Using Healthcare Data Analytics to Create New Value

As laid out in the Health Care 2035 vision by Japan's Ministry of Health, Labour and Welfare and elsewhere, it is anticipated that a healthcare paradigm shift will come, from being evaluated based on the resources deployed to its management and assessment on the basis of outcomes aiming at further quality improvements in healthcare with cost control. A key element in achieving this outcome-based assessment of healthcare performance is the use of large quantities of healthcare data to analyze these outcomes. Against a background that includes the application of artificial intelligence to healthcare and the falling cost of genomic analysis in recent years, serious steps are now being taken toward putting healthcare big data to practical use, including initiatives aiming at implementing personalized medicine and predicting the likelihood of readmission to the hospital based on past healthcare data. This article reviews the current progress toward a future in which practical use is made of healthcare big data, also describing what Hitachi is doing with regard to the various healthcare stakeholders involved, including pharmaceutical companies, hospitals, and payers.

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1. Introduction

Against a background of ballooning healthcare costs due to the aging population and rising incidence of lifestyle disease, measures are increasingly being initiated aiming at reducing healthcare costs while improving quality to provide patients with a better balance of benefits and risks. Achieving this requires an assessment of the clinical outcomes of treatment or prevention, such as improvements in laboratory results or recovery rates. Moreover, the essential key to realizing these outcome assessments (cost/benefit analyses) is data analytics.

As the Ministry of Health, Labour and Welfare (MHLW) stated in its Health Care 2035[(1)] vision, a reorientation from assessment based on physical infrastructure, personnel deployment, and healthcare inputs to assessment based on the efficient use of healthcare resources and the outcomes is taking place.

This article describes the progress being made on the application of healthcare data and what Hitachi is doing in this field, primarily in Japan.

Table 1 — Examples of Data Generated by Actual Medical Practice

This data comes in vast quantities and diverse forms, building up over time and differing by patient and by the illnesses they suffer from.

Data	Description
Health insurance claims for medical fees	Itemized invoices that hospitals submit to payers for medical services provided to patients that are covered by health insurance
Health insurance claims for dispensing fees	Itemized invoices that pharmacies submit to payers for drugs dispensed to patients that are covered by health insurance
DPC	A payment system used in Japan for hospital treatment based on "comprehensive evaluation" (which includes the base fee for hospital admissions, tests, drugs, injections, diagnostic imaging, and so on) and "payment by results"
Electronic medical records	Medical records recorded by practitioners (including laboratory data and diagnostic imaging data)
Medical checkup	Results from health checkups conducted at schools by local government or other agencies, and regular health checkups performed by service providers
Specific health checkups/specific health guidance	Results of health checks and consultations with patients aged 40 or more aiming at preventing lifestyle diseases

DPC: Diagnosis Procedure Combination

2. Market Trends and Opportunities

2. 1 Potential for New Value

At this point in time, much of the interest in putting healthcare data to use is directed at the real-world data derived from actual care delivery. This includes health insurance claim data, Japan's Diagnosis Procedure Combination (DPC) data, electronic medical records, and data from medical consultations. Opportunities for the creation of new value lie in the analysis of large amounts of this data in its many different forms (see **Table 1**).

2. 1. 1 Pharmaceutical Companies

Past practice for data use at pharmaceutical companies has mainly involved the analysis for marketing purposes of data from sources such as drug wholesaling. There has also been a step up in the scope of data use over recent years with the addition of information from clinical practice, such as that contained in the electronic medical records maintained by hospitals. Examples include initiatives aiming at uncovering unmet needs when looking for new drug development opportunities, shortening the time taken for clinical testing by identifying which patients are best suited to participating in trials, and improving the speed and comprehensiveness of postmarketing surveillance (studies conducted after a drug goes on the market). Pharmaceutical companies are boosting their ability to engage in such activities by, for example, establishing groups dedicated to utilizing real-world data.

The MHLW is also supporting this trend on the regulatory side. The amended Good Post-marketing Study Practice (GPSP) directive (issued in April 2018) allows for the collection and collation of documents for submission based on postmarketing surveillance using healthcare databases. The intention is that this will make surveillance faster and more accurate by allowing information on drug efficacy and adverse events that in the past was collected manually by individual hospitals to instead be obtained from collected data.

2. 1. 2 Hospitals

Outcome-based healthcare systems are becoming more common around the world. In the USA, work is being conducted on optimizing cost-benefits by linking outcome assessment to systems for healthcare cost reimbursement, with Medicare-Medicaid public health insurance systems playing a leading role.

In Japan, outcome assessment at rehabilitation wards for recovering patients was introduced by the FY2016 revisions to healthcare cost reimbursement, with outcome assessment being further extended by the FY2018 revisions.

