Electronic Medical Record System "MegaOakHR"

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Abstract

MegaOakHR is a core electronic medical record system that is used to record and share medical information including order instructions, medical record entries and information references. This paper reviews the development background of MegaOakHR and introduces the innovative functions and modifications now featured in its internal structure.

Keywords

electronic medical record, .NET, .NET Framework

1. Introduction

At NEC, we released MegaOak-NEMR in 2000 as a package for supporting electronic medical record systems. Since then, the functions required to support medical records have been expanding day by day via various studies, discussions and practical experience. The expectations for its future advantages have therefore become greater than ever.

Based on the above background as well as on the ongoing progress of technology, we enhanced the value of the package to the advantage of users, reviewed the system structure and released the MegaOakHR solution to the market in October 2006.

In the following sections, we will introduce MegaOakHR together and review the functional enhancements applied since its release.

2. MegaOak–NEMR

On April 22, 1999, the then Ministry of Health and Welfare published an administrative document entitled "Storage of Medical Records, etc. in Electronic Media," and proposed three principles for electronic medical record systems (authenticity, readability and storability). This publication triggered a massive introduction of electronic medical records, and led to the availability of additional functions such as the document management function covering examination reports, referral letters and summaries and the Flow Sheet function showing medical record information in a tabulated form.

One of the features of the electronic medical record is that it offers a variety of modes for representing the same data. It allows a single piece of information to be searched, processed and displayed in various forms including a Progress Note and a tabulated form (Flow Sheet).

We also studied the use of the Object Database as the DBMS because the medical record system features a data warehouse type characteristic in addition to its conventional job status. However, we eventually decided to use the Oracle system that is used in existing ordering systems in consideration of the desirability of its continuity as a package.

On the other hand, in terms of hardware the server availability in the initial stages of the design process used a powerless CPU of about 400MHz. So we selected the so-called fat client configuration in which client processing is executed in consideration of the fact that it would be difficult for the server to process multi-dimensional search and display image constructions for more than 1,000 clients. Also, in order to improve the processing speed, availability and stability, we selected a system in which the client disks hold cached data and async processing is executed by a message queuing process.

3. Expectations for the Electronic Medical Record System

The functions required for electronic medical records and the roles expected of them are increasing on a daily basis. Since the period before the "three principles" were proposed, academic societies and forums including JAMI (Japan Association for Medical Information) have been studying and actively discussing optional formats for electronic medical records. As accumulated experience and social contexts have changed, the format has gradually changed and begun to take on a more concrete shape. What had not been possible before has now become a matter of course, and we are now at the stage of

making another leap forward to the next stage.

Currently, there are the following three requirements for the new functions.

1) A function for improving the quality and efficiency of hospital jobs.

2) A function for improving safety by preventing incidents, etc.

3) A function for improving security in relation to the personal information protection law, etc.

4. New Functions of MegaOakHR

This section describes the representative new changes of MegaOakHR that were developed based on the above requirements.

4.1 Improvement of Usability

Ergonomic principles require that the natural movement of human sight is to move from left to right, and from up to down. With MegaOakHR, the information to be checked and the buttons to be operated first are located at the top left position, and the buttons to be operated last are located on the bottom right position. Although this layout may increase the movement of sight, it is effective for the medical world in which a birds-eye view and prevention of overlooking are important factors.

The colors and positions of buttons have also been changed in order to prevent them being mistaken. Buttons for “close” and “cancel” type operations are colored green and are placed at the bottom left, those for “register” and “enter” type operations are colored yellow and are placed at the bottom right and other buttons are colored blue and placed in the center (**Fig. 1**).

To prevent the mistaking of patients, an illustration matching the sex and age of each patient is displayed on the medical record display (**Fig. 2**).

4.2 Promotion of Team Treatment

In a hospital, various kinds of medical staff are engaged in the treatment of each patient. It is an important factor for the prevention of incidents that information is transmitted accurately among the staff.

We developed several mechanisms for transmitting instructions and indications across the occupation categories, and

Fig. 2 Illustrations on the main display.

