Featured Articles

Innovative Disease Prevention Support Involving Collaborative Creation with Customers

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OVERVIEW: One of the major challenges facing the healthcare field is the pursuit of measures for strengthening disease prevention in Japan and elsewhere in order to control healthcare costs. To achieve this, it is important to provide highly effective prevention measures to large numbers of people, particularly intervention in groups. Accordingly, developing the associated technology involves field work and data that is coordinated with customers. Hitachi is working with the Hitachi Health Care Center and Hitachi Health Insurance Society to develop techniques for assisting the prevention of chronic diseases and for the analysis of medical costs. Drawing on the results of this work, it is also verifying the benefits that these measures deliver in practice.

INTRODUCTION

CURRENTLY, with rising medical costs having become a major social issue particularly in developed economies, one of the measures being adopted to overcome this challenge is improvement of disease prevention, especially focusing on chronic diseases[(1)]. The USA is proceeding with its Population Health Management measures for getting the right mix of healthcare services, including disease prevention, while the UK has introduced free health checks through the National Health Service (NHS) and in certain regions is offering lifestyle improvement programs that seek to prevent conditions such as diabetes and hypertension. Similarly, Japan has its "specific medical checkup" and "specific health guidance" programs that target metabolic syndrome, a precursor of chronic diseases.

One of the challenges for implementing these initiatives is the need to deliver highly effective measures to large numbers of people. Healthcare services provided by medical institutions involve examining and correctly diagnosing individual patients, providing them with treatment, and assessing the results individually. Disease prevention, on the other hand, is a public health measure that offers the same prevention services to groups of people and assesses performance across the entire group. The use of healthcare information in electronic form is important to achieving this because of the need to understand people's state of health and the benefits of services at the group level.

In response, Hitachi has been looking at electronic consultation results and medical claims and working on the development of healthcare information processing techniques with the aim of providing highly effective disease prevention measures. In particular, this has involved technology development in collaboration with customers based on Hitachi's belief that the use of large amounts of actual data to verify performance in the field helps develop technologies that are genuinely useful. Specifically, Hitachi has worked with the Hitachi Health Care Center, which is responsible for the health management of staff and the Hitachi Health Insurance Society, which staff are able to join to conduct analyses of healthcare data from several hundred thousand people, utilizing the findings to promote overall staff health and verifying the effectiveness of the measures adopted.

This article considers the health management activities undertaken by insurers such as health insurance unions, and describes technology development that has been undertaken with the aim of making these activities more effective. Note that the data used in this research was collected subject to auditing based on the ethics rules set by Central Research Laboratory of Hitachi, Ltd. All data was used in an anonymized form.

EFFECTIVE HEALTH MANAGEMENT AND TECHNOLOGY DEVELOPMENT

Insurers often deal with health management by contracting a service provider to deliver health guidance (see Fig. 1). The following three factors are considered important for making this sort of health management more effective.

(1) Health guidance that is both effective and efficient

Even if the health guidance delivered by a guidance service provider is effective in itself, it will not be able to be provided to large numbers of people or at a reasonable cost if it requires too much work. It is important that guidance be provided in a way that is both effective and efficient.

(2) Selecting participants who will benefit from health guidance

Health guidance is unlikely to deliver significant benefits if it is provided to people who already have a healthy lifestyle or to people in whom disease has progressed to a point where other treatments are more important. Accordingly, it is essential to select participants who will benefit from health guidance. Providing guidance to people who are unlikely to benefit from it is a waste of funds and it is not uncommon for participants to lose interest in trying to make lifestyle improvements a second time.

