Healthcare Dynamics Informatics for Personalized Healthcare

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OVERVIEW: As popular needs diversify in the field of healthcare services, service providers are being asked to deliver detailed services oriented to the personality of each service recipient on either the individual or organizational level. To this end, service providers collect information from administrative records, reimbursement records, and clinical tests in particular to evaluate individual medical techniques. The knowledge gained from such information, however, is not totally sufficient due to its fragmentary nature and limited scope. In other words, it is important to collect information continuously as an individual makes the transition from a healthy state to illness and then on to recovery. The Hitachi Group proposes the concept of "healthcare dynamics informatics" as a new form of healthcare informatics centered about the individual. As an initial example of such informatics, they are currently working on "health checkup services using mobile phones."

INTRODUCTION

HUMAN beings are diverse creatures—each person is different in both mental and physical terms. For this reason, the main concern of any recipient of healthcare services is whether individual services that provide therapies are truly effective "for me." This concern is voiced without distinction to health-maintenance services (such as physical examinations and general checkups) and medical services. As a consequence, healthcare sites are making continual efforts to provide patients with optimal services by collecting as much information as possible starting with knowledge gained from basic and clinical studies conducted overseas and in Japan.

There are two important concepts underlying informatics (information science) in healthcare: EBM (evidence-based medicine), or medical care based on scientific evidence, and personalized healthcare, or medical care customized for individuals. Fig. 1 shows the basic configuration of the information system in healthcare.

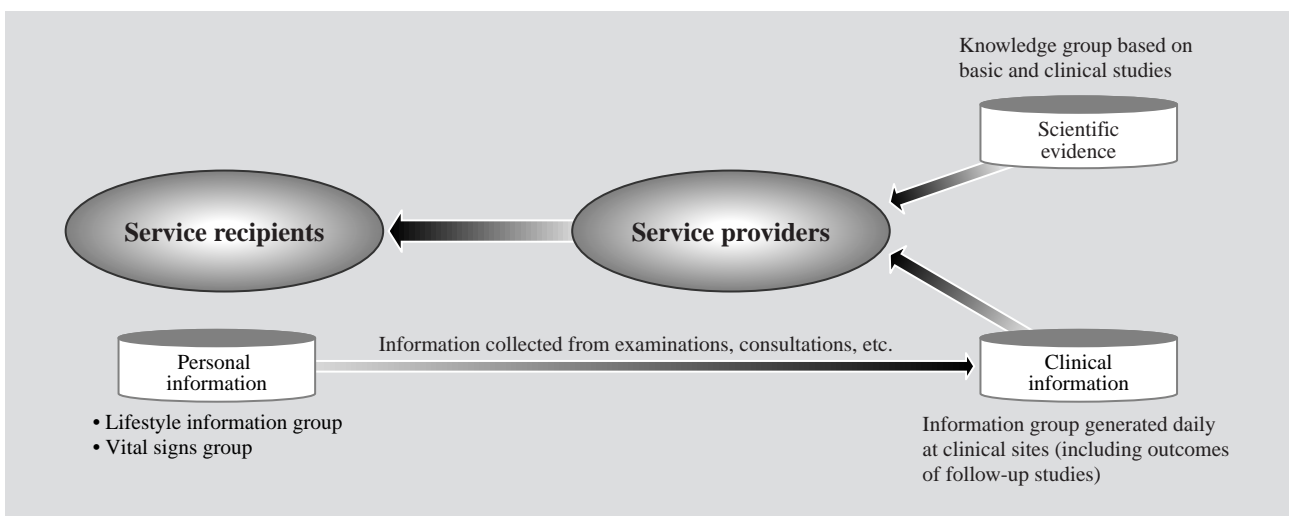Evidence in EBM means the results of evaluating

Fig. 1—Healthcare Information System.
A necessary condition for personalized healthcare is the systemization of information held by recipients and providers of healthcare services.

a specific medical technique (such as one type of prescription) among randomly sampled groups. Such an evaluation, while indicating the general effectiveness of a medical technique with regard to a group or groups, cannot necessarily indicate its effectiveness for a specific individual.

