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The Effects of Information Technology and Organizational Change in Medical Organization

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Key words: electronic medical records(EMR), hospital management, information technology, process analysis, resources-based view

1. Introduction

Hospital management has recently been attracting attention. Many hospitals post losses while providing services that are very significant for the lives of citizens[1]. If hospitals are to provide high-quality services in a stable manner in an aging society, they will have to consider efficiency as well as fairness in management and policy. In this respect, the government is promoting the

[1] According to Japan Municipal Hospital Association (2005), deficit-ridden hospitals accounted for 389 hospitals or 32.6% of 1,195 hospitals responding to a poll. Deficit-ridden hospitals accounted for 88.6% of 631 municipal hospitals, 44.5% of 247 other public hospitals and 43.2% of 317 private hospitals. The operating balance (healthcare service revenues minus costs) per 100 beds showed a loss of 7,827,000 yen.

computerization of healthcare services including the introduction of electronic medical records, or EMR. Information technology is thus expected to become an effective tool for improving the efficiency of hospital management. Despite the government's positive recommendation and subsidization of the EMR introduction, however, the EMR system has failed to spread. Many hospitals introducing the EMR system have failed to achieve remarkable improvements. Nevertheless, some hospitals have successfully taken advantage of the EMR introduction to realize high-quality healthcare services and improve management efficiency[2]. Through the analysis of one particular success story for the EMR introduction at Otowa Hospital in the Rakuwakai Healthcare System, this study focuses on the EMR introduction process and aims to find factors behind the success and its effects.

As information technology spreads in many industries, discussions on such technology's characteristics and impact on organizations have been conducted in the context of product development, inventory management, logistics, business relations, inter-company relations and so on. As noted by Melville, Kraemer & Gurbaxani (2004), however, the mechanism for IT to influence organizational performance has not necessarily been specified. Given that the IT introduction is not a sufficient condition for competitive advantage, an important challenge is to specify the strategy and IT introduction process to take advantage of IT's characteristics to improve organizational performance.

IT used in the healthcare industry including hospitals and clinics is divided into three categories . The first is the electronic medical records to make and store electronic data about patients. The second is the ordering system to electronically transmit medical treatment and dose instructions and reports within a medical organization[3]. The final one is the medical accounting system to electronically compute medical treatment costs and request receipts. The government now plans to require the EMR to be introduced[4]. Generally, the EMR is introduced not only to realize paperless data management but also to be linked to other information systems for better organizational performance. Therefore, our discussion here will assume the three systems to have been integrated into the EMR system[5].

[2] In this study, the successful EMR introduction is defined as representing "the realization of high-quality healthcare services and the improvement of management efficiency."
[3] The ordering system conveys doctors' instructions and testing requests to a logistics division through an in-house network .
[4] Nihon Keizai Shimbun (2-9-2005)
[5] More than 90% of hospitals have introduced medical accounting systems that have direct effects on hospital management. But not a large number of hospitals have introduced ordering and EMR systems whose effects are still questioned. The Otowa Hospital subject to this study introduced ordering and EMR systems simultaneously.

Discussions on the EMR have been widely conducted among consulting companies, EMR vendors and medical societies. These discussions focus on advantages of information systems. Medical economics and informatics experts adopt a macro approach to the EMR. They look mainly to policy and management problems. No approach to the EMR has been analyzed from the viewpoint of hospitals that actually introduce and manage the EMR, however. Few studies have been conducted on the EMR introduction process, the effects of the EMR and factors behind successful EMR introduction at the hospital level.

A conclusive finding of this study is that a factor behind the hospital's successful EMR introduction was hospital staff members' simultaneous implementation of the new IT process and organizational Changes. An additional significant factor was that a project team comprising representatives from functional divisions of the hospital studied and analyzed each division's operation process thoroughly before the EMR introduction. The process analysis allowed the project team to review and resolve operational bottlenecks and synchronize the flow of information and patients. The hospital also made an effort to internalize organizational IT capacity by developing in-house medical system engineers and customizing software. The combination of these factors allowed the hospital to take full advantage of the EMR for achieving high-quality healthcare services and efficient management.

This study consists of five sections. The second section discusses the framework for the case study. The third section deals with the history of healthcare policies and the present state of the EMR introduction. The fourth section outlines the Rakuwakai Healthcare System and its Otowa Hospital subject to this case study and describes the history and process of the hospital's EMR introduction. Based on the case study and data about the effects of the EMR introduction, the fifth section looks into the effects from three aspects – organization, staff, and patients and the local community. Finally, we discuss the factors behind Otowa Hospital's successful EMR introduction. This study is based on our five interviews with and visits to Otowa Hospital (in 2004 and 2005).

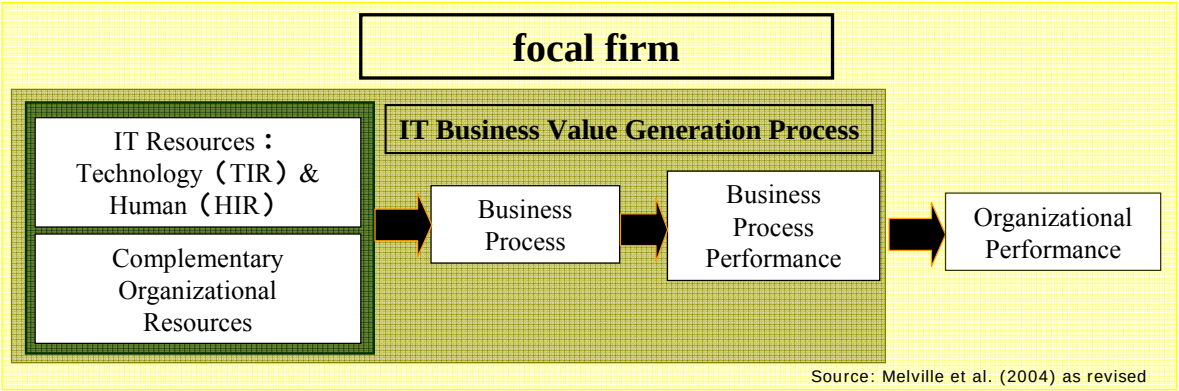
2. Analysis Perspectives

The relationship between IT and organizations has become a key subject in business administration over the recent years. Specifically, studies have been conducted about the effects of IT on social and economic systems, organizations, tasks, communication and performance (e.g.

