

REVIEW

The role of medical informatics in the management of medical information

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Abstract : With progress in information and communication technology, medical information has been converted to digital formats and stored and managed using computer systems. The construction, management, and operation of medical information systems and regional medical liaison systems are the main components of the clinical tasks of medical informatics departments. Research using medical information accumulated in these systems is also a task for medical informatics department. Recently, medical real-world data (RWD) accumulated in medical information systems has become a focus not only for primary use but also for secondary uses of medical information. However, there are many problems, such as standardization, collection, cleaning, and analysis of them. The internet of things and artificial intelligence are also being applied in the collection and analysis of RWD and in resolving the above problems. Using these new technologies, progress in medical care and clinical research is about to enter a new era. *J. Med. Invest.* 67:27-29, February, 2020

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COMPUTERIZATION OF MEDICAL INFORMATION

Medical information comprises basic information shared between patients and medical staff, and it is widely used in clinical practice, telemedicine, regional collaboration, health welfare, clinical research, education and training, hospital management, etc. Medical information was written and stored on paper not so long ago, but now it is being digitized with advancements in information and communication technology (ICT), and it is stored and managed appropriately by computer systems. As a result, large amounts of information can be handled conveniently in terms of both time and space. In contrast, management and security have to be dealt with extremely carefully. Because medical information, in particular, contains a large amount of sensitive personal information, it is important to construct secure medical information systems, to manage and operate it properly, and to save it appropriately.

Requirements for electronic storage methods and the location of medical care history and medical care records are clarified based on the “Notice on Storage of Electronic Media Such as Medical Care History” issued in April 1999 and the notice “Location of Storing Medical Care History and Other Records” issued in March 2002. In the case with three principles of electronic storage (provision of authenticity, visual readability, and storage property) can be guaranteed, medical care history and medical care records were permitted to be handled as electronic documents, which are required to be created or preserved by law and regulations in principle. Similarly in other industries, the “Law Concerning Use of Information Communications in the Storage of Documents Made by Private Operators (e-Document Law)” was enacted in November 2004 and has enabled the handling of documents in which preparation or storage is made obligatory

by laws and regulations. Concurrently, the existing “Guidelines for Storage of Medical Care History and Medical Care Records of which Storage Duty is Stipulated in Regulations” and the “Guidelines for External Storage of Medical Care History” are to be reviewed by the medical field, and “e-Document Law Ministerial Ordinance” was issued by the Ministry of Health, Labour, and Welfare Health in March 2005. Additionally, the “Guidelines for Personal Information Management by Medical Treatment and Nursing Care Organizations” were made public in December 2004 after guidelines related to the operational management of information systems that contribute to the protection of personal information and the guidelines for appropriate support for the e-Document Law are to be comprehensively prepared.

Based on the above regulations, “Guidelines for the Security Management of the Medical Information System” were issued in March 2005, with full implementation of the “Act on the Protection of Personal Information (Personal Information Protection Law)” enacted in May 2003. Currently, the latest version of the guideline (the fifth edition) announced in May 2017 has been revised in response to the spread of and diversification and refinement of cyber-attacks targeting medical institutions, promotion of regional medical cooperation and medical care cooperation, and new technologies and services such as the internet of things (IoT) (1). It also supports the revised version of the Personal Information Protection Law (Amended Personal Information Protection Law), which was enacted in September 2015 and fully implemented in May 2017. Dealing with medical information, it is necessary to keep in mind the above rules and guidelines, and it is important to consider information morality and literacy.

CLINICAL ROLE OF MEDICAL INFORMATICS

The introduction of medical information systems is increasing every year, and the introduction rate of medical information systems in 2017 was 34.4% at medical institutions nationwide and 76.3% at hospitals with 400 beds or more (2). Moreover, old systems have already been updated to second- or third-gener-

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ation systems in many facilities. Medical information systems have many benefits, including speeding up information access and transmission, linking and sharing information, search functions, ease of data aggregation, space reduction for data storage, and long-term storage. On the other hand, there are several demerits such as limitations on operating locations, visibility, recording of mixed information comprising characters and pictures, response to failure or blackout, security risk, and high cost of introduction and operation. In addition, there are some problems such as reading medical care records for purposes of other than clinical use, upgrading of authentication systems, and online medical care. The clinical task of the medical informatics department is the introduction, construction, operation, and management of these systems, and trying to solve their problems with advantages and benefits for their departments.

Another clinical practice of the medical informatics department is the construction, operation, and management of regional medical liaison network systems using ICT. In recent years, as the importance of medical liaison networks has increased, the medical information network base has become a focus. At least 270 regional medical liaison networks have been launched nationwide in 2017 (3), and 26 cooperation system networks cover all area of their own prefectures (4). Regional medical networks are classified into three types: those that connect networks already established in the local medical zone, those that connect all participating facilities to one central server, and hybrid types.

In the first example, if the respective networks use medical systems from the same vendor, it is not difficult to connect the networks using a regional cooperation system owned by the same vendor. However, if the respective networks use medical systems from different vendors, it becomes necessary to combine them by utilizing standard formats. Usually, medical information in a regional medical liaison network is shared in the system by standardizing the medical information using an international standard format by Health Level Seven (HL7) and managing it in standardized storage based on the Standardized Structured Medical Information eXchange2 (SS-MIX2) at the central server. In the second type of connect all participating facilities to one network, medical information is shared by one central server using the above methods.