(3) Having the understanding of others associated with health guidance

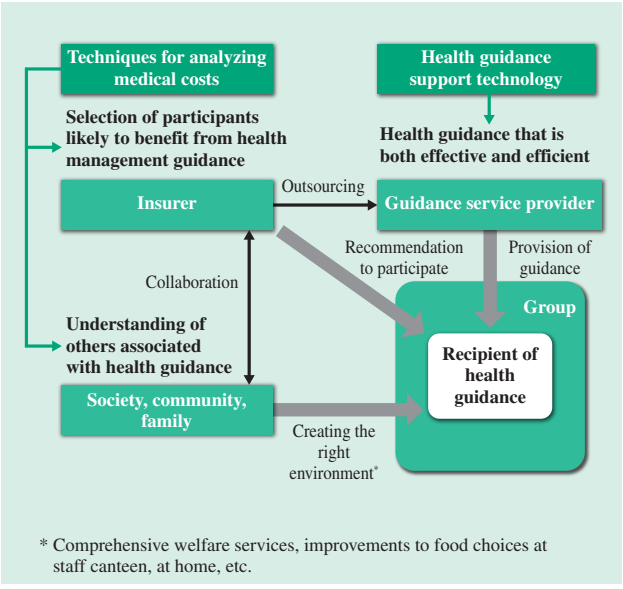

Fig. 1—Structure of Insurance Business and Technologies being Developed.
After first selecting the participants, the insurer contracts a guidance service provider to provide health guidance.

The environment around a person who is trying to make lifestyle improvements is important to their success. This means it is important that the entity paying for the health guidance (typically the insurer), and also the other people involved, such as the employer or family, appreciate the need for the guidance and help provide a supportive environment.

In response to the first of these objectives, Hitachi has developed health guidance support technology that can efficiently generate effective health advice. For the second and third objectives, Hitachi is working on developing techniques for analyzing medical costs in ways that demonstrate, in terms of medical costs, the prevalence of chronic diseases and the benefits of prevention achieved by health guidance.

TECHNOLOGIES THAT SUPPORT DISEASE PREVENTION

This chapter describes the health guidance support technology and the techniques for analyzing medical costs that enable effective health management, as described above.

Health Guidance Support Technology

Overview of Hitachi's Lifestyle Change Program

Hitachi devised a lifestyle change program that focuses on metabolic syndrome. The program aims to reduce visceral fat by a gradual weight loss of 5% (or 7% for those weighing over 90 kg) over a 90-day period (see Fig. 2). Participants first set specific behavior targets using cards that each represent 100 kcal of exercise or food and then record their weight and daily activity (number of steps walked, use of 100-kcal cards, etc.). The participants then receive health management advice from healthcare professionals ("Advisors") via e-mail, typically at 10-day intervals. The idea is that they will reach their weight loss target by continuing this pattern of 90 days of weight loss and 90 days of weight maintenance[(2)].

Health Guidance Support Technology that Generates Advice Options

One of the challenges of giving health management guidance is how to make the preparation of the advice included in the e-mails sent to participants by Advisors more efficient. Because Advisors send health guidance to a large number of participants, they have a heavy workload that requires them to prepare a large amount of advice every day. When this work was analyzed in detail, it was found that Advisors prepare this advice based on an appraisal of each participant's weight and