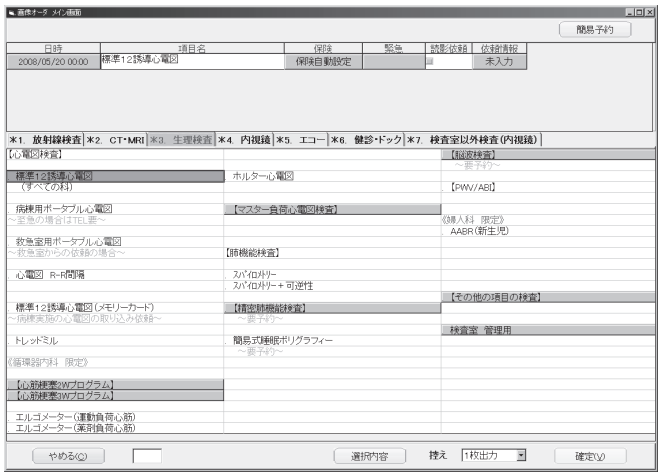

Fig. 1 Change in button positions and colors.

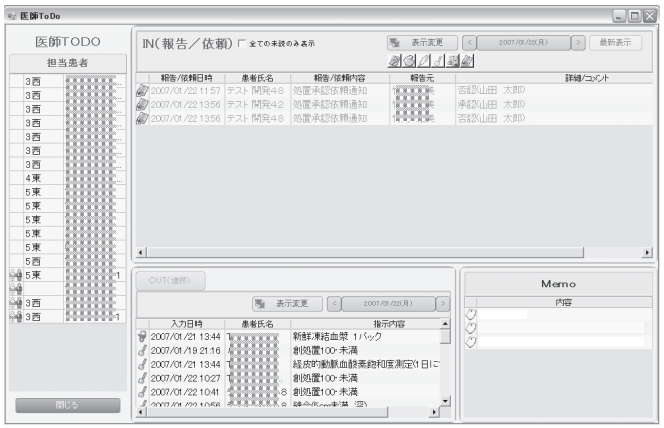

Fig. 3 Example of Doctor ToDo.

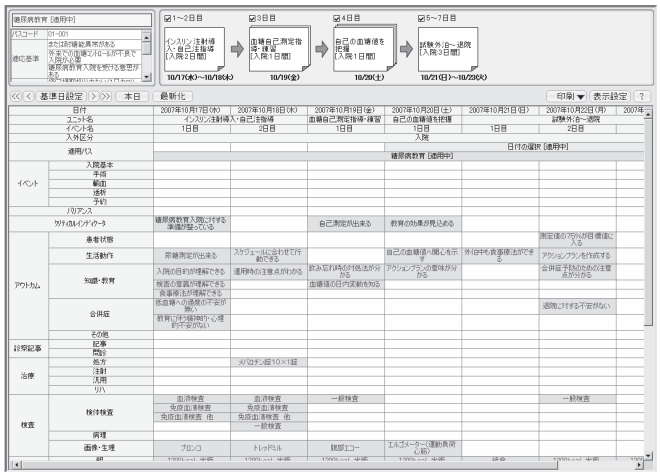

Fig. 4 Example of a clinical pathway system component display.

those that have already been released include “Doctor ToDo” (**Fig. 3**), “Nurse ToDo,” “Ward ToDo” and “Patient ToDo.” The staff receiving such instructions can also use these mechanisms as memoranda or make inquiries on the instructions on the ToDo lists (ToDo means a memo of what should be done or what should not be forgotten).

4.3 Other Functional Enhancements

To enhance the function of clinical pathways and enable fine support for treatment, we developed a clinical pathway system component that allows treatment processes to be combined according to the specific circumstances and conditions of the disease and the patient (**Fig. 4**).

With regard to the document management function for describing summaries and referral letters, we provided a mechanism for saving labor in document compilations by enhancing the previous data quotation function.

As the requirements for security enhancement have become important, as seen with the personal information protection law, we have developed an access log function for preventing and surveying illegal access events and an access control function for preventing reference to patients other than those in the charge of an assigned user.

5. Internal Structure of MegaOakHR

5.1 Adoption of .NET Framework

The hardware environment has changed significantly since the development of MegaOak-NEMR. With MegaOakHR, we have rearranged the modules to enable effective utilization of hardware resources. However, since it has not been possible to redefine all of the source codes from the viewpoints of their development periods and influence, it has been necessary for us to retain the previous modules and enable the new modules to coexist with them by assuring their compatibility. We described in the above that “the medical record system contains a data warehouse type character” and, in order to ensure this characteristic it is also necessary that the system is capable of defining views flexibly based on a physical database schema.

