

Suggestions for the Development of Telemedicine in Mongolia: Reviewing Development History of Telemedicine in the Republic Of Korea

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Objectives: This study reviews the history of telemedicine in Korea and presents future directions for telemedicine. **Methods:** Journal papers, reports, and government publications on telemedicine were collected and reviewed as technological advances sequenced in chronological order. **Results:** Development of telemedicine in the Republic of Korea was promoted by revising medical law in 2003 and introducing broadband internet services in 1999. **Conclusion:** For the success of the introduction of telemedicine, financial support has become the key to ensuring stable operations. Telemedicine services must be suitably priced, which calls for revisions to related legal and administrative policies.

Keywords: Telemedicine, Remote Consultation, Telecommunications, Delivery of Health Care, Health Policy

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Introduction

According to the European Hospital Survey (2014) of 28 EU Member States, telemedicine with other physicians has been implemented in 31% of the hospitals surveyed while telemedicine with patients has been implemented in only 13%

[1]. On the other hand, the Health Insurance Review Agency found that telemedicine has been implemented in less than 2% of hospitals in Korea [2].

Telemedicine with other physicians was prohibited in Korea before the revision of the Medical Service Act in 2003. While the revised Act permitted telemedicine to a greater degree and

led to many related projects, telemedicine is still not widely implemented in hospitals. Regardless, extensive research has been conducted on this topic. Physicians and citizens are showing a growing interest in telemedicine, especially in terms of improved patient accessibility to medical services, the timeliness of medical services, and reduced costs in visiting medical institutions. The Korean government has decided to expand the existing practice of physician-physician telemedicine, and a pilot project for patient-physician telemedicine is now underway. The Korean Medical Association and many physician organizations in Korea have opposed telemedicine, claiming that it will worsen medical circumstances such as lowering the medical fees and ruining the medical delivery system. The physicians themselves have yet to reach a consensus, with some groups supporting remote patient monitoring known as ubiquitous-Health (u-Health).

Mongolia is a country with a very different medical environment compared to Korea. The low population density, arising from a vast land and small population, has resulted in poor accessibility to medical services. This is where telemedicine can prove to be most effective. Against this backdrop, this study reviews the history of telemedicine in Korea and presents possible future directions for telemedicine.

Review of Telemedicine in the Republic of Korea

1. Telemedicine not permitted by medical law before 2003

The first incidence of telemedicine in Korea occurred in Yeonchun County Health Center and County Hospital and Seoul National University Hospital in 1988, but no records remain [2]. The first recorded case of telemedicine was performed in October 1990 between health centers, country hospitals, and tertiary hospitals over a public switched telephone network (PSTN) via a 9600 bps modem. The hospitals involved were Yeonchun County Health Center and County Hospital, Seoul National University Hospital (SNUH), Hwachun County Health Center and County Hospital, Hallym University Chuncheon Sacred Heart Hospital, Uljin County Health Center and County Hospital, and Kyungpuk National University Hospital. The project, however, was terminated in September 1991 due to poor transmission speed and technical issues [2, 3].

With the government-led establishment of an ultra high-speed information and communications infrastructure, plans were developed for remote informatization in rural areas. A telemedicine system was implemented over a T1 network (1.544Mbps) between Gurye County Health Center and County Hospital and Cheonnam National University Hospital, and between Uljin County Health Center and County Hospital and Kyungpuk National University Hospital. Accordingly, fees were introduced for remote consultations and remote image inspections [3, 4]. Telemedicine between Uljin County Health Center and County Hospital and Kyungpuk National University Hospital reached a peak with 585 cases of image inspections and 236 remote consultations in 1995, but fell to 61 image inspections and 0 remote consultations in 1997 [5]. In 1995, a telemedicine system for secondary opinion was established between Samsung Medical Center and Johns Hopkins Hospital [4]. This is the first instance of a system set up to obtain secondary opinions from a medical institution outside of Korea.

Many telemedicine systems were implemented, but failed to achieve visible results. The primary reason was that PSTN networks had a maximum speed of 14,400 bps, and the standard for 56 Kbps high-speed modems was adopted in 1999. Exclusive lines capable of high-speed transmissions were too costly to acquire. Although the speed improved to 128 Kbps with the introduction of integrated services digital networks (ISDN), these networks were still insufficient for telemedicine video conferencing.