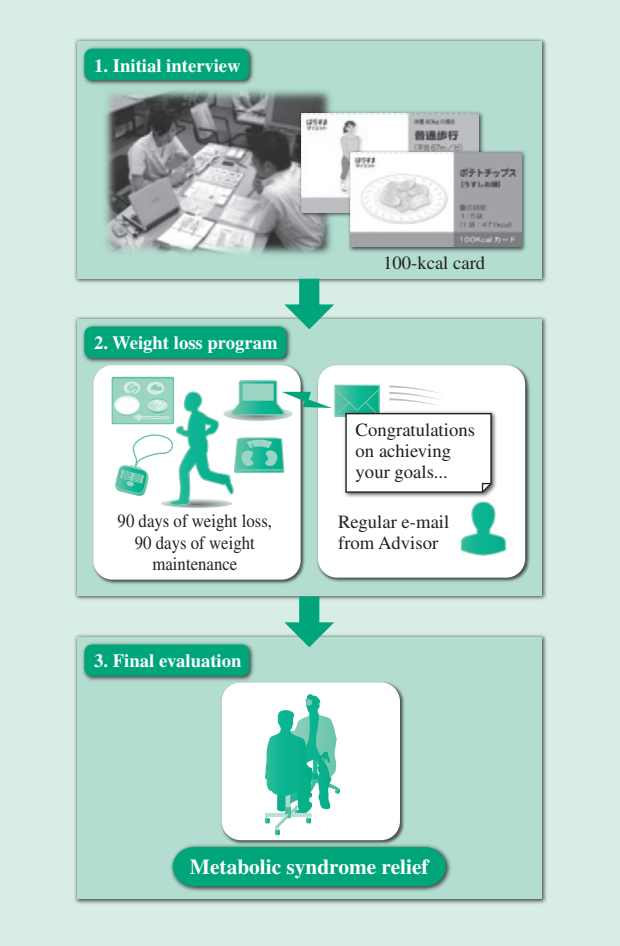

Fig. 2—Hitachi's Lifestyle Change Program.
Reduce weight by 5% (or 7% for those weighing over 90 kg) over a 90-day period by using 100-kcal cards to set behavior targets.

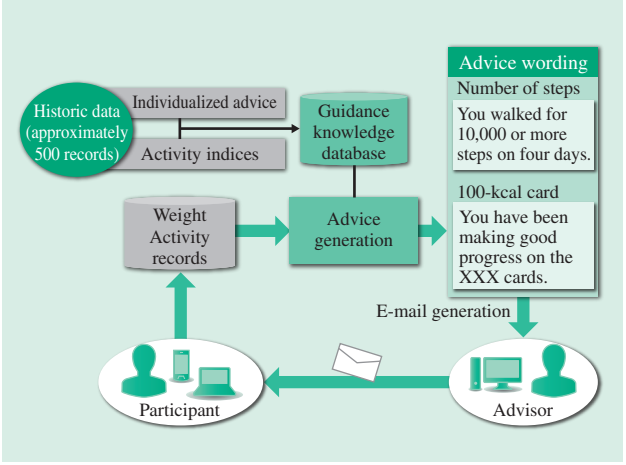

Fig. 3—Health Guidance Support Technology for Auto-generation of Advice Options.
Advice options are generated automatically based on factors such as the participant's weight and activity records.

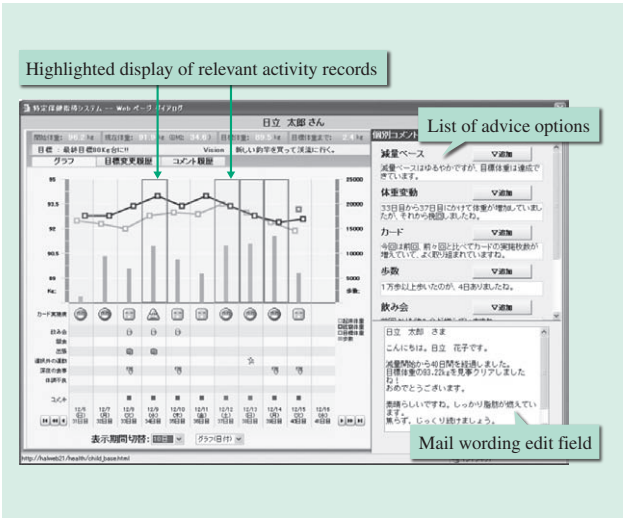

Fig. 4—Advisor Screen in Guidance Support System.
Advisors can prepare e-mails by selecting the appropriate advice from a list of options.

activity records, and that this takes a lot of their time.

In response, in collaboration with the Hitachi Health Care Center, a detailed analysis that included use of natural language processing techniques was conducted on approximately 500 sets of written advice sent out by Advisors in the past. The results indicated that most of the advice contained praise for participants' activities and that the advice could be categorized into a number of patterns. Based on these findings, Hitachi established a knowledge database for health management guidance and developed health guidance support technology that automatically generates advice options based on participants' weight and activity records (see Fig. 3)[3].

Fig. 4 shows the screen provided for Advisors by the support system built using this technology. The participant's weight and activity records are displayed on the left and a list of possible advice options praising their activities is displayed on the right. Also, because it takes time to identify praiseworthy activity records in text format, moving the mouse cursor over candidate advice options highlights the corresponding activity records in a red frame. When the Advisor uses the mouse to click the add button for the most suitable advice, an e-mail is generated automatically with that advice inserted into the message.

