Featured Articles

Care Cycle Optimization Using Digital Solutions

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OVERVIEW: The healthcare industry is undergoing reforms with numerous initiatives being undertaken to control healthcare costs without compromising the quality of care. These initiatives include a shift to healthcare cost payments based on outcomes under the concept of value-based healthcare, the allocation of public healthcare budgets to medical districts, and stricter evaluation of the cost-effectiveness of drugs. Healthcare reform requires supplying optimal care in ways that consider the entire medical district by integrating and analyzing data from across the care cycle. Collected medical data can be used to identify subpopulations within which drugs have heightened efficacy and to assess the cost-effectiveness of drugs, and also to transform the value chains of pharmaceutical companies. This article describes the challenges in the healthcare sector that can benefit from data analytics as well as the digital solutions and collaborative creation with customers being promoted in different regions for solving these challenges.

INTRODUCTION

WITH healthcare costs increasing at an accelerated pace around the world, how to control costs while at the same time maintaining people's health is a common societal challenge. Different countries are making various attempts to solve this problem, with 50% of the payments under Medicare, a public insurance scheme, said to be changed to value-based payments (payment based on outcome) by fiscal year 2018 in the USA. The National Health Service (NHS) in the UK, meanwhile, is seeking to prevent unbridled increases in healthcare costs by adopting a system under which each geographical region is responsible for managing its own budget. This has created an environment in which what is needed is a population health management approach that seeks to improve outcomes, including prevention and convalescence, not only at one hospital, but also in the entire medical district.

Meanwhile, the business of pharmaceutical companies is being significantly impacted by the stringent cost-effectiveness appraisals to which their drugs are now subject.

This article considers how to meet the societal challenge of combining improved outcomes with control of healthcare costs as well as what will happen to the various healthcare service providers in the future and what Hitachi has to offer, looking at these questions from the viewpoint of big data, with a particular focus on what is happening in Europe and the USA, which lead the world trend in healthcare services.

TRENDS IN THE HEALTHCARE SECTOR

Circumstances Surrounding Healthcare Services

The approximately 6,000 hospitals in the USA together have around one million patient beds, and are paid approximately $110 billion in healthcare costs. Among these, Accountable Care Organizations (ACOs), defined as "groups of hospitals, clinics, and other care facilities that have responsibility for healthcare in a region," that operate under an incentive arrangement whereby they cooperate with each other and are permitted to keep a portion of the savings if they succeed in keeping the total increase in healthcare costs below a budgeted amount. Partners HealthCare, for example, earned approximately $29 million in 2012 from the Centers for Medicare & Medicaid Services (CMS), a public health insurance organization in the USA. On the other hand, there is also a mechanism that metes out penalties if they fail to guarantee healthcare quality, for example, if the rate of readmissions within 30 days is above average or the public insurance reimbursement rate goes down, and this trend is expected to continue regardless of the political administration.

Circumstances Surrounding Pharmaceutical Companies

In terms of pharmaceuticals, the pursuit of cost-effectiveness is becoming increasingly severe. In the UK, for example, certain drugs with poor cost-effectiveness have been appraised as "not recommended for reimbursement" by the National Institute for Health and Care Excellence (NICE) despite receiving regulatory approval. Japan, meanwhile, introduced cost-effectiveness appraisals on a trial basis in the FY2016 revisions to its medical payment system.

Given these circumstances, it is no longer enough for pharmaceutical companies simply to persuade doctors to prescribe their drugs. In particular, the more expensive the drug, the more important it is that they also provide support to ensure that treatments are administered to patients correctly. This is because of the potential for a drug to lose its recommended status if it shows inadequate effectiveness in its statistics, whether that is due to it not being taken or due to it not being taken correctly and thereby losing its effectiveness.

In developing drugs, it is thought that the development of "blockbusters" (drugs that can be expected to be effective for large numbers of patients) will become more difficult in the future. Rather, the likely direction in the future will be toward precision medicine, which requires the development of targeted drugs, where diagnostic and therapeutic drugs are developed in tandem, or where the clinical trial process includes identifying the groups of patients for which a particular drug can be expected to be effective.