To overcome technical issues related to the network bandwidth, several projects were carried out without real-time considerations. Among these projects, one interesting case is the home fetal heart rate monitoring device implemented by the Department of Obstetrics and Gynecology, SNUH in December 1995. Under this system, non-stress tests were conducted in households, and physicians provided feedback to mothers based on the data retrieved. This was the first time a monitoring device was utilized for telemedicine [4, 6].

The Home Health Service (HHS) system, implemented by the Gwachun City Health Center from October 1, 1998 to May 31, 1999, used laptops equipped with 33.6Kbps modems to provide health services for general households. The system is said to have achieved fairly satisfactory results [7]. For three months beginning in January 1999, Goyang Community Mental Health Center (CMHC) provided telemedicine services over an ISDN

network for schizophrenia patients, and attained reliability and acceptability levels comparable to that of face-to-face treatment [8]. While the telemedicine trial for psychiatric patients focused on video consultation, Gangwon Province implemented a more general telemedicine system in December 2000 for its 16 public health centers. However, this system faced various problems such as demands that could not be met with the technical standards of that time, the use of a Doppler monitor as a stethoscope, and the unsatisfactory performance of the ISDN network for real-time telemedicine video conferencing (Figures 1, 2, 3) [9].

Most of the telemedicine-related studies and pilot projects described above conducted before 2002 stopped at the Research and Develop (R&D) stage.



Figure 1. Telemedicine system at a health center in Korea in 2002.



Figure 2. Telemedicine system at a health post in Korea in 2002.



Figure 3. Doppler device supplied as electronic stethoscope for telemedicine system in 2002.

2. Telemedicine recognized by the revised medical law in 2003

Previously, telemedicine had to be performed over a PSTN modem with a maximum speed of 56 Kbps, an ISDN network up to 128 Kbps, or exclusive lines that were too costly to acquire. In 1999, a proper network environment began to be established with the introduction of 8 Mbps digital subscriber line (DSL) technology and internet access via cable TV networks. Wireless networking was also made possible in 1998 with the launch of wireless data communication services over the Code Division Multiple Access (CDMA) network. The growing demand for the legalization of telemedicine led to revisions in the medical law. Following the approval of physician-physician telemedicine under the revised law in March 2002, research and pilot projects on telemedicine were actively carried out.

3. Successful cases of telemedicine

3.1 Telemedicine in emergency medicine

In emergency medicine, telemedicine is the most widely used in pre-hospital emergency medical systems (EMS) and between hospitals. Electrocardiograms (ECG) of acute myocardial infarction patients were sent to hospitals during the pre-hospital stage, so as to provide treatment for patients within the golden time [10, 11]. This was implemented several times in Seoul, Gangwon Province, Seongnam, and Goyang in Gyeonggi Province, but was less effective compared to foreign countries due to the shorter transport time to hospitals.

Another project involved the sending of patient records from emergency vehicles to the target hospital [12]. This was difficult because of the short transportation time and inconvenience of document preparation during transportation. In 2009, a system was developed to provide medical guidance for paramedics on the scene. This system, in which paramedics obtained telemedicine guidance via information technology (IT), proved effective in the emergency treatment of patients [13].

Telemedicine systems were also developed for offshore patients, who have limited access to medical services unlike those on land. In 2004, Cho et al. reported on the successful use of telemedicine in instructing the suture of an offshore patient's finger [14]. Park et al. also verified the effectiveness of telemedicine for offshore locations [15]. In 2014, Kim et al. reported on the usefulness of telemedicine guidance by Busan's Fire Safety Headquarters [16].

Cooperative consultation between hospitals was studied for emergency situations to resolve the imbalanced distribution of medical professionals [17, 18], but did not go beyond the experimental stage. Later, more success was seen with the advancement of IT. One of the more recent studies was by Kim et al. in 2015, in which a smart ultrasound device was used for the remote diagnosis of a patient suspected of having appendicitis [19]. The results were comparable to that of on-site expert-performed ultrasound.

As mentioned above, research on the telemedicine for emergency medicine has covered various areas, including EMS and inter-hospitals, small-sized hospitals and large-scale hospitals, and communication between novices and experts. Despite the substantial efforts, it is only in recent years that telemedicine has seen some success.

