Hitachi's Plans for Healthcare IT Services

Masaru Morishita
Kenichi Araki
Koichiro Kimotsuki
Satoshi Mitsuyama

OVERVIEW: The soaring cost of healthcare has become a problem for developed economies in recent years as their populations age. Costs are also rising fast in emerging economies where one of the side effects of better living standards is an increase in the incidence of lifestyle diseases. In Japan, meanwhile, based on programs that are unlike those found anywhere else, measures are being adopted for the various stages of healthcare, which include prevention and health management, treatment, and nursing. The measures are characterized by the highest levels of quality and the increasing use of IT. However, less progress has been made on providing cross-disciplinary services that span different programs, and on making good use of the information generated by the individual services. In response, Hitachi is working on the global deployment of healthcare IT services developed in Japan, and on looking into services that utilize various types of information.

INTRODUCTION

WHILE facing the prospect of a very large population of elderly people, Japan has also over recent years maintained its position as the nation with the longest life expectancy. It's healthcare expenditure as a proportion of gross domestic product (GDP), on the other hand, is 9.5% (in 2011), placing it 16th in the Organisation for Economic Co-operation and Development (OECD)[1]. This indicates that healthcare services are delivering a high level of cost-performance, which can be seen as a result of various preventive, health management, nursing, and other programs such as medical checkups for mothers and children and medical checkups for school children.

While the philosophy behind these healthcare services is coming to be appreciated outside Japan, various differences of approach in areas like lifestyle, education, and values mean that these programs or services have often failed to catch on when transplanted to other countries. In Japan, meanwhile, while services extend from prevention and health management to treatment and nursing, little progress has been made on integrating the operation of these services across different programs.

Recognizing this situation, Hitachi is focusing on the data generated at each stage of healthcare services and looking into new service businesses that operate by integrating this data.

This article uses the example of a healthcare information technology (IT) project in the UK to describe the services currently under consideration and the technology developments that they will require.

HITACHI PROJECT IN UK

Current Situation and Challenges Facing Healthcare in UK

Greater Manchester county, the site of Hitachi's proposed joint development project in the UK, is made up of 10 cities, including Manchester and Salford, has a population of approximately 2.6 million, and is located about 300 km north-west of London, the capital of the UK.

Like other developed economies, how to care for the increasing number of people with chronic illness is a major issue for the UK. However, it lacks any obligatory preventive measures similar to Japan's health check programs. Instead, each region runs their own voluntary programs, including Greater Manchester. Nevertheless, they share many points in common with Japan, with the questions of how to improve the overall quality of healthcare and cut costs posing major challenges.

Although the UK has the National Programme for IT (NPfIT), which is operated on a top-down basis by the National Health Service (NHS) and includes the management of appointments and the sharing of clinical information between health providers, it has been unable to deliver adequate benefits, having yet to be fully adopted in the field apart from certain functions such as the sharing of basic patient information that have entered widespread use. Recognizing these failings, work is now proceeding at the regional level on measures for the sharing of clinical information between local healthcare providers in the form of bottom-up programs that take note of the views of doctors on the ground.

Project Overview

NHS Greater Manchester (NHS GM)[*1], the Manchester Academic Health Science Centre (MAHSC)[*2], and NorthWest EHealth (NWEH)[*3] are establishing a healthcare IT environment for Greater Manchester that is centered in Salford and based around a secure medical data sharing system that is designed to ensure privacy. Hitachi has been involved in this project since April 2013 and is participating in studies.

Salford already has a network for the sharing of medical data between general practitioners (GPs). The connection of the above medical data sharing system to this existing network makes it possible to control access to data based on patient consent and other factors. This function for sharing highly confidential medical data between healthcare providers is vital if healthcare professionals are to be able to use the system with confidence. In addition to allowing for the future expansion of data sharing through the connection of other existing networks outside Greater Manchester, potential applications for the system extend beyond providing coordination between healthcare providers, and include such areas as medical research.

The medical data sharing system also has potential for providing even greater value by adding functions for the repurposing of data within a secure and privacy-protecting environment and by allowing for the addition of applications that deliver a variety of different services. Hitachi believes that it can make a significant contribution to the project by drawing on the healthcare know-how and core technologies it has built up through its past experience, primarily in Japan, and by taking responsibility for developing these additional functions.