This health guidance support technology was incorporated into an information system for improving the efficiency of health management guidance using Hitachi's lifestyle change program. The system handles the input and browsing of weight and activity records as well as generating advice and transmitting e-mail, enabling both participants and Advisors to

access these records via an Internet server. Advisor work times were evaluated after the system was installed at the Hitachi Health Care Center. The results confirmed that tasks that previously took about 25 minutes could now be completed in about 5 minutes[4].

Techniques for Analyzing Medical Costs

Medical Cost Analysis and Challenges for Health Management

To demonstrate the prevalence of chronic diseases and the effectiveness of health management guidance, Hitachi is developing techniques for analyzing medical costs that model the progress of illness from deterioration in lifestyle practices to the emergence and subsequent worsening of symptoms by utilizing health check records and claims data held by an insurer. Chronic diseases progress through the interaction between diabetes, hypertension, hyperlipidemia (abnormal cholesterol, etc.), and their associated complications. This creates a challenge because it means that it is not easy to model the progress of illness in ways that consider these interactions using past techniques for the detailed analysis of things like incidence rates and medical costs that focused on individual diseases.

Disease Progression Model Using Bayesian Network

Accordingly, Hitachi is working in collaboration with Hitachi Health Insurance Society to construct a disease progression model that represents the detailed relationships between multiple diseases and contributing factors by utilizing a machine learning technique called a Bayesian network. A Bayesian network is a way of modeling the probability dependencies between data items.

Fig. 5 shows the relationships between the main contributing factors determined based on this disease progression model for chronic diseases. Factors between which dependencies are greater than a certain probability are indicated by lines. The data used to build the model consisted of Hitachi Health Insurance Society health check records and claims for approximately 110,000 people. Fig. 5 also shows how the model represents the interrelationships between diabetes, hypertension, and hyperlipidemia, and the relationships with complications such as nephropathy or cardiovascular disease. In this way, the complex interrelationships between contributing factors can be modeled.

To determine whether this disease progression model expresses the progress of chronic diseases from the initial appearance of symptoms and their subsequent worsening, the model was used to predict the following year's medical costs for 20,000 people based on their health check records and claims, with the difference between actual and predicted costs being calculated as a standard deviation. The results demonstrated that the following year's medical costs for the 20,000 people could be predicted with a margin of error for accuracy of about 5% or less[5].

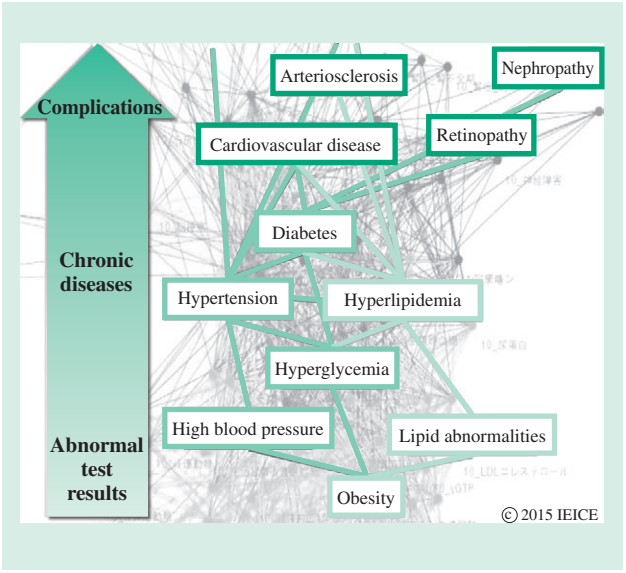

Fig. 5—Interrelationships between Contributing Factors to Chronic Disease[5].
A model represents the interrelationships between conditions such as diabetes, hypertension, and hyperlipidemia (abnormal cholesterol, etc.).

USE FOR HEALTH MANAGEMENT AT HITACHI HEALTH INSURANCE SOCIETY

The technology developed together with Hitachi Health Insurance Society is being deployed in practice and its performance is being assessed. This chapter describes some of this work.