The accuracy of more advanced disease progression prediction and diagnosis support has also been improved by advances in technologies for the collection and analysis of large quantities of data, and it is hoped that this will reduce patient stress and enable the early detection of illness.

2. 1. 3 Payers

A major issue for payers is how to control rising healthcare costs while also maintaining and improving the health of the people they insure.

The Data Health Plan embarked upon by the MHLW in FY2015 calls for payers to formulate and implement plans for using the plan, do, check, act cycle to establish, operate, assess, and improve their insurance businesses based on the analysis of healthcare data. An incentive scheme for increasing the percentage of people getting health checks was introduced as part of measures for supporting the efforts of payers, providing institutional support for healthcare cost control measures such as avoiding medical conditions becoming more severe due to the person failing to visit a doctor.

Fukuoka City has worked with Hitachi to establish a system for collecting data on medical and nursing care that had previously been administered on an ad hoc basis both inside and outside officialdom. As the system can be used for such tasks as analyzing the current state of medical and nursing care costs, estimating what will happen with these in the future, and assessing current nursing care need certification for different medical conditions, it provides a way to utilize data in the medium- and long-term planning for medical and nursing care[2].

3. What Hitachi Hopes to Achieve

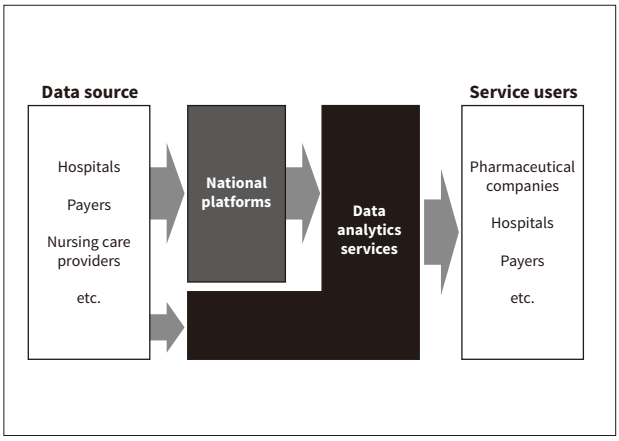
3. 1 Concept

Hitachi intends to contribute to reducing healthcare costs and improving quality by operating services that analyze healthcare data from a variety of sources, including national and local government, healthcare providers, and partner companies.

Likely users of these services include pharmaceutical companies, hospitals, and payers. In the case of pharmaceutical companies, the services will provide support for activities such as the use of databases for postmarketing surveillance or clinical trials, and new drug development involving the use of large quantities of data to develop therapeutic drugs for rare conditions with few cases. For hospitals, Hitachi is looking toward the use of advanced medical practices such as genomic diagnosis, the aim being to provide more effective treatments that have fewer side effects and impose less of a financial burden. For payers, the services will contribute both to improving the health of the people they cover and the financial performance of the insurer by analyzing data on medical services reimbursement and using this to intervene in ways that are tailored to individual circumstances. **Figure 1** shows a flowchart of the services.

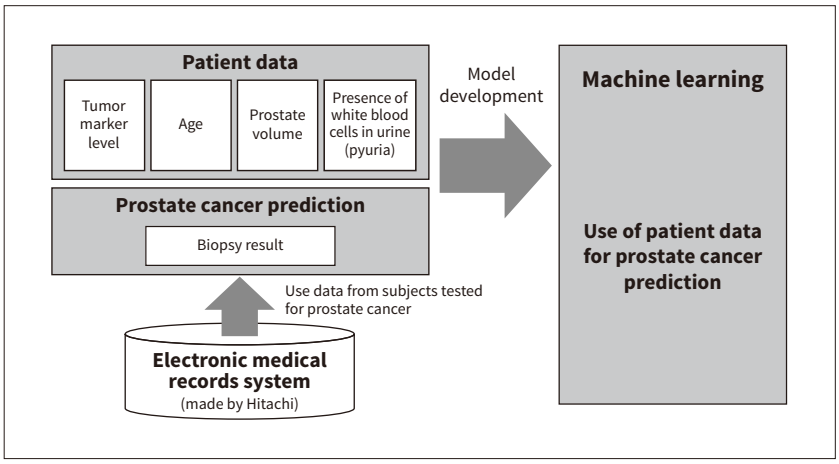
Figure 1 — Future Data Services

Services are provided using both data based on specific contracts from such data providers as hospitals and payers, and anonymized data from such sources as data providers or the national platforms provided by central government (including approved operators).