Crowston & Malone, 1995; Aoshima, 1998; Okuno, Takemura and Shintaku, 2002; Fujimoto et al., 2002; Takeda, 2000). Regarding the relationship between IT and organizational performance, earlier studies have agreed that IT is a tool rather than a condition in itself for organizational achievements and that IT interacts with various elements of organizations to enable high performance.

Recently, the resources-based view has frequently been used for considering IT and various elements of organizations. The RBV attributes the gap between companies' performance to the difference between their resources and capabilities (e.g. Barney, 1991). Similar logic is adopted for discussing IT-related resources and capabilities (e.g. Mata, Furest & Barney, 1995). As IT-related resources and capabilities, Wade & Hulland (2004) that surveyed earlier studies cited the management of relations with outside organizations, responses to markets, the integration of an internal organization process and IT, information system introduction plans and management Changes, information system infrastructure, IT skills and the operation of cost-efficient information systems. RBV-based studies have focused on key resources or capabilities according to the context and considered the significance of human resources and organizational capabilities as well as IT resources.

Figure 1. Model Regarding IT Skills and Organizational Performance



Melville et al. (2004) made a simple model of RBV discussions and offered an analysis framework regarding IT skills and organizational performance (see Figure 1). According to the model, "IT-related resources" comprising technology and human resources interact with "auxiliary organizational resources" (non-IT resources, organization structure, policy, routines, culture, etc.) to affect real business processes or organizational performance. Although the model is based mainly on a business organization, this study builds on this viewpoint, gives attention to the EMR introduction process and looks for resources and capabilities for the successful EMR introduction in analyzing the

specific case[6].

3. Medical Policy Changes and Progress in EMR Introduction[7]

Basically, the medical industry has been tightly regulated. In particular, the number of doctors, the number of nurses, the number of beds, equipment, medical treatment fees, building shapes and many other areas at hospitals are rigorously regulated in accordance with medical subjects and scale. Since the number of nurses is fixed according to the number of beds, for example, cost reductions are difficult in an industry where personnel costs are structurally high. In order to increase its profitability, therefore, a hospital will have to increase the number of patients to be diagnosed every hour through the improvement and Change of business processes.

The government's medical policy is shifting its focus from fairness to efficiency in order to cope with an expansion in medical expenditures due to the aging of the population[8]. There are two major policies in this respect[9]. The first is a division of labor between medical institutions. This means functions are divided between hospitals (acute and convalescent hospitals) and between hospitals and clinics[10], depending on the medical condition. The division of functions is designed to allow each medical institution to provide special services, increasing the efficiency of overall medical services. The second policy is the medical fee system's shift from the fee-for-service principle to the diagnosis procedure combination, or DPC, at acute hospitals. The shift is designed to prevent the problem of excessive medical services experienced under the fee-for-service principle and curb overall medical fees by limiting the fee for a service to a fixed level.

The two policies are closely related to the informatization of medical care through the EMR. The effective, efficient division of functions between medical institutions requires these institutions to be able to share patient data in a smooth fashion. For the adoption of the DPC system, each diagnosis procedure at each individual hospital must be classified and entered into a standard format. If paper medical records are used, the classification and standardization may consume a massive amount of time and costs. The government has these two reasons to subsidize the EMR introduction.

[6] Most RBVs focus on elements regarding sustainable competitive advantages. But this study does not cover any sustainable competitive advantage phase (ex post restrictions on competition: Peteraf, 1993) because it aims to analyze the EMR introduction, its effects and factors behind its success.
[7] See Ku, Kubo and Yamashita (2005) for details.
[8] The development of medical services in postwar Japan has given relative priority to fairness (as represented by the universal health insurance coverage created in 1961) on the strength of a soaring economy.
[9] Other policies include the promotion of evidence-based medicine, or EBM, and the provision of information to patients.
[10] Under a system to promote division of functions between hospitals and clinics, medical treatment fees are fixed according to how frequently referral forms are written by clinics. Medical treatment fees are increased for patients with referral forms.

In 2004, only about 4% of hospitals (400 of some 9,000 hospitals) and some 3% of clinics (3,300 of 97,000 clinics) in Japan had introduced the EMR. Of some 800 hospitals with 400 or more beds, less than 120 or about 14% had adopted the EMR. The EMR introduction has not been smooth (IT Select, May 2005). Many hospitals and clinics suspended the EMR introduction[11].

4. Process and Impact of EMR Introduction at Rakuwakai Otowa Hospital

4-1. Outline of Rakuwakai Otowa Hospital

Rakuwakai Otowa Hospital is one of core hospitals of the Rakuwakai Healthcare System that has a giant network in Kyoto. Otowa Hospital has the largest number of beds in the city (at 698 beds), being ready to treat a wide range of patients from those in the acute phase to those in the chronic phase[12]. When the hospital opened in 1980, it was specialized for in-patients to meet local requests. Later, it was transformed into a general hospital. The hospital has increased the number of medical subjects to 29 and the number of beds to 698 in the pursuit of comprehensive services. In 2000, it was given a hospital function rating of Composite B. Later, the hospital gradually enhanced its acute functions and was certified as Japan's 12th specialized acute hospital in 2002. In 2003, it became the first hospital in Kyoto Prefecture to acquire the ISO9001 certification. These certifications indicate that the hospital has been objectively appreciated as having high-performance testing systems, meeting requirements regarding high-quality medical services and preparing a mechanism for maintaining such services.