Hitachi's Involvement

Hitachi is currently involved in the following three areas.
(1) Use of IT in measures to prevent or manage lifestyle diseases such as diabetes.
(2) Development of primary functions based on use cases that are directly relevant to the needs of

healthcare workplaces that use the medical data sharing system.
(3) Improvements across all healthcare processes aimed at cutting costs while maintaining the quality of healthcare delivery.

While these objectives are currently being pursued independently, the aim is to combine (1) and (3) by implementing them together on the medical data sharing system being developed through (2).

Project Goals

Unlike past solution services that introduced IT to deal with immediate requirements, a major feature of this project is its objective of establishing and operating new services while also identifying needs in collaboration with partnerships between industry, government, and academia that have a leading role in local healthcare.

In addition to developing services for the residents of Greater Manchester, the aim for the future is also to take the service model and technologies created in Greater Manchester and deploy them not only elsewhere in the UK, but also in Japan and other countries.

RESEARCH AND DEVELOPMENT OF TECHNOLOGIES THAT UNDERPIN SERVICES

Value to Customers of New Businesses

The businesses currently under consideration by Hitachi, such as the UK project described above, supply new value to users at each system layer, namely (1) data collection, (2) use of collected data, and (3) services that use this data (see Fig. 1).

Specifically, the objectives for each layer are to provide, (1) a safe, secure, privacy-protecting and reliable data collection platform, (2) functions for extracting, analyzing, and correlating that simplify the use of complex healthcare data, and (3) disease prevention services that both improve quality of life (QOL) and control costs and services of use to product development by pharmaceutical or food companies.

To deliver this value, Information & Telecommunication Systems Company of Hitachi, Ltd. is working jointly with its Central Research Laboratory and Yokohama Research Laboratory on the research and development of the required technologies.

The following sections describe some of the technologies that Hitachi is considering using in these services.
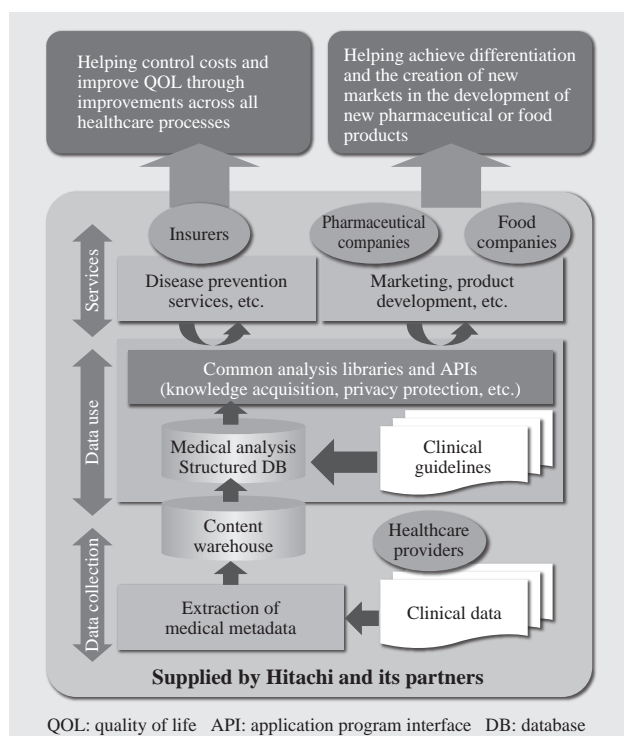
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*1 The UK's NHS aims to provide everyone with a uniform level of healthcare services. NHS GM is the coordinating body for the 10 clinical commissioning groups in Greater Manchester.
*2 A consortium made up of The University of Manchester and healthcare providers in Greater Manchester. Plays a leading role in healthcare research in the region.
*3 A non-profit organization (NPO) set up by The University of Manchester and healthcare providers in Greater Manchester. Handles the development and operation of software for Greater Manchester.

Fig. 1—Three-layer Model of Healthcare IT Services.
Hitachi supplies the new value required by the healthcare sector through the layers of, (1) data collection, (2) data use, and (3) services.

k-anonymization

In a variety of fields, collected data is coming into use for secondary purposes such as analysis. This data repurposing requires data to be anonymized so that individuals cannot be identified to protect privacy. Normally this is done using simple anonymization techniques such as the deletion of information that could be used to identify someone, such as their name and address, or the replacement of these fields with random numbers or text. However, because healthcare data may include details of rare health conditions, for example, the combination of a small number of data fields can still potentially be enough to identify people, even from data that has been subject to this simple anonymization. To deal with this problem, interest has turned to a technology called "k-anonymization" that modifies data such that, when a conditional search is performed based on a number of fields, the result always returns at least a minimum number (k) of matches.