Implementing these services will required the secure management of confidential personal information (healthcare data) and its use in anonymized form. Furthermore, because data acquired from actual medical practice was not collected with secondary uses in mind, the data quality needs to be improved to ensure its reliability and integrity. In other words, a wide variety of know-how and technology is required for purposes that include anonymizing the data and keeping it secure. Hitachi has diverse channels for engaging with healthcare stakeholders and has experience with technologies for using data and with work on improving medical services that draw on such resources as its research centers and its own hospitals and the Hitachi Health Insurance Society. The following sections use examples from these activities to describe its work on the Tokumei Bank information management service, a prostate cancer prediction model, and use of genomic information.

Figure 2 — Prostate Cancer Prediction Model
Prediction uses machine learning and is based on patient data contained in electronic medical records.



3. 2 Hitachi Solutions and Initiatives

3. 2. 1 Tokumei Bank

Hitachi uses the Tokumei Bank, a secured information management service that utilizes searchable encryption, to provide various medical research institutions with a patient registry system for the secure collection and storage of clinical data such as information on diseases from medical practitioners and patients. Applications of this patient registry system include the management of information on multiple system atrophy (MSA) at the University of Tokyo Hospital. Information supplied through medical practitioners at participating hospitals around Japan is stored centrally on the cloud along with patient clinical data and personal information.

All use of patient information must be done in ways that ensure data reliability, with secure data management practices that comply with national guidelines[3]. The idea for the Clinical Innovation Network (CIN) proposed by the MHLW, for example, includes expectations for cost savings and more efficient information collection using patient registry data. The amended GPSP directive redefines postmarketing surveillance using healthcare databases and preparations are being made to allow registry data to be used in postmarketing surveillance.

Hitachi plans to launch a full-scale patient registry service in October 2018 that is based on its past experience and standardizes the required functions. It is anticipated that greater use will be made of patient registries in the future to speed up activities such as postmarketing surveillance and the clinical trial process.

3. 2. 2 Prostate Cancer Prediction Model

A considerable amount of work is taking place around the world on utilizing artificial intelligence (AI) in hospital-based diagnosis for diagnostic accuracy and efficiency improvement.

While the first step in prostate cancer diagnosis is to take a blood sample to measure the level of tumor markers, a definite diagnosis frequently involves performing a biopsy (obtaining a tissue sample from the suspected tumor). Unfortunately, biopsies are stressful for patients because they require the collection of cells from the body. Hitachi has been conducting research that supports prostate cancer diagnosis by applying machine learning to data from 512 people who underwent checks at Hitachi General Hospital, including their tumor marker levels, age, and prostate volume (see **Figure 2**). The results matched those from biopsies, being able to correctly identify prostate cancer more than 70% of the time[4]. Prediction based on tumor markers alone has an accuracy of only about 50%.

Although further improvements in accuracy are required for clinical use, given the low level of stress it imposes on patients' bodies, deployment of the model in practice has potential benefits that include helping with early detection. The model also has potential applications for other diseases in which tumor markers are useful for diagnosis (not just prostate cancer).

3. 2. 3 Use of Genomic Information

The dramatic reductions in the cost of genomic analysis over recent years thanks to such technological innovations such as DNA sequencers are turning precision medicine into a realistic possibility, using

information such as the patient's genome as a basis for providing treatments that are both effective and have few side effects.

In the field of cancer, the MHLW has made strong progress toward bringing the genomic diagnosis of cancer under insurance coverage, having designated centers for genome-based cancer treatment around Japan as part of its "data health reform." In the case of rare diseases, the Japan Agency for Medical Research and Development (AMED) is leading the Initiative on Rare and Undiagnosed Diseases (IRUD), working on the collection of genomic information and its use for the diagnosis of such conditions.

Along with these developments, it is anticipated that correlating genomic information with medical information collected in actual practice will play an important role not just in diagnosis and treatment, but also in innovative medical research and development.

Hitachi has supported national genomics research in Japan through the establishment of large databases and genome cohorts. Hitachi is stepping up the pace of its involvement in the practical realization of genomic medicine, including the development of new genomic diagnoses, having entered into a comprehensive collaboration with Tohoku University in September 2017 to develop personalized medicine practices for cancer and other intractable diseases.

4. Conclusions

The shift toward outcome-based assessment in healthcare will likely strengthen in the future, giving rise to innovative medicine and new healthcare services that are patient-centered. This will likely lead to data-driven healthcare becoming routine, with the provision of healthcare services being based on disease analysis and evidence from medical practice using data that is orders of magnitude greater in both quality and quantity than in the past.

Operating as part of an ecosystem made up of a diverse range of participants, and drawing on its strength in the use of technology to resolve challenges that include data quality improvement and the appropriate management and use of personal information, Hitachi is seeking to become a provider of data-driven healthcare services that contribute to innovative and patient-centered medicine.

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