4-2. Problems at Otowa Hospital before EMR Introduction

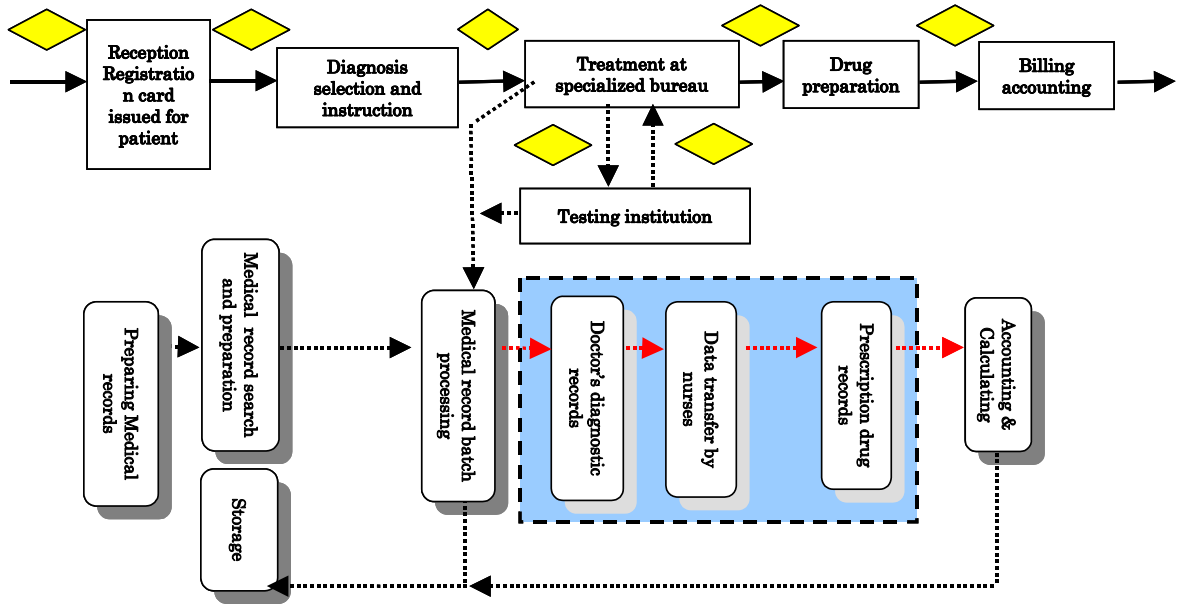
The problem that faced Otowa Hospital before the EMR introduction was that operations were failing to keep up with the increase in the number of out-patients. The largest reason was that the medical service process (reception, diagnosis selection and instruction, doctors' diagnoses, testing,

[11] In projects implemented by the Ministry of Economy, Trade and Industry under a Fiscal 2000 supplementary budget for the promotion of medical institution networks using advanced IT, a medical association in Hisai Ichishi of Mie Prefecture, Okayama Citizens' Hospital and a Kobe City medical association suspended the EMR introduction (Nikkei Healthcare September 2004). Reasons for the suspension included unspecified purposes for the EMR introduction, lack of the EMR system's ability to be integrated with existing software, an emphasis put on subsidy acquisitions, an insufficient review of business processes and greater-than-expected initial costs.

[12] A medical institution is classified as a clinic if the number of beds for in-patients is limited to 19 or fewer. An institution with 20 or more beds is a hospital. Usually, hospitals may be classified as small if the number of beds is limited to 100. Medium-sized hospitals would have several hundreds of beds. Hospitals having more beds are considered large (IT Select 2.0 Editorial Department, 2005).

preparation of drugs, billing and payment) was not synchronized with the flow of medical records (searching using batch processing, conveyance and posting) as indicated by Figure 2.

Figure 2. Flow of Patients and Medical Records (pattern diagram)



▪→ : Flows of operations and patients

・ : Waiting (wasted) time for patients

・Dashed line: Flow of medical records

・Within dashed line area: Value-adding activities

Source: Interviews

The largest problem with paper medical records is the discontinuity attributed to the time gap between "searching and conveying of medical records" and "diagnoses of patients." Even after a diagnosis, a patient or a hospital staff member cannot take the next steps (testing, preparation of drugs and accounting) until a medical record's arrival. They are forced to kill time waiting. As a result, a smooth flow of patients is affected, limiting the number of patients diagnosed. Speedy medical services for patients cannot be secured. This means that the mismatch between the flow of patients and that of information (medical records) leads to the separation of diagnostic steps, wasting of time and limiting of the number of patients diagnosed. In a bid to solve this problem, Otowa Hospital attempted to optimize each step while failing to fundamentally optimize the whole of the diagnostic process. This has been the same case with other hospitals as well.

A hospital organization has made it difficult for functional divisions to cooperate and

communicate with each other. A hospital consists of groups of experts including doctors, nurses, co-medicals (such as pharmacists and medical technologists) and clerical workers. These groups implement various functions. A hospital thus adopts a flat management divided by function. In general, hospitals have no clear authorization system to control divisions and have difficulty in integrating divisions. They have faced a chronic "division and coordination" problem. At hospitals characterized by a flat management comprising groups of experts, different categories of experts take charge of medical service steps and barriers have existed between these categories. This indicates that functional divisions have failed to communicate or cooperate with each other. Such operational problems limits the number of patients that can be diagnosed, lengthens waiting times and causes congestion in waiting rooms. This leads to a decline in patients' satisfaction and income at hospitals.

