Highly Advanced Healthcare Support Services for the 21st Century

Takeshi Hashiguchi
Hiroshi Takeuchi, Ph.D.
Akira Uemura

OVERVIEW: The decreasing birthrate and increasing number of seniors in advanced countries is becoming an unavoidable situation, and the role played by medicine is becoming increasingly extensive as a means of sustaining an energetic society. People's needs in terms of health maintenance and medical therapy are becoming even more diverse and more advanced than ever before, and there is a demand for further increased quality of medical therapy. Meanwhile, as a result of various types of research related to genes and their functions, medicine has entered a major transition phase, shifting from a science based on traditional standard values to personalized medicine that is tailored to the characteristics of the individual's constitution or medical condition. In this backdrop, Hitachi, Ltd. has coined the term THEME (tailor-made health maintenance for each) to exemplify the directions that medicine will take in the 21st century. Within the continuous flow of risk assessment — screening for diseases — therapy, Hitachi is focusing on three major themes for medicine in the 21st century: (1) individual risk assessment based on the individual's constitution, including measurements of the individual's susceptibility to disease; (2) more accurate advanced disease screening, including function diagnosis (e.g., positron emission tomography (PET), which examines the function of cells, as opposed to CT or MRI, which examines the shape and location of organs); and (3) more appropriate "low invasive therapy," based on the results of diagnoses, which places little burden on the client.

INTRODUCTION

AS humans, our greatest concern is continued health. And when we become ill, our natural desire is to receive therapy that presents little burden, and to return to society as quickly as possible.

The 20th century was referred to as the "Century of therapy," in which attention was focused on what to do when a person became ill. In the backdrop of scientific advances such as those in the field of genetic research, the 21st century will be known as the "Century of prevention," in which attention is focused on preventing the client from becoming ill. In the past, medicine has focused more on the illness itself than on the individual that became ill. It can be presumed, however, that in the future, there will be an increasingly strong trend toward medicine that focuses on the individual.

Here, we will discuss the effects that the popularization of gene analysis technology and low invasive therapy will have on medicine, and, in that backdrop, the solutions and services that Hitachi proposes in the medical field for the 21st century, particularly in the area of advanced healthcare services.

MEDICAL ADVANCEMENTS AT THE BEGINNING OF THE 21ST CENTURY

In keeping with the establishment of a foundation for genetic research, as in the through studies such as the Human Genome Project, there has been an acceleration in research, on a global scale, into the relationship between disease and genes.

In the past, very little genetic information from individuals has been put to use, with the exception of studies into certain diseases with extremely strong genetic influences. In the near future, however, it is assumed that such individual genetic information will come to be used commonly in each phase of medicine (risk assessment, screening, and therapy).