At the same time, the expression "personalized healthcare" has become quite common as basic and clinical medical studies based on the decoding of the human genome continue to progress and social awareness of this trend increases. The idea here is to perform diagnosis and therapy after scientifically determining personal traits. For example, genome information could be researched before administering a specific drug to investigate that person's sensitivity to it, and if the drug could be predicted to be effective, it would be administered, and if not, another form of treatment could be applied. At present, personalized healthcare implies personalized medical techniques that make use of genome information. In the future, however, we can expect it to mean healthcare services on the whole that take into account not only personal traits but also an individual's lifestyle and even one's way of thinking toward one's health.

Ideally, any healthcare service would be based on evidence and be personalized as well. Both the service recipient and the service provider must be presented with information based on mean values and statistical knowledge and on individual physical characteristics indicating what kind of effect and risk might be associated with a certain medical technique. In Japan, it is becoming a general rule that medical accidents in medical institutions be publicly disclosed, and the need for service providers to clearly demonstrate the appropriateness of their practices is increasing all the more.

In parallel with the above, people are becoming even more concerned with healthcare and medical services. Regardless of whether the technique in question is commonplace or new, information on effects and safety should be managed while taking individual characteristics into account, and that information should be used at healthcare sites to facilitate mutual understanding. This approach is essential to improving the quality of healthcare services overall and the degree of satisfaction in service recipients.

The following describes "healthcare dynamics informatics," which is advocated by the Hitachi Group as a way of achieving personalized healthcare, and introduces a specific example called "health checkup

services using mobile phones."

PROPOSAL OF HEALTHCARE DYNAMICS INFORMATICS
Present State of Healthcare Informatics

In Japan, the fields of healthcare and medical care are independent from both an academic and social perspective mainly for historical reasons. Both are under government control for the most part, and informatics here is consequently limited to the application of group statistics. The information groups handled by healthcare, for example, are centered about items of health checkup as dictated by law and information needed for statistics managed by health checkup centers and local governments. Those handled by medical care, on the other hand, are centered about information needed to manage medical practices for counting systems and reimbursement records.

Services in the healthcare field come under the control of various systems from a cost perspective. As a consequence, the construction of informatics [(1) clarify the purpose of use, (2) systematize the information needed for that purpose, and (3) manage by an optimal method] that can directly assist service providers and recipients has fallen behind that of other fields. The system is such that the construction of informatics, the evaluation of medical services throughout the diagnosis and treatment process and at the level of each medical technique, and the improvement of medical services cannot naturally occur at healthcare sites and medical institutions.

For these reasons, there has been little discussion in the healthcare field on the suitability of applying IT on a platform of people-centered informatics.

Value of Information

Deregulation throughout healthcare has had a stimulating effect, and healthcare is taking on the characteristics of the general service industry in contrast to its past nature as a public service. A major feature of Japan's healthcare system has been the provision of identical services at the same price at any hospital. In this way, it has contributed to the nearly uniform provision of world-class medical treatment to the nation's people. In the current public health insurance system in Japan, however, it has been difficult for insurance premiums to keep up with escalating medical costs as medical techniques continue to progress. It is thought that, in the future, most of this increase in costs due to improved medical techniques will have to be covered by diagnosis and
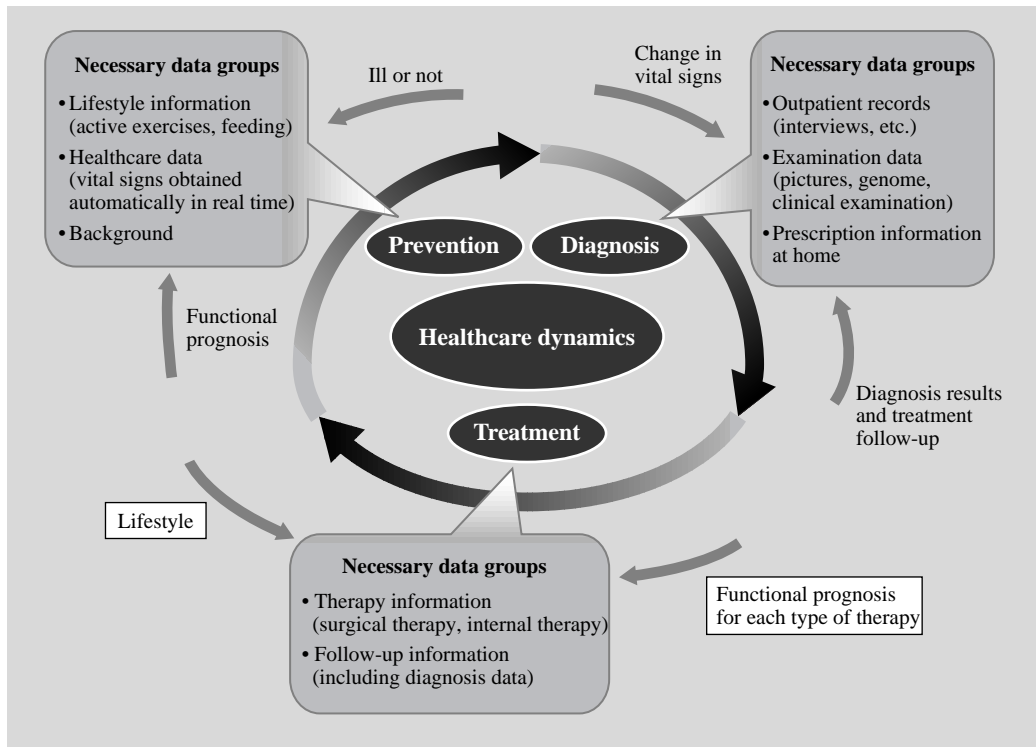
Fig. 2—Concept of Healthcare Dynamics Informatics. Within the flow of prevention, diagnosis, and treatment, informatics must be constructed for handling the dynamic characteristics of individuals (healthcare dynamics).