Savings on Medical Costs Associated with Hitachi's Lifestyle Change Program

Hitachi Health Insurance Society has been providing specific health guidance (active support) using Hitachi's lifestyle change program since 2008. A survey was conducted in 2008 using claims data held by Hitachi Health Insurance Society that tracked 312 participants in the lifestyle change program and compared them to 2,358 non-participants. The results indicated a significant drop in the number of visits to a medical institution by participants compared to non-

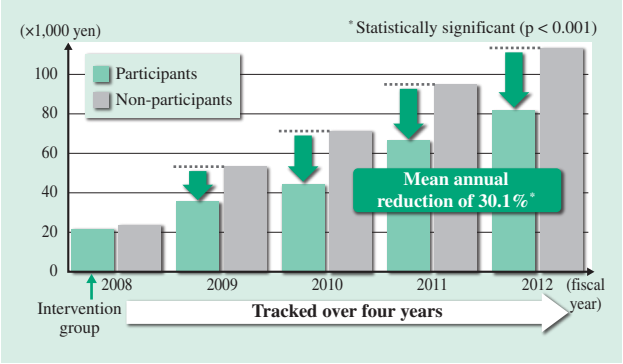

Fig. 6—Annual Per-person Medical Costs.
Participants in Hitachi's lifestyle change program have medical costs that are approximately 30% lower than non-participants.

participants (see Table 1). Fig. 6 shows a comparison of the annual per-patient medical costs. This indicates that medical costs for participants are approximately 30% lower than for non-participants[5]. Together with the shortening of work times for Advisors (as described above), Hitachi's lifestyle change program is able to provide health management guidance that is both effective and efficient.

Note, however, that participation in specific health guidance is voluntary, meaning that selection bias is possible.

TABLE 1. Number of Health Checks per Person per Year
The number of visits per year to medical institutions by Hitachi's lifestyle change program participants is less than those of non-participants by a statistically significant margin.

Survey fiscal year	Participants	Non-participants
FY2008	2.1 times	2.2 times
FY2009–FY2012	3.3 times*	3.8 times

* Statistically significant (p < 0.01)

Selection of Recipients of Health Management Guidance Based on Benefits

The selection process for receiving health management guidance is based on the level of disease risk as indicated by test results and other predetermined criteria, similar to the specific health guidance (active support) program, for example, which is available to those not on medication who have a fasting blood sugar level of 100 mg/dL or above, a neutral fat level of 150 mg/dL or above, and a systolic blood pressure level of 130 mmHg or above. However, the criteria are generally set broadly and the benefits of guidance may vary between individuals, even if they are on the same active support program, or depending on the nature of the health management guidance offered. Essentially, rather than risk of disease, the selection of participants should be based on who will benefit from health management guidance. Accordingly, Hitachi has used the disease progression model it created using the techniques for analyzing medical costs to develop

