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Background/Introduction

Diagnostic imaging has progressed very quickly and has greatly contributed to clinical medicine. Large-sized medical imaging systems including CT and MRI have become common in our country, and patients can undergo such examinations everywhere. On the other hand, it is difficult to utilize the imaging data obtained at individual hospitals on a nationwide basis. Several problems remain to be solved, including poor efficiency in clinical practices, overly high medical bills and concerns about medical safety. We believe that the advance of Information and Communication Technology (ICT) may enable us to use "big data" to solve some of these problems.

The Japanese Radiological Society (JRS) is advocating the development of so-called "Japan Safe Radiology." The aim of this project is to construct a system for network-type management of diagnostic imaging nationwide. Concretely, we aim to generate, analyze and utilize a national database of diagnostic imaging and thereby to improve medical techniques in terms of safety, standardization and optimization of image scanning, and also to apply it to medical policy. The characteristic of this project is to carry out an "all Japan" organization under the auspices of the largest society related to diagnostic imaging in our country (JRS) in cooperation with JIRA (Japan Medical Imaging and Radiological Systems Industries Association). This attempt is the first in the world and wholly original. A structure that collects information on radiation doses and utilizes it has been partially constructed in the United States [1]. However, there is no management system that integrates medical imaging data on the national level. In this project a storage server and registry server will be newly established. Information on medical imaging data collected all over the country will be integrated in the servers. By utilizing this imaging data, new medical technology may be developed, and multi-center collaboration studies may also be designed with ease, resulting in the promotion of clinical study. Specific items to be carried out include (1) proper distribution of medical equipment and radiologists, (2) development of a Clinical Decision Support (CDS) system for proper utilization of medical equipment, (3) network-type management of radiation exposure doses (Dose Index Registry: DIR), (4) proper quantitation of medical imaging data based on the establishment of Japan's Quantitative Imaging Biomarker Alliance (J-QIBA) and (5) unification of diagnostic reports. The final goal of our project is the clinical application of artificial intelligence (A.I.). In the next section we present describe in greater detail the activities to be advanced in Japan Safe Radiology.
Description of activity and work performed

The overall structure of "Japan Safe Radiology" is shown in Fig. 1.

The first goal at which "Japan Safe Radiology" is aimed is unified management of medical resources: i.e., the establishment of a national database of diagnostic imaging (Japan Medical Imaging database: J-MID). The database will be generated by collecting CT and MRI images from medical institutions all over the country. Collected data will be shared, analyzed and utilized as big data. We have already started to design and develop a small-sized system using data from six medical institutions. In the future this system will be extended to all university hospitals, general hospitals and clinics. Our goal was to construct an environmental where the image presentation service can be utilized on the Cloud. Design and development will be performed for the gateway system of a client, which can respond to every PACS maker (Fig. 2). From there, consideration will be given to the integration of this database to include other domains such as endoscopic and pathological images. Cooperation with JIRA will be necessary to accomplish this project.

We plan to advance the following six items based on this J-MID.

1) Proper distribution of medical equipment and radiologists

In our country the number of large-sized medical imaging systems such as CT and MRI has been increasing compared with that in other technologically advanced nations (Figs. 3 and 4). On the other hand, the number of radiologists is running short, and about 2.09 times the number of radiologists employed in Japan are currently required to interpret CT and MRI examinations (Fig. 5) [2]. Also, the medical equipment is unevenly distributed, and the regional gaps in radiological medical practice are large. In order to narrow these regional gaps, both medical equipment and radiologists should be distributed more appropriately, based on the data of J-MID.

2) Development of a Clinical Decision Support (CDS) system for proper utilization of medical equipment

We plan to develop a CDS system. Using this system a diagnostic examination suitable for each patient’s condition will be automatically selected in clinical practice. The guidelines for the choice of a diagnostic examination will be stored in this system. On the occasion of an initial examination order a physician could call up relevant patient data from the registry server of J-MID, based upon which a proper examination for the patient will be automatically selected. Reduction in the orders of duplicated examinations, improvement in diagnostic accuracy, reduction of medical radiation exposure and medical expenses, improvement in the quality of a radiologist's report, and overall advances in the efficiency of clinical practice, etc. are expected. Please refer to the poster presentation.
3) Network-type management of radiation exposure dose (Dose Index Registry: DIR)

In addition to image data, radiation exposure doses will be collected from J-MID, with the aim of developing a system that performs automatic statistical interpretation (Dose Index Registry: DIR). Eventually the optimization of scanning protocols and radiation exposure doses will be performed, and improvements in medical safety will be seen. The exposure doses for coronary CT at each national university of our country is shown in Figs. 6 and 7. The diagnostic reference level is set at the 75th percentile of the dose distribution from a survey conducted across a broad user base in Japan. As shown in the figures, the exposure dose differs markedly among institutions. The optimization of an exposure dose should be considered at some institutions. In cooperation with Japan Network for Research and Information on Medical Exposures (J-RIME), which is aiming to standardize radiation exposure across large-scale imaging systems, new evidence could be obtained.

4) Proper quantitation of medical imaging data based on the establishment of Japan Quantitative Imaging Biomarker Alliance: J-QIBA)

An imaging biomarker is an indicator that can express disorders noninvasively and quantitatively. Many researchers have undertaken clinical studies, and various useful biomarkers have been reported globally. However, due to differences in medical equipment, scanning protocols and calculation methods, it is difficult to make direct comparisons of imaging biomarkers obtained at different institutions. This has been an unsolved problem worldwide. In this project the standardization of quantitative imaging biomarkers will be attempted based on imaging information of J-MID. A platform for advancing accuracy and standardizing imaging biomarkers will be structured so that they do not differ among various vendors and equipment.

5) Unification of diagnostic reports

Not only imaging data but also diagnostic reports will be collected, as much as possible, by J-MID. This will enable us to compare new data with a large dataset of previous images and reports at individual institutions in daily practice. By integration with the database of pathological imaging and reports we will be able to share rare cases, contributing to the education of radiologists and the improvement in their diagnostic performance. In the future, part of this database could also be utilized to fine-tune the JRS registration system and evaluate medical treatment fees and hospital evaluation systems, etc.

6) Clinical application of artificial intelligence (A.I.)
Diagnostic imaging support with A.I. has been improving, and the technology for differentiating and classifying extreme variations in imaging by deep machine learning has recently been established. In this project, an automatic diagnosis system based on deep learning will be constructed using accurate annotation including the kind of diagnostic imaging, the site of disease, the final diagnosis and other medical data (findings and diagnostic information, etc.). Various new applications or services could develop by environmental management such as big imaging information that has perfect anonymity. Moreover, this environmental management will lead to the training of human talent for analytics in the field of diagnostic imaging.
Conclusion and Recommendations

In this presentation we have outlined a future view of "Japan Safe Radiology". We have clarified the problems that Japan faces with advanced medical imaging at the present time and have started to address them by imagining the establishment of a new system for diagnostic imaging. Various hurdles remain. However, our aim is to use cutting-edge data processing systems to develop a system in Japan that can serve as a model for other countries worldwide.

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