Another likely future development will be an effort to shift away from the business of treating disease, toward the business of preventing it. One example is the French company, Sanofi, which has a main focus on diabetes and is attempting to redefine itself from a pharmaceutical company to a healthcare company by adopting an approach to patients that incorporates IT and collaboration with other industries. This includes care management services for diabetes.

CHALLENGES IN THE HEALTHCARE AND PHARMACEUTICAL SECTORS

This chapter considers the respective challenges facing the healthcare and pharmaceutical sectors as they respond to these circumstances from the viewpoint of data utilization.

Healthcare Sector

One quarter of the people enrolled in Medicare, the USA's public health insurance system for the elderly, have five or more chronic conditions, make an average of 13 doctor visits each year, and are prescribed 50 different types of drugs, with more than 13,000 different types of drugs prescribed in total. Given this environment, it is difficult for doctors to determine, on their own, which treatments will provide the best possible outcomes without harmful drug interactions, and there is a recognized need for clinical decision support systems (CDSSs)[1]. Not only in the general treatment, but also in specialist care such as oncology care, it is anticipated that the use of CDSSs will grow strongly in the future because of the need to determine which treatments will best suit individual patients (whether chemotherapy, radiotherapy, or a combination of the two will give the best results, what sort of anti-cancer drug to use, what sort of radiotherapy system to use, etc.).

Improving patient outcomes requires that the right decisions be made when patients are admitted to the hospital, such as which ward they should be sent to and what sort of care they should receive, and also when they are discharged, including not just whether discharge is appropriate but also the sort of follow-up care they will require. To be effective, this requires that decisions be based not only on the hospital's own data, but also on the integration of a wide variety of data from all stages of the care cycle, which extends from prevention to treatment and convalescence. All of these are aimed at guaranteeing a favorable outcome.

Under circumstances where healthcare costs are becoming less fee-for-service-based, one way for medical institutions to improve their profits is to improve their business efficiency. Rather than simply presenting business key performance indicators (KPIs) as in the past, there is a demand for analytics that can specifically give achievable guidelines such as how to improve bed occupancy or shorten waiting times. Achieving this requires a wide variety of information, including local health statistics and data on the frequency of emergency patients, as well as staff and equipment scheduling information. In the USA, where the income per bed is over a hundred million yen per year, improving bed occupancy has a very significant impact on business. In other words, analytics directly affects the bottom line.

Pharmaceutical Sector

The major changes relating to data in the pharmaceutical sector have to do with the availability

of medical data. Whereas past practice was to apply standardized medical statistical analysis to data from clinical trials collected in accordance with strict protocols, now that large volumes of medical data are becoming available, there is also the potential for obtaining valuable information using a large volume of medical data that were not necessarily recorded for the purpose of analysis, such as marketing, discovery of new drug efficacy, characterizations of subpopulations in which drugs are especially effective, and signs of adverse events. And, by integrating these data with data from medical accounting systems, cost-effectiveness analysis is also possible.

Furthermore, in cases where pharmaceutical companies are seeking to enter the business of preventing disease, as described above, there is a need for more effective planning for disease prevention, such as by determining people's health status by analyzing data from lifelog devices, or by building patient disease progression models that model their progression from being healthy to having a disease, and using the models to determine appropriate interventions. In that case, since it is necessary to provide predictions that match reality, including complications, it will require analytics that integrate data from when patients were healthy, such as screening data, and also healthcare-related data, such as receipts.

Analytics for Care Cycle Optimization

When viewed from a patient's perspective, the analytics referred to in the two sections above present the optimal services the patient should receive at various points in time, from before becoming ill, during treatment, and after recovery. And, when viewed from a healthcare service provider's perspective, it indicates what kinds of services are suitable for patients with what kinds of conditions, through all stages, from preventive services to acute care and convalescence care. In this way, the analytics provided by Hitachi are intended to optimize all stages of the care cycle by supporting appropriate decision-making at each stage.

Table 1 shows some examples. The themes listed for pharmaceuticals are positioned as treatment-related. Unlike the visualization of management indicators provided in the past, these analytics give achievable measures based on prediction, and impact the quality and management of work at medical institutions and pharmaceutical companies. While estimates of the scale of business in North America for analytics services that operate at this level is said to range widely, from about 500 billion yen to about two trillion yen in 2018, the business opportunities are expected to be large, in either case.