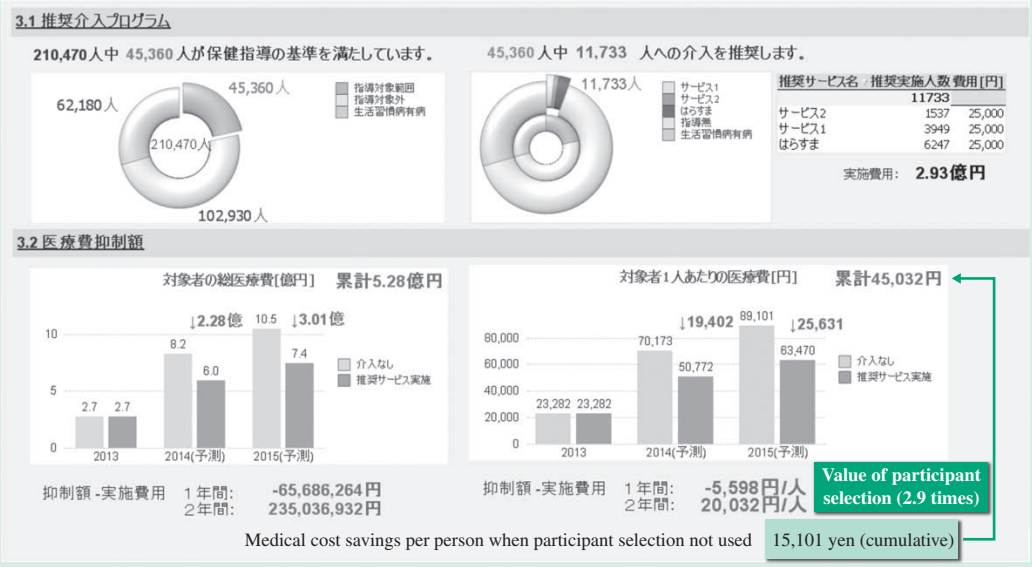

Fig. 7—Functional Prototype of Participant Selection Method for Health Management Guidance.
The method can select who should receive health management guidance and predict the resulting savings in medical cost.

a method for selecting participants that is based on the benefits of health management guidance.

Fig. 7 shows part of a screen from a functional prototype that uses this selection method. The pie chart at the top left indicates the number of participants eligible for the health management guidance program and the chart at the top right indicates the number of participants who are likely to benefit. The bar charts in the bottom part of the screen show the medical costs of chronic diseases predicted by the disease progression model. They show the predicted one-year and two-year costs with and without the program. The total medical cost is displayed at the bottom left and the cost-per-individual at the bottom right. The predicted medical cost savings over two years are 45,032 yen per person, roughly three times greater than the savings achieved if the selection process is not used (if participants are instead randomly selected from those eligible).

Claims data was used to determine the benefits in the case of 50 people currently involved in a health management guidance program run by Hitachi Health Insurance Society, and who were chosen using this benefits-based selection process. While monitoring of these participants has so far only been going on for half a year, the medical cost savings have already been approximately six times those for conventional health management guidance. Hitachi intends to continue monitoring progress closely.

Use of Workplace Health Maps

It is recognized that the benefits of health management guidance are compounded when the insurer and employer work together on its implementation, and the Ministry of Health, Labour and Welfare is proceeding with collaborative activities it calls “collabo health.” The sharing of information about employee health

