A study on the development of local clinical decision support system (CDSS): How to make a Korean Watson?

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ABSTRACT

It is believed that all Korean hospitals should be provided with AI doctors free of charge. It is necessary to make a local Clinical Decision Support System (CDSS) like IBM Watson by country. The Korean Ministry of Health and Welfare should develop an artificial intelligence doctor such as IBM Watson and provide it as required to hospitals. How do we make a Korean-style Watson? I would like to suggest three ways. The first is to create a Clinical Decision Support System, such as IBM Watson, from a hospital's own clinical data. The second is that hospitals in one region or one country should cooperate to make CDSS. Third, hospitals utilizing global CDSS, such as Watson, have already developed a new CDSS through their clinical database. In this paper, I claim that the third method is the best.

Key words: AI doctor, IBM Watson, clinical decision support system, the need for local CDSS, a guideline for making local AI doctor, Korean Watson.

INTRODUCTION

Hospitals in Korean metropolitan areas have many patients. However, IBM introduced Watson in hospitals outside the metropolitan areas. As a result, patients did not go to the Big Five hospitals in the metropolitan areas and started looking for a hospital that had introduced Watson (Big Five Hospital, 2017). A change has occurred in the Korean medical community. This is the first time that a large number of patients are rushing to Kacheon-gil Hospital, which introduced Watson in Korea. And there was a change in the hospital. Korean hospitals are experiencing an abundance of authoritarian culture, which has begun to crack. The patients tried to follow Dr. Watson's prescription among the prescriptions provided by the human doctor and Dr. Watson. The tendency of these patients has made doctors nervous. But the latest data released by Gacheon-gil Hospital, which has been a year since Watson’s inception, showed that patients did not follow Watson as a result much compared to early introduction. Apart from the patients' response, Korean patients accept only about 50% of Dr. Watson's prescriptions (American Society of Clinical Oncology, 2017). This is because of Korea's unique characteristics. Therefore, Daegu Kyungpook National University Hospital decided to use its own data to develop clinical decision support systems (CDSSs). This is because Dr. Watson has been trained at an American hospital, and may even make a prescription that is not appropriate for Korean hospitals. This will not be the case in Korea alone. CDSSs like Watson will be developed in the future. It will be popularized in developed countries such as the United States and in less developed countries with relatively poor medical environments. But every country's medical environment is different. So the Global CDSS have to be transformed in a way that is compatible with each country’s health care system. How can we the most efficient CDSS be made? I want to find the answer to this question by examining the situation in Korea where IBM Watson, as a kind of Global CDSS, was introduced.

Classification of clinical decision support system (CDSS)

Varun et al. (2016) discussed the developmental stages of medical imaging technology using artificial intelligence in the light of the fifth stage of autonomous vehicle technology.
Table 1: CDSS and development model by technology stage.

<table>
<thead>
<tr>
<th>Levels</th>
<th>Development stages of autonomous vehicle technology</th>
<th>Development stages of artificial intelligence medical imaging technology</th>
<th>Global CDSS (Clinical Decision Support System)</th>
<th>Local CDSS development model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>No active control</td>
<td>Disease sign marking</td>
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<tr>
<td>Level 2</td>
<td>Assisted automated</td>
<td>Assisted medical imagery interpretation</td>
<td>MS MINE</td>
<td>One Hospital CDSS Model</td>
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<tr>
<td>Level 3</td>
<td>Semi-automated</td>
<td>Semi-medical imagery interpretation</td>
<td>(Microsoft Intelligent Network for Eye care)</td>
<td>Local Hospital CDSS Model</td>
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<td>Level 4</td>
<td>Highly automated</td>
<td>Highly medical imagery interpretation</td>
<td>IBM Watson</td>
<td>Local Hospital CDSS Model with Global Developed CDSS (like IBM Watson)</td>
</tr>
<tr>
<td>Level 5</td>
<td>Fully automated</td>
<td>Fully medical imagery interpretation</td>
<td></td>
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development. The recently developed CDSS (Clinical Decision Support System) programs are that IBM Watson, Microsoft Intelligent Network for Eye care (MINE), and Google's AI Eye Doctor. I think IBM Watson is the most famous CDSS in the world. Table 1 summarizes the current development of CDSS and deployment models in light of this step.