The k-anonymization technique being developed at the Yokohama Research Laboratory has the following characteristics[2].

(1) Reduced information loss through application of data compression theory

(2) Configuration based on distributed anonymization to support scaling out

Because it requires the introduction of a degree of vagueness to the data, this loss of data accuracy is a downside of k-anonymization. However, the above reduction in information loss acts to counter this problem. The other characteristic of good scalability means that system configurations can cope flexibly with different quantities of data.

Graph-based Clinical Repository

Because clinical data has a large number of different fields, with factors such as tests and symptoms varying from patient to patient, the data sets tend to be sparse with many missing values. Furthermore, even when patients have the same disease, the potential presence of underlying conditions or complications for each case is different. In addition to these characteristics of clinical data, because many case analyses need to be performed in ways that take account of the time sequence patterns for complex medical practices, the analysis of clinical data has traditionally required a lot of time and effort.

To make the analysis of clinical data more efficient, Hitachi's Central Research Laboratory is currently developing a technology to construct graph-based clinical repository. Its features are as follows.

(1) Clinical data is represented using graphs.

(2) Clinical semantic relations between medical conditions and diagnosis or treatment are added based on medical knowledge.

A graph is a way of representing data as nodes and edges, where the edges link the nodes together. In this case, the nodes represent clinical events (such as diagnosis or treatment) and the edges represent the time relationships (elapse of the time) between events. Expressing complex clinical data in this way simplifies the analysis of time sequence patterns. Also, because automatically adding semantic relations between medical conditions and diagnostic or treatment actions allows interpolation of any parts of the data that are missing, it is possible to automate the task of preparing data for analysis, something that in the past needed to be done manually by someone with medical knowledge.

Disease Prevention Support Technologies

Central Research Laboratory of Hitachi, Ltd. has developed an IT system to support Hitachi's own diet program, which is operated by the Hitachi Health Care Center and boasts a high success rate. In 2009,
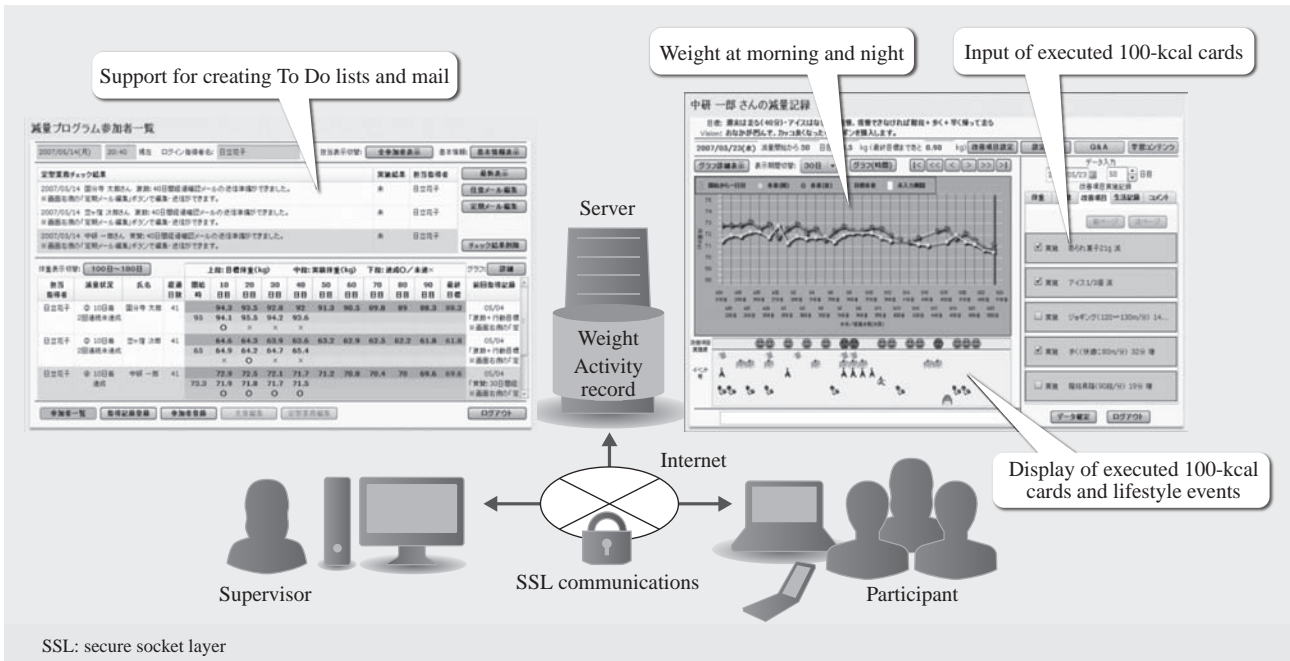
Fig. 2—Structure of Hitachi's Cloud-based Healthcare Support Service.
The diet program sets targets for reducing calorie intake in 100-kcal increments. The system records daily progress and weight, and helps public health nurses provide guidance.