Table 1. Examples of Analytics for Care Cycle Optimization
The table shows examples of challenges that people have sought to solve by applying analytics to medical data in both the clinical and pharmacological fields.

Field	Challenge and its significance
Clinical care	• CDSS for oncology care It improves patient outcomes by selecting the optimal treatment. • Predicting risk of readmission within 30 days Hospitals are subject to public insurance penalties that can add up to hundreds of millions of yen or more if readmission rates are worse than average. • Improving bed occupancy rate In a 1000-bed hospital, a 1% improvement can increase income by one billion yen or more.
Pharma-ceuticals	• Marketing It can be used for development and sales strategies by providing information on disease distributions. • Patient stratification It reduces waste and improves drug development efficiency because efficacy can be confirmed from early in development. It can significantly reduce development costs by reducing the number of patients in costly phase 3 clinical trials.

CDSS: clinical decision support system

DIGITAL SOLUTIONS FOR ACHIEVING CARE CYCLE OPTIMIZATION

Rapidly Supplying High-quality Solutions

While working on collaborative creation with customers, Hitachi has also been looking for the policies that customers need to better and more rapidly solve these challenges. This chapter uses concrete examples to describe the bottlenecks Hitachi has identified through its demonstrations of processes up to now and how to solve them, looking at the problem from the perspective of supplying analytics services to customers. The challenge of predicting the risk of readmission within 30 days, an important theme in the USA, is used as an example.

When a patient with a particular condition is discharged, medical institutions want to know, as accurately as possible, what the probability is that the patient will be readmitted within 30 days. Patients with a low risk of readmission can be discharged to their home or outpatient care, but, those with a high risk of readmission need to be kept in the hospital for necessary treatment or be monitored after they are discharged. When the precision of prediction is low, there are more readmissions and reimbursements can be penalized.

As it is not self-evident which data need to be considered when building a model to try to solve this kind of problem, the first step is to collect data from hospital systems. Hospitals have many systems, and while these contain so-called structured data recorded in electronic medical records, the collection of these data requires processing, such as assigning standard codes to convert hospital-specific local codes into standard codes, and correcting data errors and omissions. However, these steps were also required for data analysis up to now and are performed routinely.

On the other hand, in terms of useful resources for creating good prediction models, there are many kinds of reports such as physical findings on admission and nurse notes that are written in freely-entered text. This unstructured data accounts for 60 to 80% of hospital data and, having found through conversations with customers and analytical case studies that this kind of data is extremely important, Hitachi used natural language processing technology to extract information, and to capture information through integrated processing of the structured data and text data.

From the data extracted in this way, it is possible to extract an analysis dataset matching the hypothesis of analysis, to select the items to use as variables with artificial intelligence (AI) technology such as machine learning, etc. from the hundreds of thousands to millions of data items about the patients in the dataset, and finally, to create a model (see Fig. 1).

The series of processes up to this point is thought of as the "data refinery" required for creating models, and the last two processes are the exact reason why building complex models is so difficult. For analysts to extract the dataset and select items while at the same time making sense of the relationships between the extremely large number of items is an extremely difficult process that requires a lot of work.

Hitachi has demonstrated the ability to reduce the load on analysts in the process of extracting the dataset and selecting items by using a technique[2] that utilizes medical knowledge to embed relationships that can potentially be considered in the analysis into the medical data beforehand, and to use this embedded knowledge to develop prediction models that have higher precision than those in the past[3].

Since the technique can reduce the time and effort required for building models to several tenths or less compared to past practices, particularly in cases like this where the number of data items to be considered is large, it is possible to refine models by repeating the hypothesis testing process over and over again.