In a bid to solve such a problem, Otowa Hospital tied up with some clinics in 1997 to separate the out-patients. Earlier, Otowa Hospital had accepted any kind of out-patients. More than 1,000 out-patients had visited the hospital daily. Most of them had failed to bring referral forms to the hospital. Given a hospital's mission to meet the needs of a wide range of local patients, Otowa had not been allowed to simply reduce the number of out-patients or abandon the chance to earn income from out-patients that had accounted for some one-third of total revenues.

Otowa Hospital had thus faced two challenges before its EMR introduction in 2001. One was to "shorten waiting times and secure affordable diagnostic space" to improve out-patients' satisfaction. Another was to increase the efficiency of the diagnostic process for out-patients in order to "improve the capacity to accept out-patients" and expand revenues. The hospital decided on the EMR introduction as a means to solve the two challenges.

4-3. EMR Introduction Process and Organizational Steps

The Rakuwakai Headquarters took three steps to help solve various out-patient problems. They were (1) the introduction of the EMR and the creation of a project team (or task force) to increase the efficiency of the operational process, (2) the development of IT experts and customization of EMR software, and (3) the promotion of cooperation between the hospital and other local medical institutions to divide labor.

(1) EMR Introduction Process and Creation of Project Team

The Rakuwakai Headquarters held the first meeting to consider the EMR introduction in January 2000. On the agenda at the meeting were operational improvements and structural Changes

to reduce costs of storing paper medical records, shorten patients' waiting time and cut unproductive time in the operational process. Participants discussed the EMR introduction as a specific measure. Later, a decision was made on the EMR introduction and a project team was launched. The headquarters took a top-down decision-making approach on making the decision and created the project team that was given the relevant authority[13]. So as to lend logistic support for the EMR introduction project, the headquarters raised investment funds, improved staff members' IT literacy and trained medical systems engineers.

The project team comprised eight people led by a doctor. The seven other than the leader represented doctors, nurses, radiological technologists, the clinical laboratory, the pharmacy, the management division and the information system division (including medical systems engineers). The team first documented the whole of the operational process in a bid to review it in its entirety, analyzing each step and the number of steps followed in each division. The project team members, who represented different divisions, looked at an operation flow for each division, identified coordination and workflows between divisions and specified bottlenecks and unnecessary steps. As indicated by Figure 2, the most serious bottlenecks were found to be at the medical record preparation step and the batch processing steps before and after the diagnostic steps. The team members shared their findings concerning time wasted between steps and gradually devised solutions.

A process analysis led to the finding that the EMR introduction could cut the number of steps from 38 to 14 for a medical treatment process for an out-patient. In parallel with these operations, the project team played a role in providing all hospital workers with EMR introduction information and solutions continuously. Team members wrote down improvement proposals and decisions on simili paper and posted such written memos within the hospital on the day after each project team meeting. This allowed all hospital workers to become aware of the EMR introduction. The team sought other hospital workers' understanding on the EMR and reflected their opinions in the EMR introduction plan.

Table 1. Flow of Steps after EMR Introduction

Electronic medical records		
Office	Diagnostic room	Treatment, testing, radiation

[13] At a hospital, as an organization of professionals, an objection can easily emerge to the introduction of new systems like the EMR. This may be because the introduction of a new system can force organization members to change their routine operations or undertake an extra burden to get used to the new system.

Appointment after diagnosis ↓ Arrival ↓ Arrival confirmation S ↓ Issuing basic slip S ↓ Floor worker S	Diagnosis, services Dr ↓ **Ns** Writing medical records Dr ↓ Deciding on appointment Dr ↓ Inputting data into receipt computer S ↓ Automatic accounting ↓ Delivering out-of-hospital prescription S ↓ End	Inquiry (rate) Ns Testing instruction Dr ⇔ Testing appointment Dr ↓ Blood drawing, testing, photographing Co ↓ Confirming results Dr

Note: S (service clerk), Dr (doctor), Ns (nurse), Co (co-medical)

Source: In-house data (made available by Rakuwakai)

Upon the EMR introduction, the hospital adopted a large room layout to accommodate medical bureaus. In order to solve the problem of insufficient coordination between medical bureaus, the hospital changed the room layout to allow doctors and nurses from different medical bureaus to worker together and increase their communication[14].

(2) Customization of Software and Development of IT Skills

The benefits of the EMR system were expected to remain limited unless all hospital workers actually made full use of the system. Therefore, the headquarters conducted a fact-finding survey about hospital workers' IT skills and implemented education programs to improve their IT literacy level. An internal survey at Otowa Hospital in October 2000 found that those unable to use Word accounted for 53.2% of nurses, 22.7% of co-medicals and 20.0% of clerical workers (most doctors were able to use the software). After the survey, Otowa Hospital commissioned Toshiba Corp. to educate hospital workers on IT skills. Each trainer taught two nurses to improve their basic skills for operating the EMR system. The hospital thus took preemptive steps to solve problems that could emerge upon the EMR introduction.

It is also very important for a hospital to customize the EMR software in accordance with its operations. Otowa Hospital trained nine medical systems engineers[15] to develop customized software that could be easily used by doctors, nurses and pharmacists, instead of ordering a vendor to customize the software. (The customization covered an easy-to-see screen, clicking, subjects and other areas[16].) The hospital's MSEs have taken advantage of their experience on the medical service front to develop their capacity to integrate operations at hospitals and EMR knowledge. MSEs' operations have covered all information systems development including not only software development but also security matters and coordination with clinics.