therapy applicable to no insurance.

In the field of healthcare, greater room for discretion in improving quality and managing costs corresponds to the introduction of competitive principles at both the individual level and the organizational level such as medical institutions. This means that service providers must accurately assess the needs of each service recipient, and, at the organization level, that highly skilled staff must be trained and employed to maintain high-quality services.

In the general service industry, efforts are constantly being made to raise the quality of services, and obtaining various types of customer information toward that end is of prime importance. Likewise, to raise the quality of services in healthcare, a mechanism must be created for describing customer information (clinical information) in a medical institution and for using that information at sites where decision-making is performed daily. This is because a service provider that can relate on-site information and customer needs to speedy and substantial improvements in quality will survive the competition.

Concept of Healthcare Dynamics Informatics

The methodology for systematizing the information described above is called "healthcare informatics," and the means of applying this methodology become the information technologies needed in this field (see Fig. 2).

Instead of using information independently in prevention, diagnosis, and treatment, information should be managed and analyzed continuously and collectively. It should then be possible to provide desirable healthcare services scientifically based on individual physical (and in the future, mental) features and social characteristics as well. In general, for common diseases that tend to increase as a society ages, significant individual differences can be found in the process of contracting an illness, being ill, and getting better. The factors behind this are assumed to be personal traits and lifestyle.

Diagnosis, for example, can make use of information obtained during prevention (daily life), i.e., a time series of healthcare data such as weight and blood pressure and of lifestyle information such as eating habits, habitual exercise, and hours of sleep. This information will enable a service provider to determine whether a disease has been contracted suddenly or gradually over several years. In addition, combining long-term lifestyle information (which is generally difficult for a medical institution to obtain) with detailed examination data including genome information from a medical institution will make it possible to draw up a map of therapies. A service recipient that has received treatment according to such

a map of therapies now has information on a functional prognosis and prognostic factors and can therefore endeavor to prevent a recurrence and get better based on one's own judgment. Furthermore, by sharing information on a service recipient's improvement after treatment with the service provider, the latter can analyze the suitability of the diagnosis/therapy in question on either an individual or group basis and reflect results in everyday services.

From a scientific point of view, the accidental nature of results in healthcare services cannot be removed as they can in information collected in clinical tests. Nevertheless, it can be seen that some service providers today are taking it on themselves to manage and analyze data on a daily basis and to use analysis results either directly or indirectly in diagnosis and treatment. This appropriate management of information and the ability to access and apply it on an everyday basis in a clinical environment can make a significant contribution to improving the quality of services. Furthermore, in addition to information collected unilaterally under prescribed circumstances, service providers should also be interested in what concerns a service recipient having any lifestyle before and after

morbidity. That is to say, information should be collected under the assumption that managing and evaluating a patient's concerns might be valuable in dealing with individual diversity.