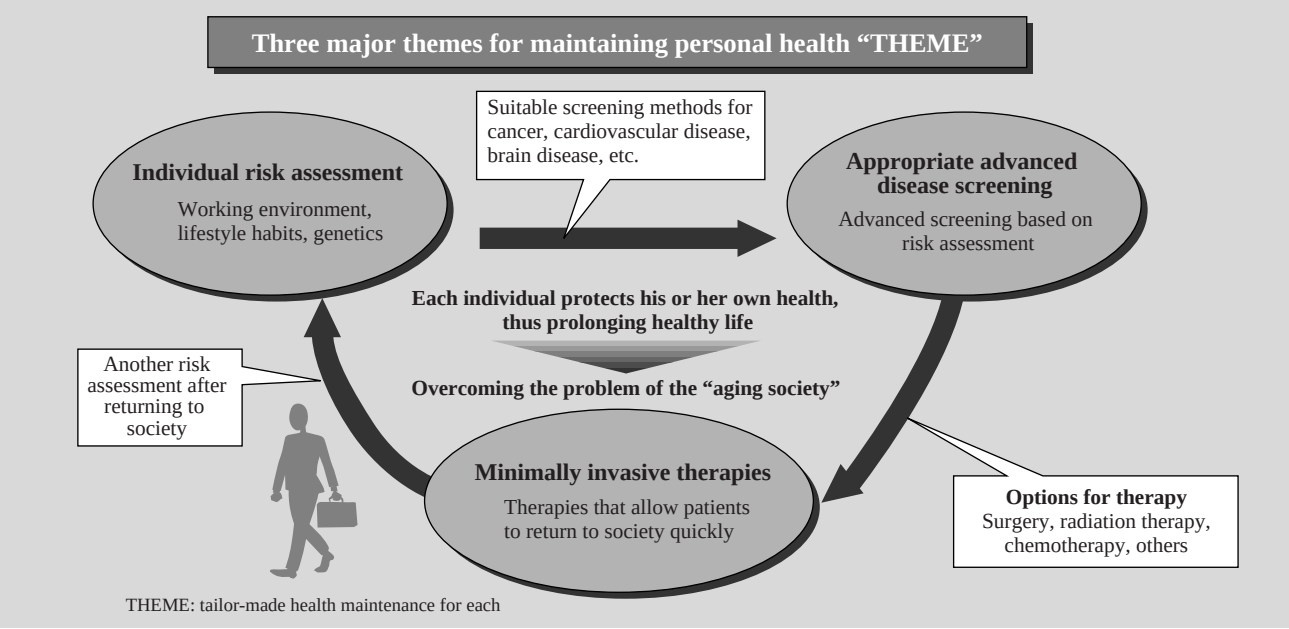

Fig. 1— Directions for Medicine in the 21st Century.
There is a need for medicine that has been optimized for the individual, with a systemization of the process of "projection of personal risk — appropriate advanced disease screening — appropriate low invasive therapy."

In the following sections, we will discuss the current status and image for the near future of medicine in each of phases mentioned above, keeping in mind the developments in genetic research and other cutting-edge medical research.

The Risk Assessment Phase

Traditionally, the main goal of physical check-ups has been to conduct the same tests for a specific group, and screen for common diseases such as cancer and diabetes.

As the relationship between genes and disease becomes clearer, it has also become clear that the degree of susceptibility to certain diseases differs from one individual to the next.

For example, health guidance has traditionally been given uniformly, regardless of the individual's constitution (the individual's sensitivity to tobacco, alcohol, etc.). But if the cancer susceptibility rate could be tested for each individual, and that information used in physical check-ups, then it will be possible to carry out these check-ups in a format tailored to the individual's constitution. If a certain person were diagnosed as having a comparatively high risk of cancer, then through appropriate counseling it would be possible to increase that person's day-to-day awareness of specified lifestyle habits; at the same time, by taking more frequent disease screening, early discovery of the disease can be made with even greater certainty.

There are issues that must be resolved if this practice is to be popularized; for example, the protection of individual privacy and the establishment of a counseling system. Nevertheless, we believe that physical check-ups based on judgments regarding the individual's constitution will become a major trend in the near future. In Japan, there is a system based on various laws and regulations by which people can receive physical check-ups despite having little awareness of their own condition. The above noted trend, however, will result from an increase in health awareness, characterized by a change in approach, from that of "someone will protect my health" to "I must protect my own health."

The Screening Phase

Startling progress was made in medicine in the 20th century in terms of technologies to test for specific diseases, mainly as a result of major developments in imaging technology, beginning with the discovery of the X-ray and exemplified by such technologies as CT (computed tomography) and MRI (magnetic resonance imaging).

As a result of the developments in molecular imaging, including molecular diagnosis and positron emission tomography (PET), imaging technologies in

the 21st century are about to enter a new stage that is more than ever before closing in on the "true nature of disease."

From the point of view of "increased efficiency," with a base on the foundation of each individual's susceptibility to disease as determined through molecular diagnosis, it is possible to conduct screening that minimizes the risks accompanying certain tests, including exposure to radiation, by optimizing the frequency of such medical examinations. And from the standpoint of "increased accuracy," by adding functional information derived through PET examinations and measurements of biomagnetic fields [magnetoencephalogram (MEG) / magnetocardiogram] to morphological information derived through traditional CT and MRI screening, we can look forward to comprehensive, multi-faceted diagnoses for cancer and cardiovascular diseases.