(3) Division of Labor between Organizations: "Cooperative Relations between Otowa Hospital and Other Local Medical Institutions"

Even before the EMR introduction, Otowa Hospital implemented an organizational Change to

[14] The large room layout is frequently adopted by automakers to activate cooperation and communication between functional divisions. Engineering teams, or an engineering team and purchasing division representatives, are put into a large room to work together and promote their communication.
[15] This number of SMEs is double the average for large vendors, indicating that Otowa Hospital has substantial organizing capability. System engineers at vendors are frequently criticized for lacking medical workplace knowledge.
[16] Specifically, Otowa Hospital has built on the software of the Kameda Medical Center in Chiba Prefecture for developing its customized software.

transfer most (23 subjects) of the outpatient division to cooperative clinics. The hospital has treated seriously sick out-patients while leaving cooperative clinics to diagnose less sick out-patients. By classifying out-patients by degree of sickness for different treatments, the hospital has reduced the number of out-patients subject to its services. The EMR allows the hospital to divide labor with other local medical institutions[17]. This is because the EMR allows diagnostic and testing data of patients to be conveyed without extra cost. One favorable result for Otowa Hospital, is that out-patients have been limited to referral or acute patients and the percentage of referral patients has substantially increased in regard to medical fees. At present, 92 out of 105 clinics in the Yamashina Region of Kyoto Prefecture are linked to Otowa Hospital.

4-4. EMR's Impact on Hospital Organization

The shift from paper medical records to the EMR has not only reduced costs but also brought about other positive effects attributed to the EMR's open information and automatic conveyance features. These effects are discussed below in regard to (1) hospital operations, (2) functional staff tasks, and (3) hospital organization and management and patients in the local community.

(1) Facilitated and quickened operations: As shown in Table 1, the EMR introduction has reduced the number of procedural steps to simplify operations, allowing the flow of data to be synchronized with the flow of people. At the same time as a patient is identified at a reception desk, a personal computer in a doctor's office can display data about the patient. The medical record batch processing, the most time-consuming step, has thus been eliminated. As a result, waiting time for patients has been reduced and the number of patients diagnosed increased. Otowa Hospital had adopted a reservation system to cut the average waiting time for an out-patient from 120 minutes to 70 minutes before the EMR introduction reduced this time further to some 35 minutes.

Following the EMR introduction, the no-value-added time for waiting and preparation of a bill after a diagnostic process was dramatically cut from 34 minutes to 3 minutes. A shorter waiting time can increase patients' satisfaction. The increased efficiency of operations can lead to an increase in the number of patients to be diagnosed and in earnings.

[17] The regional division of healthcare services through the EMR introduction means that a large hospital assigns cooperative clinics to treat less sick patients or people subject to continuous services. Although the EMR introduction cost could become a problem at clinics, they can expect to see a long-term income increase by serving as primary care providers to patients.

Table 2. Waiting Time between Arrival at Hospital and Departure

Measurement	Average waiting time	Ratio of waiting times of over 1 hour
October 2000 (before EMR introduction)	Average 72.7 minutes (N=4,832)	54.8%
October 2002 (after EMR introduction)	Average 33.6 minutes (N=5,877)	17.8%
February 2003 (after EMR introduction)	Average 36.1 minutes (N=6,482)	18.8%

Source: In-house survey data at Rakuwakai Otowa Hospital

A shorter waiting time has brought about an extra benefit, too. A smaller waiting room is now sufficient for patients. Earlier, the hospital had to have a large waiting room to accommodate a large number of waiting patients. Now, however, a 20-seat room is sufficient.

(2) Tasks of Functional Division Staff Members: The number of work steps declined for functional division staff members. The total number of work steps for an out-patient has decreased by 24 from 38 before the EMR introduction to 14. For an in-patient, the number has declined from 18 to 12.

For doctors, the number of work steps has increased by one -- namely data input into the EMR. But the new step is not so heavy. Rather, the EMR introduction has allowed doctors to save time. When only paper medical records were available, doctors attempting to check test data and medical records at night had to go to medical record rooms and search records on their own or ask nurses or co-medicals to bring the records. The EMR introduction has enabled doctors to obtain the necessary data at any time.

For nurses, paper medical record tasks, such as search, conveyance, writing and transfer, have been eliminated. This has allowed nurses to focus on care of patients. Their quality of service for patients can thus be improved. Using a wireless local area network and laptop computers, nurses can obtain medical records regardless of where they are within the hospital. They are now able to give appropriate bedside treatment and services for patients as well as in the nurse center. The EMR

introduction has brought about surplus workers who can be positioned on the floor for new patient services. These workers have been given jobs for such new services (including guidance for new in-patients and talking to patients).

Table 3. Change in Number of Work Steps for Each Job upon EMR Introduction

	Doctor	Nurse	Clerk	Co-medical	Total
Paper medical records	5	11	18	4	**38**
EMR	6	2	5	1	**14**
Reduction in Number of steps	+1	-9	-13	-3	**-24**

Source: In-house survey data at Rakuwakai Otowa Hospital

The EMR introduction had no marked effect on the management of drugs and other goods since the hospital had launched the SPD (supply processing and distribution) inventory management system before the EMR introduction. But it has contributed to the ability to manage dangerous articles and the reduction in unnecessary drugs.

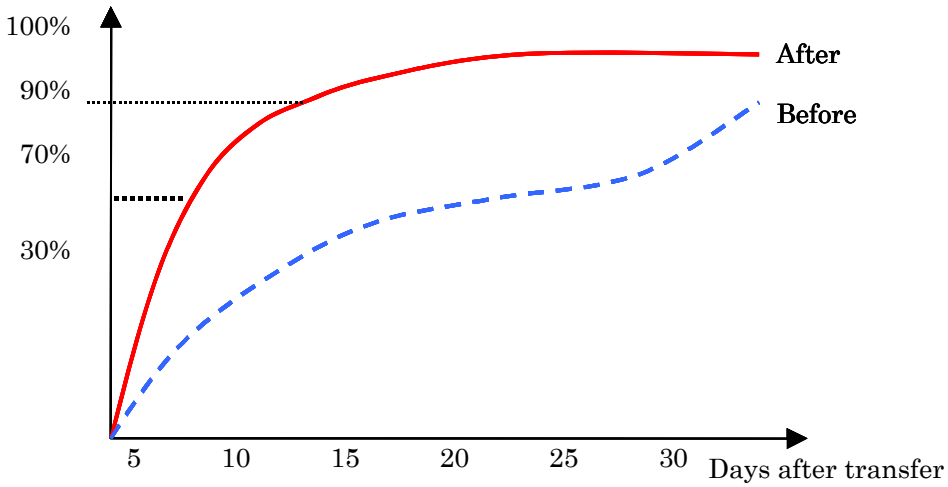
Performance of accountants and other clerical workers has been improved as their tasks have become simplified and standardized. Surplus workers emerging from the reduction in tasks can be utilized for new operations or services. The hospital can therefore now make more effective use of human resources.