SPECIFIC APPROACH TO HEALTHCARE: HEALTH CHECKUP SERVICES USING MOBILE PHONES

As a result of historical factors, healthcare in Japan has come to emphasize standardization of information (groups) for ascertaining a patient's condition and standardization of data formats. In addition, as large volumes of standardized data can be handled efficiently in IT, healthcare applications have traditionally focused on obtaining and providing knowledge extracted from group data.

From now on, however, there will be an increasing need to determine one's health on one's own. For example, if a person has been making regular outpatient visits for common diseases, that person may want to provide such outpatient information to a healthcare service provider. To meet these needs, "health checkup services using mobile phones" supports real-time management of data (groups)
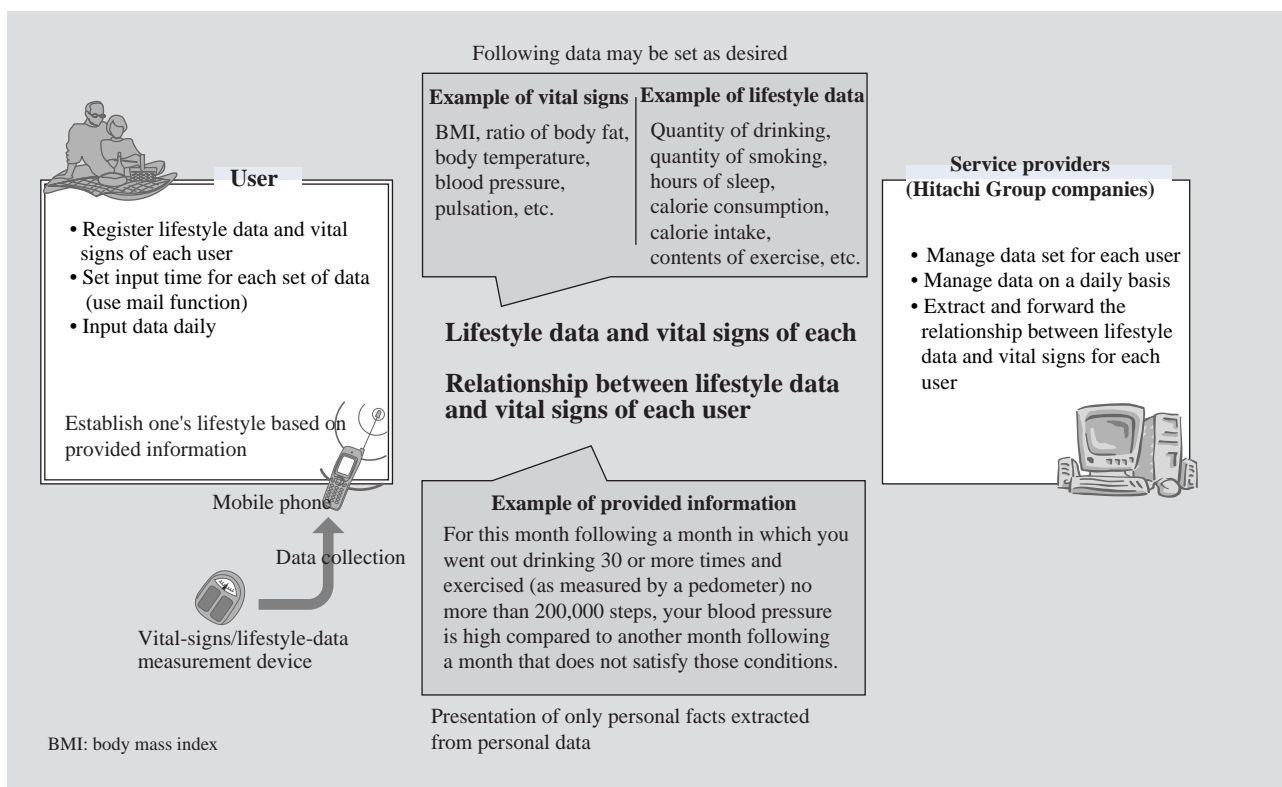