There are many Level 1 medical devices currently developed. As shown in Table 1, MS MINE (Microsoft Intelligent Network for Eye care), IBM Watson, and Google's AI Eye Doctor are major global CDSSs developed by applying deep learning in artificial intelligence to existing medical information big data.

### First steps to making an efficient CDSS

Administrative and financial support from the government will be required for developing countries to create their own CDSS for promoting the health of the people, in contrast to developed countries such as USA that have hospitals with huge capital and are thus self-sufficient. CDSS also requires additional factors for implementation.

### Financial and policy support for medical big data

The governments can prepare two plans for helping the doctor's diagnosis for the health of the people to develop a CDSS that is appropriate for the healthcare environment of their country. First, a Common Chart Form and a Patient Care Improvement Program; second, demonstration of a detailed chart creation project. The government have to also support medical clinical data. In underdeveloped countries, clinical charts are inadequate as compared with those in developed countries. Applications like Google's AI Eye Doctor can make a CDSS associated with the disease if the imaging data and terminology are completely consistent with respect to a particular disease (Jeong et al., 2017). However, not all diseases have standardized imaging data and terminology. We can make better CDSS with more detailed charts. Next, we need to provide standards and tools that can make the standardized charts into unified digital material within the country.

### Improvement of personal information protection in the medical field

Personal information protection in Korea is very strong. Even if we try to use it for an ethical purpose, the rules of the Korean medical industry makes it impossible. This is where the culture of communication is lacking in the medical community. Two things are needed to develop an open CDSS. First, the way of consent have to change from opt-in to opt-out. Second, an anonymization plan for subsequent medical studies should be established so that Connection keys as a connection point that links information from previous studies and subsequent studies are not removed. A regulatory free zone should be designated and prepared if a specific area or university or hospital meets the requirements, including a regulatory officer in charge of 24-hour consultation and responsibility.

Now, I will take a closer look at the rules of Korea. Korea has a strict privacy policy. Medical or biotechnological research in South Korea should be in accordance with the Personal Information Protection Act and the Bioethics and Safety Act. Korean Personal Information Protection Act Article 15(Collection and Use of Personal Information) defines as follows: A personal information controller may collect personal information in any of the following circumstances, and use it with the scope of the purpose of...
collection: 1) Where the consent is obtained from a data subject; 2) Where special provisions exist in laws or it is inevitable to observe legal obligations; 3) Where it is inevitable so that a public institution may perform the duties under its jurisdiction as prescribed by statutes, etc.; 4) Where it is inevitably necessary to execute and perform a contract with a data subject; 5) Where it deems necessary explicitly for the protection, from impending danger, of life, body or economic profits of a data subject or a third party in case that the data subject or his/her legal representative is not in a position to express intention, or prior consent cannot be obtained owing to unknown addresses; 6) Where it is necessary to attain the justifiable interest of a personal information controller, which is explicitly superior to that of a data subject. In this case, it is allowed only when substantial relation exists with the justifiable interest of the personal information controller and it does not go beyond the reasonable scope. In addition, the Personal Information Protection Act may be provided or shared if the consent of the subject has been obtained from Article 17 to a third party. It is made possible using the personal data for research that Korean Personal Information Protection Act (1), (2), (3) and (5) of Article 15. Korean Personal Information Protection Act Article 18 (Limitation to Out-of-Purpose Use and Provision of Personal Information) is as follows: 1) A personal information controller shall not use personal information beyond the scope provided for in Article 15 1), or provide it to any third party beyond the scope provided for in Article 17 1) and 3). 2) Notwithstanding paragraph 1), where any of the following subparagraphs applies, a personal information controller may use personal information or provide it to a third party for other purpose than the intended one, unless it is likely to infringe on unfairly the interest of a data subject or third party: Provided, That subparagraphs 5 through 9 are applicable only to public institutions: 1) Where additional consent is obtained from the data subject; 2) Where special provisions exist in other laws; 3) Where it deems necessary explicitly for the protection, from impending danger, of life, body or economic profits of the data subject or third party in case that the data subject or his/her legal representative is not in a position to express intention, or prior consent cannot be obtained owing to unknown addresses; 4) Where personal information is provided in a manner keeping a specific individual unidentifiable necessarily for the purposes of statistics and academic research, etc.; 5) Where it is impossible to perform the duties under its jurisdiction as provided for in any Act unless the personal information controller uses personal information for other purpose than the intended one, or provides it to a third party, and it is subject to the deliberation and resolution of the Commission; 6) Where it is necessary to provide personal information to a foreign government or international organization to perform a treaty or other international convention; 7) Where it is necessary for the investigation of a crime, indictment and prosecution; 8) Where it is necessary for the court to proceed the case; 9) Where it is necessary for punishment, and enforcement of care and custody. Article 43 2) of the Bioethics and Safety Act is fundamentally preventing the use and provision of personal information under Article 18 (Limitation on the Use and Provision of Personal Information for Purposes) of Personal Information Protection Act. In accordance with Article 43 (2) of the Bioethics and Safety Act, the head of the Bank of Human Origin cannot be offered the resource plan only through the use plan. There is no more precise examination on how the privacy law and the life ethics and safety law in South Korea cannot use personal information in research. However, I want to stress that the Privacy Act and the Bioethics Act regulate many things when conducting life-medical research in Korea. As compared to Korea, Japan is relatively easy to develop CDSS. Because in the medical field, Korean consent is basically opt-in, and even if anonymous, personal information is still personal. In contrast, I know that Japan’s type of consent in medicine is opt-out. And Japan does not regard anonymous personal information as personal information. Japan does not view personal information anonymized through revision in 2014 as personal information. Each country's privacy policy will be different, but in order to develop the CDSS for public interest, it is necessary to change the relevant legislation so that health information for big data can be prepared. Thus, it is easier for Japan to develop its own CDSS using an anonymous personal information database than Korea. As such, the most important requirements for CDSS development are social consensus on social use of personal information and preparation of legal mechanisms.