Through such advancements in screening technologies, cancer and cardiovascular diseases will be discovered at an earlier stage than ever before, and it will become possible to obtain effective, detailed information at the time of discovery including a prognosis for recovery. As a result, even once a disease has been discovered, it will be possible to store sufficient information and transfer it reliably to the following "therapy phase."

Effects in the Therapy Field

Optimization of therapy methods

In the midst of increasing trends toward evidence-based medicine (EBM), it can be assumed that therapy methods in a form tailored to the individual will be arranged from among various types of treatments, based on a more accurate understanding of that individual's constitution or condition, as discussed earlier. For example, in the case of cancer, by genetically investigating the client's constitution or type of cancer, it becomes possible to select effective therapy methods with little side effects from among the various treatments available, such as surgery, chemotherapy, or radiation therapy methods. There are expectations that the development of pharmaco-genomics in particular will dramatically reduce the side effects common to chemotherapy.

Improving quality of life (QOL) through prognosis (the rise of low invasive therapy)

Surgery methods, which in the past have relied heavily on the skills of the surgeon, are also about to enter a major transition phase.

There has been growing attention focused on "Low invasive operations," in which the clients are able to leave the hospital on the day of the operation or only a few days later to return to society, where they would have required several weeks in hospital or in rehabilitation with a traditional surgical operation. Meanwhile, in terms of radiation therapy, advances have been made in proton therapy systems that allow localized irradiation of the cancerous nidus, suggesting that we are close to an era in which even cancer clients can receive therapy with little disruption of their everyday lifestyle patterns.

HITACHI'S "THEME" ACTIVITIES

In the face of the medical advancements discussed above, there is a need not only for traditional stand-alone medical equipment and information systems that have been designed for specific operations; there is also a need for solutions and services for entire systems that can respond flexibly to changes in the healthcare (see Fig. 2).

Below, we will discuss the concept of advanced physical examination support services with a focus on the fields of general physical check-ups and specific medical screening, in the context of "THEME," which was mentioned at the outset.

Advanced Physical Examination Support Services

In terms of the next-generation physical examinations discussed in the previous section, Hitachi, Ltd. uses the name MOLDIP (molecular diagnosis and imaging for preventive medicine) to define advanced examinations that place an emphasis on a molecular biology-based viewpoint, and has made this its business concept for physical examinations and screening in the 21st century (see Fig. 3). As a starting point, we will proceed with genetic diagnosis forming the core of activities in molecular diagnosis, and PET diagnosis at the core of molecular imaging activities. By merging these two types of diagnosis, we hope to achieve the types of services described below, and in doing so give rise to new diagnostic values that are even closer to the true nature of the disease, popularizing these values as an advanced form of medical examination.

(1) Support services for genetic health check-ups ("BIO-DOC")

Hitachi has developed next-generation physical examination that includes both assessments of individual susceptibility to common diseases and