Fig. 3—Overview of Health Checkup Services Using Mobile Phones.
Health checkup services using mobile phones support (manage) personal healthcare data in
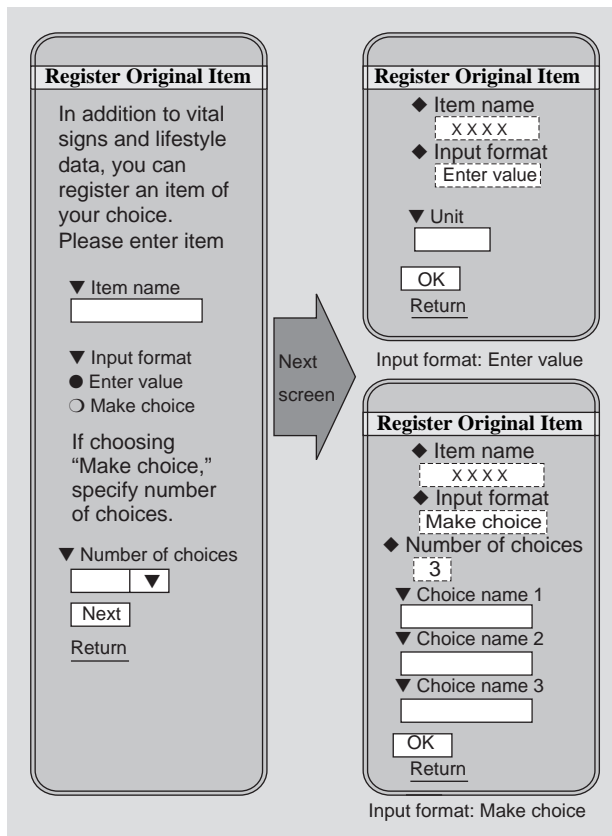*accordance with one's health awareness and lifestyle.*

Fig. 4—Screen Images in Health Checkup Services Using Mobile Phones.
In addition to recording changes in specific types of data, obtaining information on what data is of concern to individual users is also important.

adapting to individual lifestyles, the extraction of lifestyle data and vital signs, and the provision of information describing the characteristics of extracted data and relationships among them (see Fig. 3). Considering that 50 percent of people in the 40-60 year old age group own a mobile phone, we can use this mobile-communications literacy as a foundation for proposing a healthcare-data-management support service featuring the following menu.

(1) Information-management support for individual health needs

The user may select and set data items as desired. This capability does away with the old concept of information collection in healthcare. A function is even provided for setting and naming original items in accordance with individual needs. Fig. 4 shows screen images of this function.

(2) Input support

This service sends mail to the user to request previously specified information at a previously specified time. For example, given a service recipient

that sets "hours of sleep" every day, the recipient could have the service send mail while he or she is commuting and reply to that mail directly after indicating the previous night's hours of sleep. The service stores that data on receiving the reply.

(3) Provision of data-mining results using personal time-series data

As opposed to group-oriented knowledge and advice extracted from statistical results, this function extracts associations in stored lifestyle data and vital signs using data-mining techniques and provides that information to the user. For example, given a month in which a user went out drinking on more than 20 days and slept, on the average, for less than six hours, this function might advise the user that his or her blood pressure is significantly high compared to another month. In short, the function provides "facts" extracted from personal data.

In addition to easy and inexpensive product development and general-purpose information-processing technologies that make information-maintenance possible, the dramatic penetration of mobile phones is a boon to healthcare making the management and collection of information far easier than before. The spread of such mobile-phone-based services should accelerate research of people-friendly healthcare informatics described in the previous section.

CONCLUSIONS

This article has described healthcare dynamics informatics as promoted by Hitachi Group.

Over the last four years, Hitachi Group has been researching and developing ways of extracting information from clinical and genome data to assist in diagnosis*. Much of these R&D efforts focused on a database that would integrate diagnosis/treatment information and genome information for certain diseases. It was found that information that could help clinical physicians diagnose individual patients appropriately and lead to more effective treatment was more than just knowledge gained from domestic and overseas literature and from cohort research. It also consisted of information concerning individual differences in patients obtained at various clinical stages.

The role expected of IT in healthcare is to provide novel tools that can assist service providers in

determining how best to use individual patient information at various clinical stages once an entire distribution is understood.

In addition to proposing new services along with healthcare service providers, Hitachi Group plans to utilize state-of-the-art IT and to pursue new R&D efforts with the aim of providing superb healthcare informatics.

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