(3) Hospital Organization and Organizational Management: The elimination of handwriting has allowed transfer, reading and other rudimentary errors to be prevented. Comparing medical errors before and after the EMR introduction, the number of errors per 10,000 drug prescriptions was more than halved from 1.10 in 2000 to 0.50 in 2001. This effect is significant because even a rudimentary error can have a fatal effect on a patient.

The EMR system's open characteristics, which allow any medical workers within a hospital to freely access patient data, have transformed medical records that were the doctors' sole domain into widely shared data. The possibility of medical records being accessed by people other than the relevant doctors has prompted doctors to change their practices and qualitatively improve medical records. Doctors now put more data into medical records and more clearly. Otowa Hospital has also established a medical record audit system.

The standardization of tasks has worked to improve performance of nurses and clerical workers, contributing to raising the operational efficiency (see Figure 3). A comparison of nurses' performance before and after the EMR introduction indicates that nurses took about one month to get used to their jobs before the introduction but that this time has been reduced to one week or less following the introduction (Ku, Kubo and Yamashita, 2005).

Figure 3 Comparison of Performance before and after EMR Introduction (Nurses)



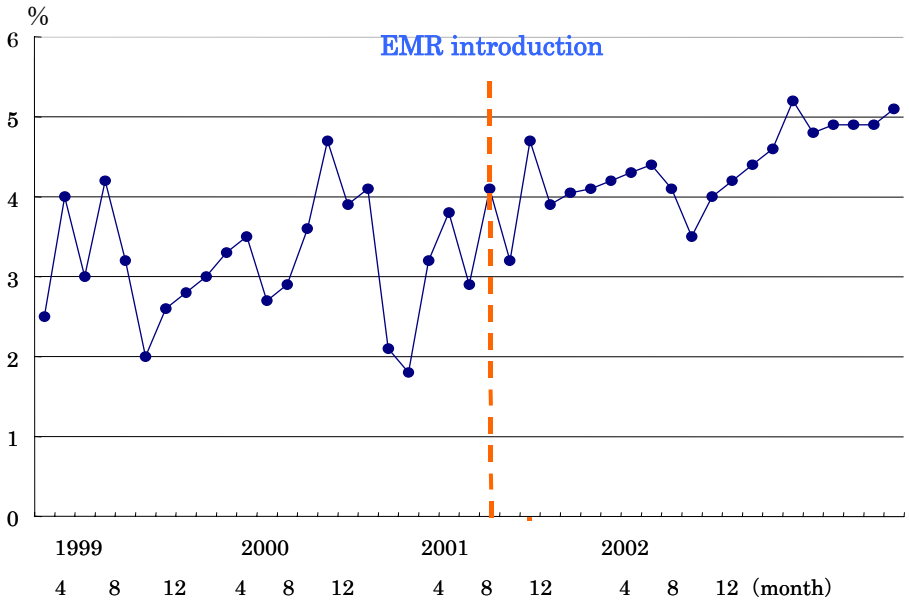
Source: In-house survey data at Rakuwakai Otowa Hospital

Since the EMR introduction, once-frequent billing omissions have been reduced to expand revenues. Figure 4 shows injection bills' ratio to total revenues from in-patients before and after the EMR introduction. This indicates that injection bills have remained at high levels since the EMR introduction. We can suspect that the elimination of medical record transfer errors and misreading has allowed the hospital to accurately collect fees that had been lost in billing omissions or remained uncollected. Such losses and uncollected fees had amounted to 2-3% of total medical fee revenues. The EMR introduction has thus led to revenue expansion[18].

Finally, the reduction of work steps through the EMR introduction has contributed to improving working conditions for hospital workers.

[18] Figure 4 data alone cannot indicate any direct cause-and-effect relationship between the "EMR introduction" and "more accurate billings." Through our interviews with hospital people, however, we failed to find any other factor contributing to more accurate billings. Interviewees said accounting clerks' transfer and calculation errors have declined following the EMR introduction. Given that other conditions have remained unchanged irrespective of the EMR introduction, we can suspect that the EMR introduction has had some correlation with more accurate billings.

Figure 4 Injection Billings' Ratio to Revenues (Accounting clerks)



Source: In-house survey data at Rakuwakai Otowa Hospital

The Rakuwakai Headquarters' poll[19] on nurses' satisfaction with the EMR found that three quarters of nurses were satisfied with the EMR three months after the EMR introduction. Those who were not satisfied were limited to several percent. Most respondents who were not satisfied were in charge of surgeries with little connection with routine operations. Therefore, we can suspect that most nurses engaged in routine operations felt the EMR introduction made it easier for them to work. Although it is difficult to quantify their satisfaction, we can suspect that the EMR introduction has contributed to nurses' work motivation.