Analysis by type of development model

**Hospital CDSS model: Kyungpook National University Hospital**

This is the case of Kyungpook National University Hospital (KUH). Dr. KUH like Alphago (Google’s AI program), who is being promoted by Kyungpook National University Hospital, analyzes and infers vast amounts of medical books, papers, and AI medical records, as well as the medical records of Kyungpook National University Hospital, when a physician connects to the program and enters patient information. The results are reviewed by a multidisciplinary team of experts from various fields and applied to patient treatment. Kyungpook National University Hospital will begin by suggesting the treatment method of chemotherapy to various cancer patients such as Dr. IBM Watson, which is developed by itself. It will be expanded to reference materials for diagnosis and prevention of other major diseases. In addition, if a partner hospital is under consideration for the support for implementation of the program, the quality of medical care will be greatly improved at the partner hospital. It is said
that Kyungpook National University Hospital is trying to establish a Korean-type AI doctor like IBM Watson, because Watson is not suitable for Korean medical domestic situations. Professor Kim Jong-Kwang of the Chilgok Kyungpook National University Hospital said, "IBM Watson is not realistic because it does not consider domestic medical insurance at all and suggests expensive cancer drugs." (Jeong et al., 2017). In Korea, there is a lot of stomach cancer and cervical cancer, but in the United States, cancer is relatively less prevalent, so there is no other way in cancer treatment before and after cancer surgery." According to Chung Ho-young, director of the hospital, "Kyungpook National University Hospital will be able to develop the Korean version of AI Doctor Alphago(CDSS), which exceeds Watson's capabilities. Now, we need to create our own digital healthcare platform and spread it overseas (YeongnamIlbo, 2017a)."

This model will digitize the existing data of a hospital to create a database and analyze it to create a medical diagnosis algorithm. As compared to the cost of developing IBM Watson for Oncology, its development cost is less, but there is a shortage of data. Figure 1 is designed from a newspaper article about Kyungpook National University Hospital's own CDSS development. The CDSS model of Kyungpook National University Hospital, summarized and added to my advantages and disadvantages, is given in Figure 1.

