding digital healthcare services for older adults and subjective factors influencing the dissemination of the new technology.

First, the results showed that most of the participants did not experience using ICT-based healthcare services, however, among the users of ICT-based services, the most frequently used services were EHRs. A higher level of utilization of EHRs comparing to other services may be a result of a relatively high level of the adaptation of electronic medical records in Korean hospitals and clinics[25]. Big data and AI for decision making showed a lower level of utilization among the physicians which can be explained by continuous development of the technology and adjustments in terms of the integration of this technology into practice[26].

Second, the present findings also demonstrated the perceived necessity of the utilization of the five types of digital healthcare services, where higher perceived necessity was found for EHRs. A higher level of existent adaptation of the EHRs in hospitals and clinics may result in the higher interest of the primary physicians' in its use[25]. On the other hand, the absence of a standardized EHRs system and the high cost of their utilization make it difficult to fully adopt EHRs in the primary level healthcare facilities [27]. Also, continuous development of the policy regarding EHRs, and a unified system of their use will facilitate the establishment integrated system of patient data sharing between different levels health facilities. The results confirmed that physicians have a lower demand for telemedicine compared to the other digital healthcare services. Furthermore, Korea has a high level of urbanization, so most of the population is located in the cities and has an easy access to the healthcare facilities, while people in the rural and remote areas have a lower access, which may result in the lower interest of physicians in telemedicine[28].

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Third, the results suggested that the physicians show more interest in the information related to the patients' health condition than their daily activities. Physicians have a higher necessity for the ICT-based assistive technology, healthcare applications, and big data and AI for decision making than telemedicine, but it is still lower than 50% (Figure 1). These three types of services are closely connected with biometric data that the physicians wish to have for continuous monitoring and analyses of patients' health status. The patient information reported as the most important was the emergency call button (fall button), blood pressure, heart rate, and medicine intake. The patient information preferred by the physicians is identical to the service receivers' opinions reported by Jeon and Seo[29]. Other research suggested that the information exchange system integrated with non-medical (welfare and social) services improves the quality of patients' life with chronic conditions[30].

Fourth, physicians' priorities with regard to the strengthening of dissemination of digital healthcare services were mostly focused on the convenience of the services provided to the users (compatibility) and applicability of the provided services (complexity). The treatment improvement from using digital healthcare devices and their trialability (observability) was the third most important factor regarding the dissemination of digital healthcare services. Smith and colleagues reported similar results for telehealth where improved access to care, the efficiency of telehealth, and clinical effectiveness received higher priority[31]. However, the physicians considered the importance of the digital healthcare services coverage by health insurance and trialability lower than the other parameters related to the dissemination of digital healthcare services[31]. The digital healthcare services integration in the process of service delivery should be accompanied by the development of the adequate policies, programs, and continuous training of the physicians on the adaptation and implementation of the new technologies in daily medical practice[32].

Several practical implications are suggested based on our findings. First, the government is recommended to take into consideration physicians' priority regarding digital healthcare services under the Korean New Deal program. The development of the unified EHRs system and investment in the development of ICT-based assistive technology and healthcare applications is needed to ensure the compatibility and complexity of the digital services. Introducing the new digital healthcare services should be designed to help to organize remote monitoring for patients and assist in decision making.

Second, cooperation with enterprises and other stakeholders is recommended to provide physicians with the patients' biometric information. Furthermore, providing education and training for medical staff should be considered to increase the awareness of the necessity and usefulness of the health behavior among physicians. Health behavior information as part of the health promotion will help to prevent health complications.

Third, appropriate programs and strategies should be developed to adapt digital healthcare services for older adults and ensure their usefulness and ease of use for continuous dissemination. Furthermore, further efforts will be needed to observe the objective effects of the implementation of the new technology and promote it.

4.1 Limitations

The study has several limitations. First, the study sample may be biased as about 70% of survey participants were recruited using the snowballing method, and 74.1% of the respondents reported an absence of the experience providing ICT-based healthcare services. Future research should be based on the random sampling method and better represent the entire population of primary healthcare physicians. Second, analyses of the dissemination of digital healthcare services were based on the diffusion of innovation theory and a more in-depth study is necessary for policy development and technology dissemination. Third, only the relationships between the perceived necessity of digital healthcare services and experience of using ICT-based healthcare services, personal

innovativeness, and social-demographic characteristics were analyzed. Further analyses are needed to evaluate other factors related to the adaptation new technologies.

V. Conclusion

This paper illustrates the need for digital healthcare services among physicians aiming to provide enhanced care to older adults, and physicians' priority in the dissemination of the innovations. Among the suggested five types of digital healthcare services the lowest demand was noted for telemedicine, while EHRs were in the highest demand. Physicians' priority in the dissemination of innovation was most focused on compatibility and complexity. Therefore, the physicians may view providing EHRs services as more convenient for the patients and less complicated as EHRs may be operated by more hospital staff.

In summary, our results explored physicians' awareness of the digital healthcare services and the demand for services they need in daily practice. We hope that the current study will provide a direction for the continuous development of policy and strategy to introduce appropriate digital healthcare services for the improvement of Korean healthcare services delivery. Despite the fact that the Korean government introduced the Korean New Deal program which supported the introduction of telemedicine, our study illustrated the necessity for other digital healthcare services above that for telemedicine. These findings should be taken into consideration in future healthcare services design.

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