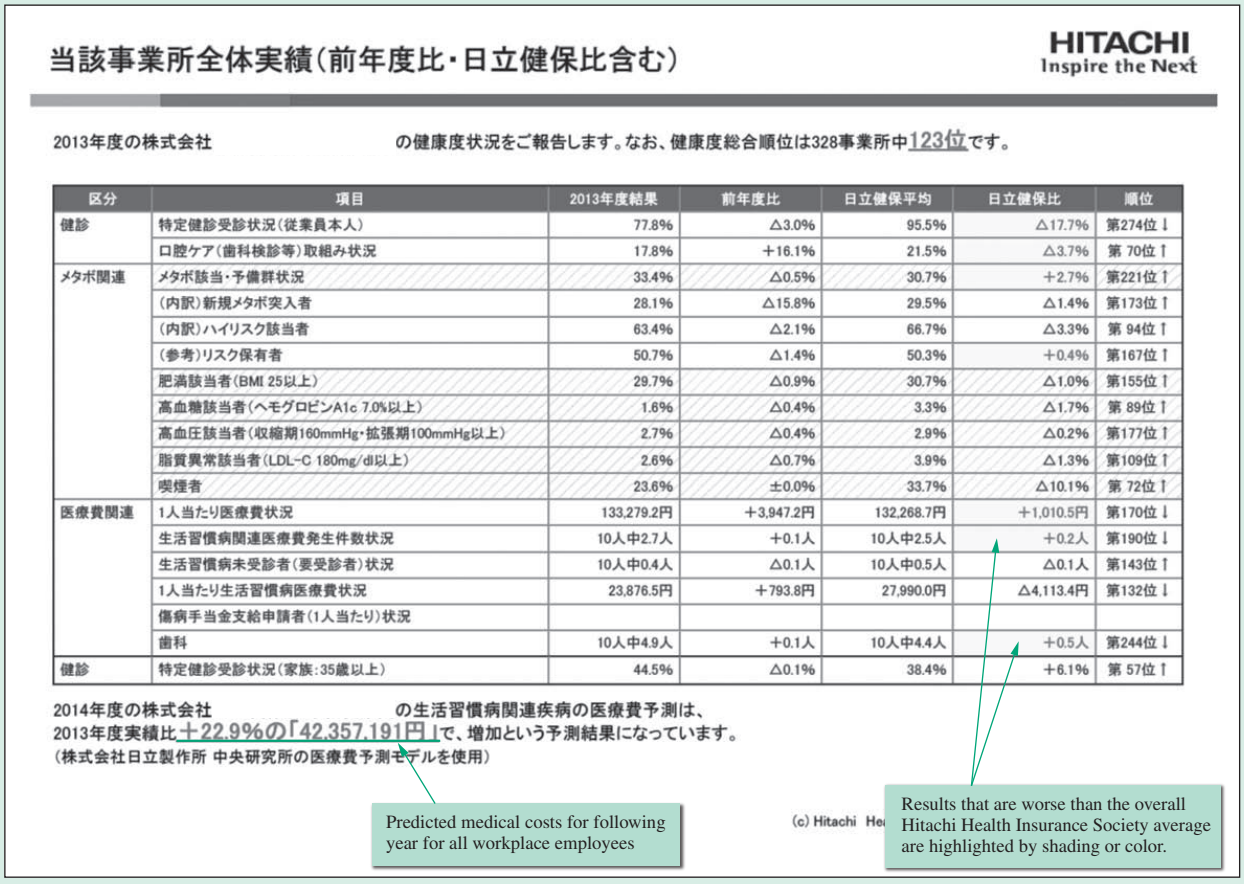

Fig. 8—Workplace Health Maps (Data for Entire Workplace).
The map is used to assess the health of employees at the workplace by showing their state of health and the predicted medical costs associated with chronic diseases.

problems between insurer and employer is crucial to this initiative. Accordingly, Hitachi is working on the development of "workplace health maps" that can assess the health of employees at a workplace through a comparison with the overall state of health of all employees.

Fig. 8 shows part of a workplace health map (data for entire workplace) being used in practice by Hitachi Health Insurance Society. The indices selected based on health check, metabolic syndrome, and medical cost criteria are compared to the mean values for all of Hitachi Health Insurance Society to compare the healthiness of workplace employees. The map also shows the predicted medical costs for the coming fiscal year for all employees at the workplace, which are determined using the techniques for analyzing medical costs developed by Hitachi. In addition to the overall totals shown in the figure, detailed documents are also produced showing things like health check results and medical costs that are used by Hitachi Health Insurance Society when requesting the cooperation of particular workplaces. The workplace health map is a useful resource for implementing "collabo health."

CONCLUSIONS

Drawing on actual data and practical know-how held by Hitachi Health Care Center and Hitachi Health Insurance Society, Hitachi has been working on the development of health guidance support technology and techniques for analyzing medical costs, and the evaluation of their effectiveness in practice. In doing so, it has established techniques for controlling the prevalence of chronic diseases and rising medical costs.

This new ability to collect and analyze large volumes of diverse information on people's health is shedding light and providing quantitative data on areas that were previously hidden. Meanwhile, knowledge and skills previously restricted to those with expertise or experience are now becoming widely available. By making active use of healthcare information through collaborative creation with customers, this is facilitating the development of innovative technologies for reducing the incidence of chronic diseases and the supply of highly practical products and services.

The increased prevalence of chronic diseases is also a major social issue outside Japan. In an initiative involving collaborative creation with a customer, Hitachi is developing a new healthcare service for preventing chronic diseases in Manchester in the UK. The techniques and knowledge resulting from the customer collaborative creation activities described in this article will also be deployed in this UK project. Similarly, Hitachi intends also to deploy techniques and knowledge from the UK in Japan and other countries or regions.

Once you lose your good health it is too late. Hitachi is seeking to create a world in which, by learning from data and the knowledge of those who have gone before, people can recognize the importance of health and take steps to maintain it before it is lost.

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