Local hospital CDSS model: Korea CDSS network

Among Korean hospitals, six hospitals, including Gachon University's Gil Hospital, Pusan University's Hospital, Daegu Catholic University's Hospital, Keimyung University's Dongsan Hospital, Gunyang University's Hospital, and Chosun University's Hospital, launched the Artificial Intelligence Healthcare Consortium. These hospitals jointly asked the Korean government to cover expenses for providing patients with artificial intelligence and build a big data platform that can exchange medical information between IBM Watsons in Korea. The consortium consists of: 1) a steering committee to expand Watson's coverage in Korea, 2) a Clinical Activation Committee to request treatment fees through monitoring clinical conditions, and 3) a Big Data Committee to establish and share a clinical data platform (YeongnamIlbo, 2017b). These are advantages and disadvantages, and are shown in Figure 2.

Local hospital CDSS model: Korean CDSS network with IBM Watson

The hospitals that have introduced Watson into Korea share a database of the materials they have prescribed through Watson. The algorithm is created by analyzing this database with the deep running method. I think this model is the best. The algorithm developed with this model will be called the KCN (Korea CDSS Network) Watson (Figure 3). Problems may occur in the form of questions about who owns KCN(Korea CDSS Network) Watson, what needs to be developed, and whether all hospitals in Korea will have access. As mentioned earlier in this study, the artificial intelligence doctor will be developed should be for all patients if possible. So I think that it is right for the South Korean government to develop and own the artificial intelligence doctor. In particular, there is need to create an artificial intelligence doctor program for patient data. Only Korean patients’ clinical big data will make the Korean AI Doctor like IBM Watson. As mentioned earlier in this study, it allows the use of personal information for the public good as indicated in Korea's the Personal Information Protection Act and the Bioethics and Safety Act.

Korean AI doctor program like Watson for oncology development scheme

Figure 4 is a schematic of KCN Watson's development. Let us take a quick look at possible questions and challenges for Korean Watson development. Can all hospitals use the KCN Watson? Who needs to develop it for use by all Korean
Figure 2: Hospital CDSS model: Kyungpook National University Hospital.

Figure 3: Korean CDSS Network with IMB Watson.

Figure 4: Local hospital CDSS Model with IMB Watson: Korea CDSS network.
hospitals? I think the government should develop. This is because it is good for the state to own the CDSS in order to help doctors’ diagnosis free of charge in every hospital in a country. Who owns KCN Watson? It does not belong to IBM. It will not belong to each hospital. Because it was anonymized through consent, it would not belong to the patients. Perhaps if the government develops it will belong to them. There are many problems surrounding ownership; this is discussed hereafter.

If this method is used to create a Korean style artificial intelligence doctor, it will use Deep Learning method twice. And this method uses a lot data than any other method. This method of development of artificial intelligence doctors uses both Dr. Watson, which was developed in the U.S., and clinical data from Korea as a method of deep learning. To develop KCN Watson, we have to publicize it in Korean society. We need to share database information from hospitals that use the Watson service. Standard guidelines are required for sharing. To do this, the government has to provide financial and administrative support. Thus, I hope that the government will be able to see the results and benefits in Korean patients.

Conclusion

It is necessary (1) to prepare a huge medical data, (2) to amend personal information protection in the medical field, and (3) to cooperate in the medical field. When preparing medical big data, how much Korean medical science should be changed? First of all, Koreans should not go to the clinic for only three minutes so that we can create rich charts, but this is not possible at the Big Five hospitals in Korean metropolitan areas. Visiting any of the Big Five hospitals for merely a few minutes will not yield sufficient medical big data to create rich medical charts. Second, in order to get medical big data, we have to digitize existing data, which requires considerable labor. What will be the labor cost of this labor force? Pass it over to passion? Will the state support it? Will individual companies be able to afford it? Is it easy to use data from Korea's EMR (electronic medical record) and the existing HIRA (Health Insurance Review and Assessment Service). All will potentially be difficult. This should be done under water. Finally, there is no realistic mechanism for harmonizing personal privacy and public interest since the guidelines are ambiguous.

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