3.2 Telemedicine for the medically vulnerable patients

3.2.1 Regional-based approach

To resolve the problems of the telemedicine system implemented in public health care centers in December 2000, Gangwon Province established a new chronic illness telemedicine system on December 30, 2003 for 28 medical institutions (4 tertiary hospitals, 12 health centers, and 12 health posts) [9, 20, 21]. The project went through two rounds of expansion in 2006 and 2007, and transitioned to support a ubiquitous environment. It

has had a positive impact on managing chronically ill patients living in remote areas in Gangwon Province [9, 22].

A telemedicine project for the islands without doctors was launched in 2006 between Goheung County in Chonnam Province and Chonnam National University Hospital, and between Wando County in Chonnam Province and Chosun University Hospital. This was followed by Sinan County in Chonnam Province in 2007 [21]. Residents in islands without doctors had been concerned about their health and were satisfied with the new system. However, there were some problems including inaccuracy, lack of medical equipment and legal provisions, high costs, and difficulties of getting drugs in health posts [23].

3.2.2 Facility-based approach

In 2005, the Ministry of Justice introduced a physician-physician telemedicine system between medical officers of correctional facilities and medical professionals for the treatment of inmates. About half of all correctional facilities in Korea were involved [21, 24].

In 2007, a telemedicine and cooperative consultation system was launched for the military personnel of troops in remote locations. The system was implemented between the medical officers of troops and military bases, between military bases and infantry divisions, and between infantry divisions and the Armed Forces Medical Command [21, 24].

In 2009, telemedicine was implemented between Guarding Police at Dokdo, a remote island off the East coast, and the National Police Hospital to improve the accessibility of medical services and emergency management for Dokdo Guards, the residents of Dokdo, and tourists. A unique feature is that the island is exempt from the ban on physician-patient telemedicine law and the direct delivery of medicine to patients is prohibited under the Pharmaceutical Affairs Act [21, 24].

4. Telemonitoring

u-Health, short for ubiquitous healthcare, refers to healthcare or medical services that are provided regardless of time and place [25]. Since 2008, government agencies and local governments in Korea have actively engaged in the development of related technology and content as well as talent cultivation.

With a rapid increase in chronic illnesses, it has become difficult to manage one's health based solely on regular

hospital visits and self-medication. A telemonitoring system was developed by using smartphone to access biometric data (blood sugar, blood pressure, body weight) of diabetes patients in real-time and to use such data for observation and intervention [26].

Discussion

Wilson and Maeder categorized telemedicine into synchronous telemedicine and asynchronous telemedicine [27]. They are defined as follows: "Synchronous or real-time systems support immediate interaction, or at least response within a timeframe that all participating parties would find an acceptable period for them to wait (typically not more than a few minutes). Asynchronous or store-and-forward systems decouple the components of the interaction so that they can occur at different times (not usually defined ab initio) at the convenience of the participating parties." Synchronous telemedicine can be applied to intensive care, emergency medicine, and mental health, while asynchronous medicine can be used in wound care, teledermatology, and telepathology. Some fields like diagnostic imaging do not belong to either category.

Now that IT has advanced to a level adequate for implementing synchronous and asynchronous telemedicine, projects are constrained by the amount of funds available for establishing telemedicine systems. Since the budget is always a concern, budget acquisition and allocation can be considered as one of the most important factors in establishing telemedicine systems.

Telemedicine is expected to be highly useful in Mongolia, which has a low population density due to its vast land and small population. For the successful implementation of telemedicine in Korea, Kim et al. suggested four critical success factors for telemedicine [25]. First, there must be health insurance coverage. Second, medical laws related to telemedicine should be reorganized to account for accidents resulting from medical malpractice, equipment failure, or communication failure. Third, physician compliance in medical facilities must be enhanced. Lastly, medical sensors and devices for biomedical measurement must have improved accuracy and reliability, and a stable network should be acquired.

The aforementioned factors are all applicable to the case of Mongolia. Korea lacked a technical foundation in the early years

of adopting telemedicine, and this led to numerous technical feasibility studies. Now that technology is more advanced, financial support has become the key to ensuring stable operations. Telemedicine services must be suitably priced, which calls for revisions to related legal and administrative policies.

Synchronous telemedicine involves a significant amount of resources, not only for real-time technological implementation, but also in acquiring the necessary medical resources. Since asynchronous telemedicine can be implemented with relatively fewer resources, an effective telemedicine system can be established through adequate resource allocation.

Conflict of Interest

The authors state no conflict of interest.

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