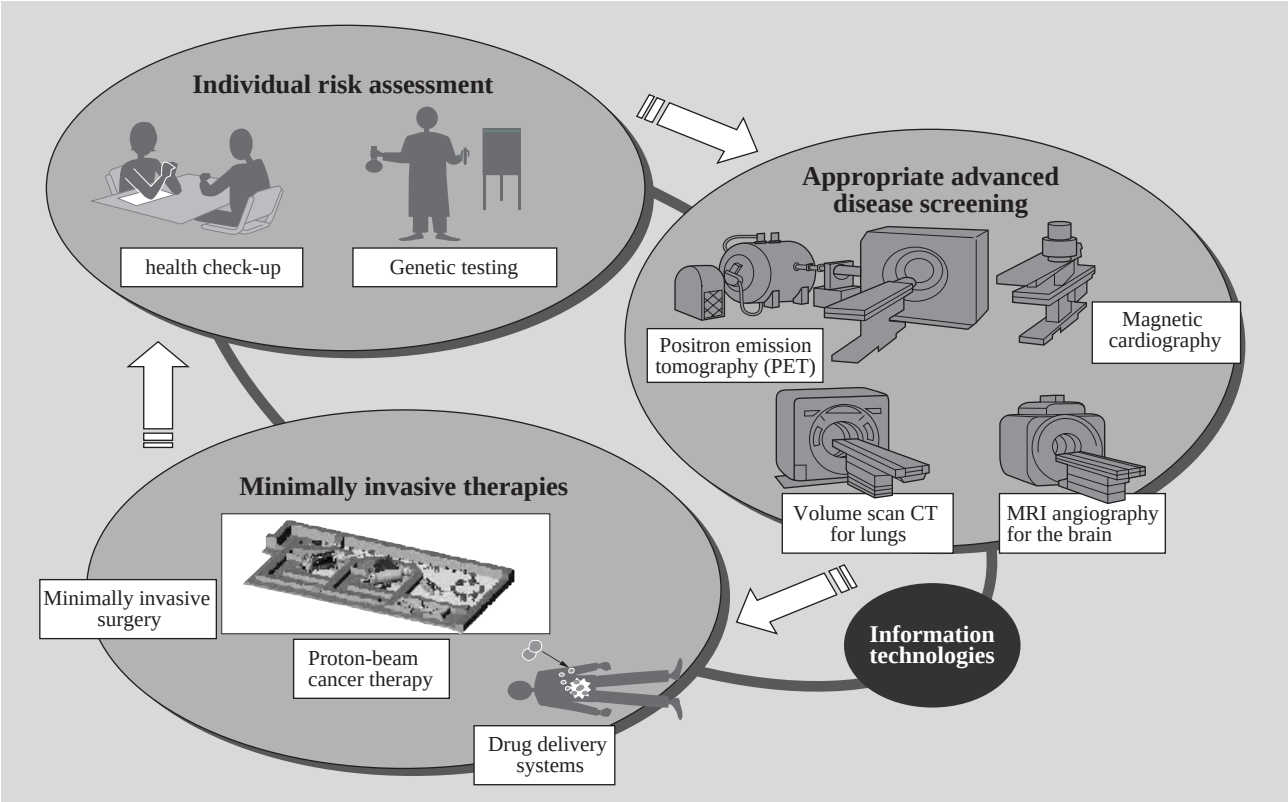

Fig. 2— Hitachi's Solutions in the Context of "THEME."
Provision of system services at each phase are required, along with IT applications that integrate all elements of health care.

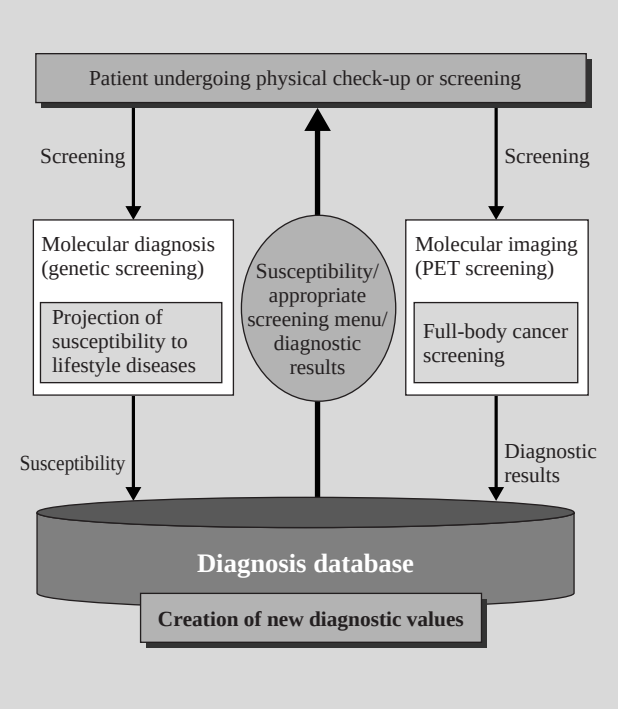

Fig. 3— Concept of MOLDIP (molecular diagnosis and imaging for preventive medicine).
New diagnostic value is created through the results of a synergy of molecular diagnosis and molecular imaging.

currently available information as obtained by laboratory tests and interviews. The inclusion of assessments of susceptibility will enhance the quality of general examinations.