In Tokushima Prefecture, as an example of the hybrid type, a cloud-based electric health record (EHR) advancement project by the Ministry of Internal Affairs and Communications called “Awa ai net” was launched in 2017, and system operation using actual clinical data was started in January 2019. The feature of this system is connecting medical information by sharing in both directions among the all medical and nursing care facilities in Tokushima Prefecture. Actually, medical information in each conventional network in the local medical area and the new cloud system is shared among the participating facilities using a connecting name identification with cross reference with international standard patient identifier cross-referencing/patient database query (PIX/PDQ).

RESEARCH OF MEDICAL INFORMATICS

Utilization of medical information is classified into primary use for actual clinical care and secondary use such as medical research, medical education, public health, hospital management, medical crisis management, and medical policy planning. Although clinical research with a higher evidence level has been emphasized, randomized controlled trials may not reflect real-world effectiveness (5-7). Recently, therefore, it has been attracting attention to use medical information in clinical practice, so-called real-world data (RWD) as medical care big data, and

analyses using RWD are also underway as part of national policy, such as the 5th Science and Technology Basic Plan (Society 5.0). RWD generated from actual clinical medicine accumulates in a data warehouse (DWH) linked to a database via a medical information system or a regional medical liaison system. RWD required for analysis is collected from the DWH; however, there remain many issues such as standardization, collection method, and cleansing of the medical care records. The medical informatics department plays a role in solving them and providing necessary information for secondary use of medical information.

Furthermore, as medical big data will be allowed to be pooled anonymously with the enactment of the “Act on Anonymously Processed Medical Information to Contribute to Medical Research and Development (commonly called the next-generation medical infrastructure law)” in May 2017, it is expected to be used for research in the medical field and the development of new diagnosis and treatment methods. In particular, image analysis and diagnosis support tools have already been developed in several medical fields (8, 9). In this field, we also have reported high-speed extraction of the organ area of the lung and liver using an improved radial basis function (RBF) network utilizing a graphics processing unit (GPU) in order to identify the extracted lesion in organs in a short time (10).

Given the rapid and impressive progress of these technologies, the use of the IoT, business intelligence (BI) tools, and artificial intelligence (AI) are all expected in the collection, extraction, processing, analysis, and prediction of medical information. Analysis methods by AI generally includes machine learning and deep learning. The former is a method or program that learns based on given information and finds out rules autonomously (11, 12). The latter is a subset of machine learning called a neural network with further advanced technology designed to learn mainly by simulating the behavior of the nervous system of a living being (11, 13). The application of AI progress is remarkable in the medical field as in various other industries. Its application is enriching and the analysis and prediction of medical information is expected to contribute to the development and constructions of new medical environments (14-16). Along these lines with the development of medical support system using AI, both primary and second use of medical information will accelerate.

In contrast to the advancements in these new technologies, technical issues have been overshadowed by procedural, professional, social, political, and especially ethical issues as well as the need for compliance with standards and information security (17). Although EHR use has increased, and clinicians are being prepared to practice in an EHR-mediated world and have made enormous advancements, many of the early expectations for EHRs have not been realized, and current EHRs still do not meet the needs of today’s rapidly changing healthcare environment. For example, the labor by medical staff using the medical information system has never been alleviated due to the burden of inputting patients’ information and to the increase in prepared documents. In addition, many patients are dissatisfied because physicians see only clinicians computers at their medical examination (18). According to a survey by the University of California, San Francisco, patient dissatisfaction rate in high computer use encounters was 83% compared with 48% in low computer use encounters (19). In such clinical practices, it is expected to develop a medical support device which is capable of automatically realizing medical document and communication correspondence with a patient using AI.

NEXT ADVANCEMENT OF MEDICAL INFORMATION SYSTEM

Medical information systems began with the medical payment accounting systems in the 1970s. These were developed into medical ordering systems, medical information systems, and regional medical liaison systems. Next, these may be further developed into an EHR including medical, health, and welfare information, and into a personal health record (PHR). Medical information systems provide tremendous opportunities to reduce clinical errors such as medication errors and diagnostic errors and to support healthcare professionals by offering up-to-date patient information. Current and new EHR technology will help to provide international standards for interoperable applications that use health, social, economic, behavioral, and environmental data to communicate, interpret, and act intelligently on complex healthcare information to foster precision medicine and a learning health system (17).

Although, it has been nearly 30 years since the quality of medical information improved by integration, sharing, and standardization of data, and the quality and efficiency of clinical medicine itself has also improved, current medical information systems still have data integration challenges and lack of functionality to exchange patient information from all or some parts of the healthcare system. These limitations can be attributed to technical, human, and organizational factors (20). However, as medical information systems and computerized clinical decision support have made contributions to medicine in the past decades, by using better medical knowledge, optimized medical information systems and computerized clinical decisions will continue to enable dramatic improvements in both the quality and safety of patient care in the future (21). In accordance with this, demands for functionality in medical information system are rising rapidly, they will be realized to improve workflow and efficiency of care, thus boosting the overall quality of healthcare. Moreover, clinical medical practice will reach a new era soon using medical support tools for decision-making by analyzing medical big data using AI and the IoT.

CONFLICTS OF INTERESTS

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