Although it is technically possible to define views on the server, we have not selected this option because it increases the server load too much and we have therefore selected configuration of views in the client memory. As .NET Framework from Microsoft was practically available at this stage of development, we adopted Visual Basic .NET 2005 as the development environment in consideration of its suitability for meeting the requirements of DataSet, one of its .NET technologies. Although previous modules were developed using Visual Basic 6.0 and Visual C++ 6.0, they exchanged information seamlessly using wrappers so that users cannot distinguish which is 6.0 based and which is .NET based.

5.2 Aiming at a Highly Sustainable Package

As MegaOak-NEMR was developed based on the PC-Ordering 97, its successor PC-Ordering 2000 and PC-Ordering/AD and by adding the electronic medical record function to them, it includes source codes from 10 years or so previously. These source codes have been complicated because of the functional enhancements and customizations applied since then and their maintainability has been degraded as a result. If they were used as they were, the development of the new system would be very inefficient and more labor than is economically viable would be necessary to package the functions required by the users.

As a result, some source codes were re-defined for MegaOakHR, in .NET. We did not simply convert the description language, but we also reviewed the internal structures of the

Module Name	Number of files	Total Steps			Number of branch			Blank lines		Commnet lines	
		Total	Max a method	Average of methods	Total	Max a method	Average of methods	Total	Average of methods	Total	Average of methods
Module A	4118	69851	544	16.96	3353	15	0.81	6924	1.68	40736	9.89
Module B	634	15310	378	24.15	616	8	0.97	1864	2.94	5773	9.11
Module C	122	1196	50	9.80	44	4	0.36	146	1.20	162	1.33
Module D	1602	24908	353	15.55	1370	15	0.86	2432	1.52	4805	3.00
Module E	151	1144	36	7.58	27	3	0.18	248	1.64	41	0.27
Module F	2523	22258	348	8.82	1030	15	0.41	3802	1.51	2943	1.17
Module G	9891	215747	1420	21.81	10609	36	1.07	26818	2.71	48408	4.89
Module H	13	169	53	13.00	9	2	0.69	83	6.38	63	4.85
Module I	394	3739	57	9.49	207	4	0.53	1139	2.89	358	0.91
Module J	607	6953	232	11.45	268	9	0.44	1192	1.96	768	1.27
Module K	952	22545	304	23.68	1270	20	1.33	6699	7.04	8725	9.16
Module L	558	6655	199	11.93	317	33	0.57	1622	2.91	1311	2.35
Module M	176	3219	461	18.29	97	11	0.55	581	3.30	1286	7.31
Module N	5	58	28	11.60	4	2	0.80	21	4.20	22	4.40
Module O	871	29935	489	34.37	1376	18	1.58	5582	6.41	11632	13.35
Module P	821	11106	210	13.53	557	15	0.68	2532	3.08	1825	2.22
Module Q	117	2415	116	20.64	139	7	1.19	632	5.40	302	2.58
Module R	693	7167	126	10.34	229	6	0.33	907	1.31	958	1.38
Module S	629	6815	163	10.83	289	9	0.46	2253	3.58	1117	1.78
Module T	23735	400713	469	16.88	20316	26	0.86	69407	2.92	147512	6.21
Module U	589	5549	59	9.42	204	5	0.35	1617	2.75	725	1.23
Module V	53	575	52	10.85	36	6	0.68	49	0.92	38	0.72

Fig. 5 Example of outputting metrics tool.

programs and carried out refactoring to eliminate redundancy with the aim of making the package capable of dealing flexibly with possible specification changes in the future. In fact, the source codes that were refactored in .NET have only 1/5th to 1/3rd the scale of previous source codes, while featuring a higher visibility than hitherto.

As a criterion for judging structural simplicity, we introduced the notion of metrics that is capable of a quantitative evaluation of the degree of complexity. It is known that source codes are poorly maintainable if they contain large numbers of steps or branches. Therefore we developed a metric measurement tool that is capable of metering the numbers of steps and branches per method. This tool helped us to easily find complicated source codes with poor maintainability and to restore them in order to ensure system simplicity (**Fig. 5**).

6. Conclusion

In the above, we have reviewed the background to the development of MegaOakHR and described its new functions and the changes in its internal structure.

The electronic medical record system is subject to requirements and expectations that are growing day by day. We will continue further enhancement of functions, response improvements and refactoring in order to facilitate the above so that hospital tasks can become more efficient and safer in the future.

*Microsoft, Visual Studio, Visual C++, Visual Basic and .NET Framework are registered trademarks or trademarks of Microsoft Corporation in the United States and other countries.

*As the products introduced in this paper are mainly provided for the domestic market, some figures feature explanations by the Japanese Language.

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