Hitachi, Ltd. has given the name "BIO-DOC" to this type of health examination, to indicate that it is an evolved form of the current health check-up service (a common type of health check-up service in Japan is called the HUMAN DOCK; this consists of several types of examination). BIO-DOC has been registered as a trademark in the United States.

In traditional check-ups, clinical test values and lifestyle habits are evaluated as a relative value within a certain group; there was little consideration for each individual's constitution or sensitivity to disease. The goal of BIO-DOC is to obtain information on genes that contributes to the susceptibility rate for specific diseases, and by doing so to use this information for diagnoses — in combination with other clinical tests and information on lifestyle habits derived from interviews — in a format that is suited to the individual client.

In order to make BIO-DOC a reality, it is necessary to put together diagnostic know-how relating to the

genetic tests required to obtain information on disease susceptibility. Hitachi is currently promoting joint research in this area with several medical institutions.
(2) PET screening support service

PET is currently being implemented in over 30 facilities in Japan. Traditionally, it has been used mainly to measure the functions of the brain, but with the development of ^{18}F-FDG and other new "radio-pharmaceuticals," there are increased expectations for the application of PET in full-body screening for cancer. ^{18}F-FDG is FDG (fluorodeoxyglucose) labeled with ^{18}F. It allows monitoring of sugar metabolism in cells. By using this as a pharmaceutical, it is possible to obtain quantified information on the function of cancer cells; in combination with traditional morphological information obtained from CT, MRI, etc., we can expect even more accurate cancer diagnoses. In the future, by combining this approach with such technologies as molecular diagnosis, it may be possible to bring about new diagnosis values that bring us even closer to the true nature of disease.

The main constituent parts of a PET system are the cyclotron, CBB (chemical black box), radiochemistry system, and the PET camera. Furthermore, in order to increase the quality of the diagnosis, it is necessary to establish an information network and a database for client information.

It is Hitachi's goal to build and maintain this type of system, and also to provide comprehensive services that cover a wide range of business operations, so as to enable health facilities and institutions with PET systems to operate these systems smoothly and efficiently.

A Form for Achieving Highly Advanced Healthcare Support Services (see Fig. 4)

Japanese medical policies are aimed at reductions in healthcare costs, so not a few healthcare institutions emphasize physical examinations and health check-up services, the price of which is not controlled by the government under Japan's public healthcare insurance system. From the point of view of marketing our service and obtaining clients with a high level of health awareness, we see that they tend to eagerly make efforts to enrich their available healthcare services under a more comprehensive management system. In this situation, institutions are demanding the establishment of networks that link institutions with other institutions, as a significant measure towards providing their clients with a high level of healthcare service regardless of an individual institution's medical facilities.

To serve the healthcare market that extends beyond the public insurance system, Hitachi will provide the following comprehensive services in order to support primary healthcare providing institutions; marketing, customer management, schedule management, management of data on clients, etc. At the same time,