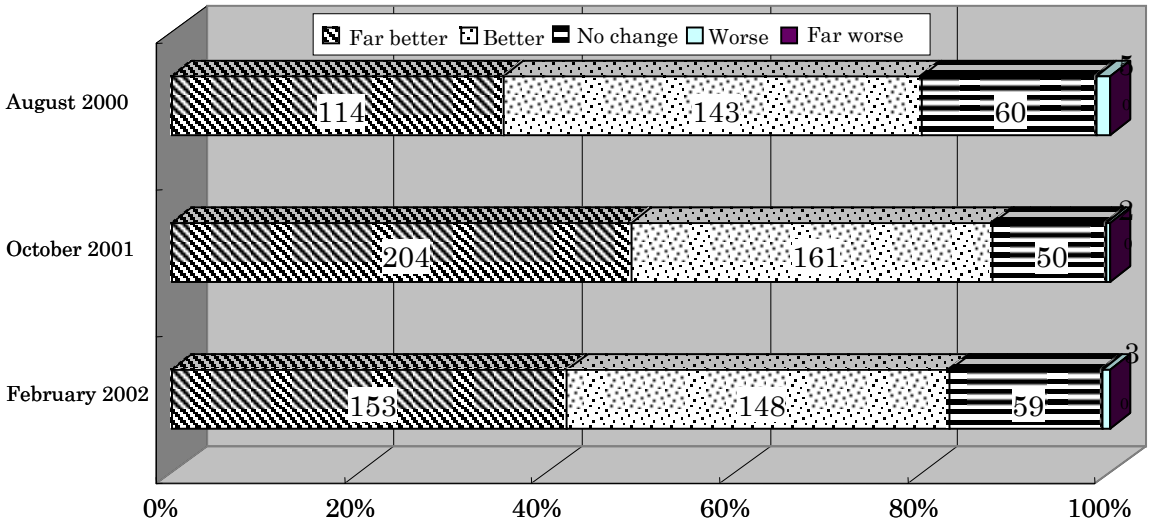
A questionnaire survey of doctors on the EMR introduction, which was conducted in October 2004 to ask respondents to choose from five alternatives, found that 16% viewed the EMR introduction as good, 11% as neutral, 65% as having room for improvement, and 8% as very bad. Doctors are thus less satisfied than nurses and believe that there is room to improve the EMR system.

(4) Patients and Regional Communities: The EMR introduction has a significant impact on patients and regional communities as well as healthcare services.

[19] The poll was conducted for each medical ward. The number of respondents totaled 234.

First, the EMR introduction has reduced financial and time costs for patients. In the case of the EMR system which is different from handwritten paper medical records, data are input in chronological order. A paper medical record has pages for different departments so that a principal doctor rarely looks at pages written by other doctors. With the EMR system, the principal doctor can easily look at data input by other doctors. The EMR system has allowed doctors to multilaterally and comprehensively check patients' clinical histories, their testing data and their characteristics. Earlier testing and other data can be utilized easily. This allows patients to save time and money incurred for double testing.

Figure 5. Patient Satisfaction after EMR Introduction



Note: Unavailable data include 25 items in October 2001 and 24 in August 2002.
Source: In-house survey data at Rakuwakai Otowa Hospital as utilized by author

Second, the EMR system has improved doctors' accountability to patients as well as patient satisfaction. Figure 4 shows patients' five-score Rickert scale response in August 2000 (n=387), October 2001 (n=442) and February 2002 (n=322) to the question: "How good are the explanations given by your doctor?" The figure, though failing to compare data before and after the EMR introduction, indicates a high degree of patient satisfaction. The average score is as high as 4.1. The EMR system allows doctors to give explanations to patients while viewing medical records displayed on PC screens. Such explanations are more understandable and give a sense of security, leading to the

high patient satisfaction. The EMR system is thus used as a tool for communication between doctors and patients. The improvement in doctors' information disclosure and accountability to patients and their families enables doctors and patients to build relationships of trust, working to boost patient satisfaction. This may lead to the improvement in hospital brands and ratings. In recent years, patients have growingly sought to obtain second opinions from doctors other than their primary doctors. In this respect, the EMR system has made it easier for the other doctors to check medical records.

Third, the EMR system makes it easier for a hospital to link up with other medical institutions within a region. As lifestyle-related diseases and other diseases requiring long-term care increase, longer observation and rehabilitation periods are required. To meet the requirement, a hospital may refer patients to easily accessible clinics. The EMR system enables a hospital to share patient data with other medical institutions so that a clinic may refer patients to a hospital more easily. The optimum division of labor for healthcare services may thereby be achieved for a regional community.

5. Conclusion and Discussion

This study has looked into the process and effects of and factors behind the successful EMR introduction at Rakuwakai Otowa Hospital. As noted earlier, the number of hospitals that have successfully introduced the EMR system has been limited. General factors behind failures to successfully introduce the EMR system include massive initial and maintenance costs, difficulty in customizing software, doctors' views and vague purposes for the EMR introduction. Given that hospitals receive government subsidies to cover part of the initial costs for the EMR introduction, we cannot view financial constraints as any fundamental problem. No wide EMR hardware gaps are seen between hospitals. Our study on the Otowa Hospital case has led us to conclude that organizational capabilities to utilize the EMR system are a key factor behind successful EMR introduction.

Regarding key resources and capabilities for the utilization of the EMR system, we would like here to analyze IT resources (technological and human resources) and auxiliary resources to support IT resources as given in Melville et al. (2004)[20].

IT resources for the EMR system include operation-based software development capabilities

[20] These resources and capabilities are interactive. With a single case, we cannot strictly identify really critical resources or capabilities for the EMR introduction.

and training of relevant in-house human resources. No wide EMR hardware gaps between vendors have been seen. This means that the key issue is whether a hospital can customize software to meet its practical needs. Otowa Hospital has "developed its in-house capabilities to customize software for EMR-using doctors, nurses and pharmacists, instead of adopting general-purpose EMR software developed by engineers unaware of the needs of healthcare operations." The hospital took sufficient time to train nine in-house medical system engineers through its unique education program and real work experience to introduce and customize the EMR system. In other words, the hospital developed human resources to assess and improve vendor-proposed systems and customize EMR software from the viewpoint of users.