Information & Telecommunication Systems Company of Hitachi, Ltd. launched a cloud-based healthcare support service that uses this IT system (see Fig. 2).

Further research was then conducted on utilizing the diet program for the prevention of diabetes and its effectiveness confirmed. As diabetes is one of the reasons for ballooning healthcare costs in developed economies, Hitachi believes that diabetes prevention is an example of the sort of much-needed service that can keep these costs down.

CHALLENGES AND FUTURE PLANS
International Initiatives for Repurposing of Medical Data

To facilitate the repurposing of medical data, countries are establishing regulations for the protection of privacy and adopting measures that encourage the use of this data.

In the case of electronic health records (EHRs), different countries are proceeding differently depending on their circumstances, with the two main approaches being the establishment of decentralized EHRs at the level of states or healthcare groups, as in North America, and the centralized, government-driven approach to establishing EHRs being adopted in Europe. Similarly, the adoption of national or medical identifications (IDs) for identifying individual citizens is also proceeding differently in different countries.

Name-matching and other similar technologies are required in cases where these IDs are not present.

US System for Handling Medical Data

In the USA, stipulations for the handling of medical data are contained in the Health Insurance Portability and Accountability Act of 1996 (HIPAA). The HIPAA permits the use and disclosure of medical data for purposes such as sales and marketing if it has been anonymized.

The requirements for anonymization are specified in detail, with the following two criteria stipulated for assessing anonymization.
(1) Whether, in the judgment of an expert in statistics, the risk of identifying an individual is very low.
(2) Whether the specified 18 attributes have been masked (information that could be used to identify individuals).

In addition to data anonymization, as in the case of anonymized information, use and disclosure without the permission of the person concerned is permitted in the case of data sets in which the available data is restricted, but in this case the data can only be used for the purposes of research, public health, or healthcare operation. Although recent amendments to HIPAA indicate moves toward making restrictions on data handling more severe, such as restricting the use of medical information in areas like sales and marketing,

overall the general trend is expected to be toward encouraging the utilization of data.

While countries outside USA, such as Japan or the UK, do not currently specify rules to the same level of detail as the HIPAA does for things like how to perform anonymization, it is anticipated that each country will enact their own requirements as more use is made of medical data in the future.

CONCLUSIONS

This article has used the example of a healthcare information technology (IT) project in the UK to describe the services currently under consideration and the technology developments that they will require.

Delivering the services described in this article will require safe, secure, privacy-protecting, and reliable healthcare cloud platforms that comply with the rules on handling medical data that apply in each country. Hitachi is seeking to establish services for things like disease prevention, process improvement, and support for drug development that can be delivered on these platforms.

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ABOUT THE AUTHORS

Masaru Morishita
Healthcare Business Department, Smart Information Systems Division, Information & Telecommunication Systems Company, Hitachi, Ltd. He is currently engaged in the development of services based on the utilization of healthcare information. Mr. Morishita is a Project Management Professional (PMP) and a member of the Japan Association for Medical Informatics (JAMI).

Kenichi Araki
Healthcare Business Department, Smart Information Systems Division, Information & Telecommunication Systems Company, Hitachi, Ltd. He is currently engaged in project management in the Manchester area of the UK. Mr. Araki is a Project Management Professional (PMP).

Koichiro Kimotsuki
Healthcare Business Department, Smart Information Systems Division, Information & Telecommunication Systems Company, Hitachi, Ltd. He is currently engaged in the planning and development of a platform for the utilization of healthcare information. Mr. Kimotsuki is a Project Management Professional (PMP) and a member of the JAMI.

Satoshi Mitsuyama
Healthcare Business Department, Smart Information Systems Division, Information & Telecommunication Systems Company, Hitachi, Ltd. He is currently engaged in the research and development of technology for the utilization of healthcare information. Mr. Mitsuyama is a member of the Institute of Electronics, Information and Communication Engineers and The Society of Instrument and Control Engineers.