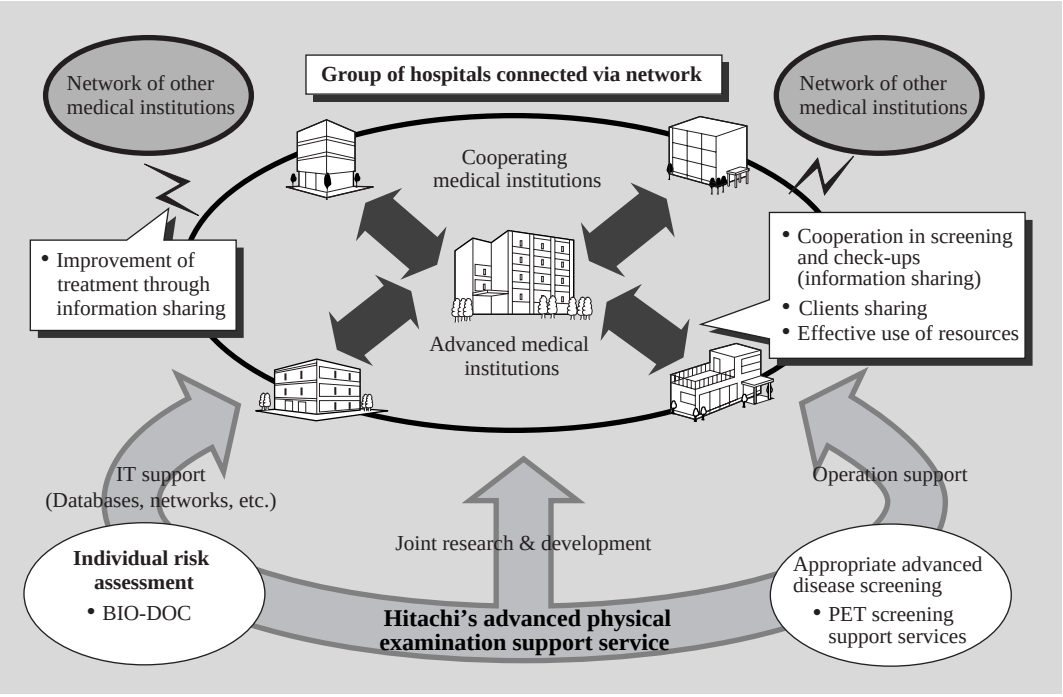

Fig. 4— Future Image of Advanced Healthcare Support Services. Providing efficient, high-quality services in the context of advanced healthcare services amid a growing implementation of networks in the field of unrestricted medical consultations.

we will strongly promote the creation of new diagnostic values through joint research with advanced medical institutions that are on the front lines of clinical practice.

CONCLUSIONS

Here, we have attempted to make one projection about the major transition phase that medicine is approaching; we have presented Hitachi's concepts, and at the same time discussed the new efforts in Highly Advanced Healthcare Support Services that form the central pillars of these concepts.

As medicine undergoes significant changes, then changes will also be demanded of medical institutions and medical staff. Based on the concept that "when society changes, we want it to be Hitachi that changes it," we will continue to provide services with new value (services that are not restricted by existing business styles) by participating actively in the plans for the major changes to take place in the medical field.

Other papers contained in this feature will discuss solutions for low invasive therapy, as well as advanced disease screening.

ABOUT THE AUTHORS

Takeshi Hashiguchi

Joined Hitachi, Ltd. in 1994, and now works at the Marketing Dept. of the Medical Systems Division. He is currently engaged in operations related to planning and proposal activities in advanced healthcare services. Mr. Hashiguchi is a member of the Japan Association for Medical Informatics, and can be reached by e-mail at t-hashiguchi@med.hitachi.co.jp.

Hiroshi Takeuchi

Joined Hitachi, Ltd. in 1971, and now works at the Marketing Dept. of the Medical Systems Division. He is currently engaged in the creation of businesses related to advanced healthcare services. Dr. Takeuchi is a member of New York Academy of Sciences, IEEE, SPIE, the Japan Association for Medical Informatics, and the Japanese Society of Computer Aided Surgery. He can be reached by e-mail at hi-takeuchi@med.hitachi.co.jp.

Akira Uemura

Joined Hitachi, Ltd. in 1973, and now works at the Nuclear Fusion & Accelerator Project Dept. of the Nuclear Power Systems Division, of Power & Industry Systems. He is currently engaged in cyclotron operations and overseeing advanced healthcare service operations. Mr. Uemura is a member of the Japan Society of Plasma Science and Nuclear Fusion Research, and can be reached by e-mail at akira_uemura@pis.hitachi.co.jp.