In other human resources development efforts, the hospital improved IT literacy of nurses and other employees to respond to routine work changes and troubles arising upon the introduction of the EMR system as a new technology. Even after the introduction, the MSEs have repeatedly upgraded the EMR system to account for real work-based improvement proposals and requests.

The first auxiliary organizational resource is an organizational culture created that enables all hospital workers to be aware of the EMR introduction. The hospital leadership's clear direction and the project team's activities contributed to the creation. Psychological resistance usually emerges to a new system introduction that requires relevant people to make routine work changes. At Otowa Hospital, however, the leadership's clear intentions led all hospital workers to grow aware of the new IT system's introduction. In addition, the project team gradually solved operational problems and adopted a permeation-oriented EMR introduction process to allow hospital workers to share these solutions and become aware of ways to use the new system. This has enabled the hospital to avoid any organizational resistance to the EMR introduction.

The second auxiliary resource is the new structure for the hospital's division of labor with other regional medical institutions. The EMR system alone has not allowed the hospital to increase the number of patients to be diagnosed. Its organizational Change to reduce the number of out-patients diagnosed through its division of functions with other regional medical institutions has been significant in paving the way for the EMR introduction. Both the organizational Change and the EMR introduction may have contributed to the facilitation of communication between the hospital and other regional medical institutions. Activated communication between divisions and between workers within the hospital through the organizational Change including the destruction of barriers between functional divisions has also worked as an auxiliary resource.

The EMR introduction process as a whole indicates that a series of efforts including the project

team's process analysis, the permeation-oriented EMR introduction process and the customization of software to front operations were designed to detect problems emerging after the EMR introduction and solve them before the introduction. The organization has led its members to grasp the significance of the new technology introduction to minimize psychological resistance to the new technology and relevant problems. The development of software customized to front operations has prevented software malfunctions, inconvenience and other problems that could have emerged after the EMR introduction. Given these two points, we may consider prevention of future problems (Thomke & Fujimoto, Front-Loading of Problem, 2000) to be important.

The above discussions have reaffirmed that the relationship between the IT introduction and organizational performance depends not on the IT per se but the interaction between IT-using human resources and organizational capabilities. Many hospitals have failed to successfully introduce the EMR system, while the government is planning to require hospitals to introduce the system. Under such situation, this study's achievements may have practical implications regarding how to design the EMR introduction strategy and process.

Finally, we would like to point to the transfer of knowledge through the large room layout, in addition to the above-mentioned effects of the EMR introduction. Before the EMR introduction, a doctor of a bureau never checked patients' diagnostic records written earlier at other bureaus (since paper medical records had had independent pages for bureaus). Since the EMR introduction, diagnostic records have been put into the system in chronological order, allowing any medical bureau to consider other bureaus' diagnostic records when conducting diagnostics. The EMR includes patient data ranging from physical conditions to past symptom changes, medical treatments and measures. Based on such EMR, doctors naturally get together in a large room to have discussions on patients. Doctors within a bureau or at different bureaus can exchange information and opinions on such matters as the real appropriateness of specific treatments, desirable treatments for specific cases and meanings of specific symptoms, while watching EMR system screens. As far as indicated by interviews, the EMR system and the large room layout have allowed doctors to transfer and share medical knowledge. The EMR system has various potential positive effects including the improvement of human resources and the activated communication within and between organizations as well as the increased efficiency of overall operations[21]. Our study has limited our analysis target to one success story. In future, multiple-case and quantitative analyses may have to be conducted to

[21] IT's function as a communication tool is frequently cited for three-dimensional computer-aided design in the product development process (Baba and Nobeoka, 1998, and Takeda, 2001).

look into the method for successful EMR introduction.

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Appended Table 1. Comparison of Service Processes for Paper and Electronic Medical Records (for repeat patients)

Paper medical records

Office	Diagnostic room	Treatment, testing, radiation
Appointment after diagnosis ↓ Arrival ↓ Old-case reception S ↓ Issuing basic slip S ↓ Searching medical records S ↓ Inserting basic slip S ↓ Conveying medical records S → (Outpatients)		Transfer Ns ↓ Drip, treatment Ns Conveying ↓ Medical records Ns Ns
	Receiving medical records (desk) S ↓ Diagnosis order adjustment Ns ↓ Diagnosis, services Dr ↓ **Ns** Writing down medical records Dr ↓ Deciding on next appointment Dr ↓ Returning medical records Ns ↓ Conveying medical records S ↓ Inputting data into receipt computer S ↓ Checking receipt computer S ↓ Accounting S ↓ Delivering out-of-hospital prescription S ↓ End	Testing instructions Dr ↓ Making and transferring testing requests Ns ⇔ Inquiry Ns Testing appointment Ns ↓ Conveying testing requests ↓ Blood drawing, testing, photographing Co → Searching previous testing results Co ↓ Conveying results Co ← Searching current testing results Co ↓ Reaffirming results Dr ↓ Box for processed documents S ↓ Recovering results S ↓ Searching medical records S ↓ Attaching testing results S ↓ Storing medical records S ↓ End
Returning medical records S ← ↓ Storing medical records S ↓ End		

Electronic medical records		
Office	Diagnostic room	Treatment, testing, radiation
Appointment after diagnosis ↓ Arrival ↓ Arrival confirmation S ↓ Issuing basic slip S ↓ Floor worker S	Diagnosis, services Dr ↓ **Ns** Writing down medical records Dr ↓ Deciding on next appointment Dr ↓ Inputting data into receipt computer S ↓ Automatic accounting ↓ Delivering out-of-hospital prescription S ↓ End	Inquiry (rare) Ns Testing instruction Dr⇔Testing appointment Ns ↓ Blood drawing, testing, photographing Co Reaffirming results Dr

Note: S (service clerk), Dr (doctor), Ns (nurse), Co (co-medical)