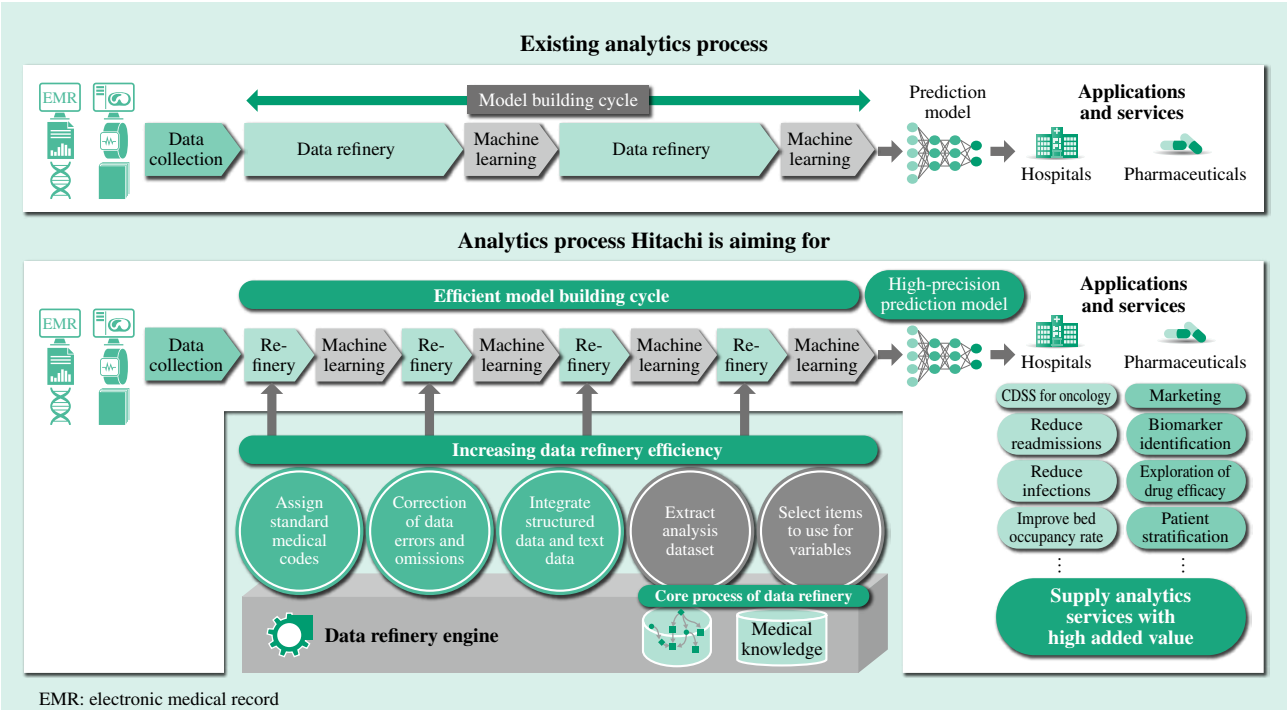

Fig. 1—Approach to Solving Challenges Based on Medical Data Analytics.
By embedding the relevant relationships required for analysis in the medical data, medical data analytics enables the efficient extraction of analysis datasets and selection of items to use as variables for machine learning.

As a data refinery is a common requirement for many forms of healthcare analytics, Hitachi hopes to incorporate it as part of Lumada[4], its Internet of Things (IoT) platform, as a function called "data refinery."

Collaborative Creation in Different Parts of the World

Healthcare sector challenges are given different priorities depending on the region. Although the USA needs to consider applications for optimizing treatments for diseases such as cancer and heart disease, China has regional features such as a deep interest in improving the operational efficiency of its hospitals, so Hitachi is engaging in collaborative creation activities with a wide variety of medical institutions based on the respective circumstances of each region[5]. Collaborative creation with pharmaceutical companies is also characterized by having different requirements for each customer, such as the different diseases in which they are interested. By placing the data refinery at the core of collaborative creation, Hitachi hopes to solve a variety of customer challenges.

CONCLUSIONS

Hitachi has been engaging in collaborative creation with customers to support the use of healthcare data represented by medical data to solve customer challenges. Even in cases where complex analytical models are needed, Hitachi has been demonstrating its ability to rapidly supply advanced analytics that solve customer challenges, drawing on the concept of data refineries to unblock the associated bottlenecks of analytics. Hitachi also wants to continue to enhance the value supplied by its data analytics business in the healthcare sector by building up further know-how.

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