

# Factors influencing diffusion of electronic medical records: a case study in three healthcare institutions in Japan

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## Abstract

This study examines the effect of three factors: information technology (IT) skills of healthcare workers, present status of computerisation in their organisations, and workers' attitudes on the diffusion of electronic medical records (EMRs) in the healthcare environment. Data were obtained from a self-questionnaire distributed to 390 healthcare workers.

The study finds that respondents need an expanded EMR capability to include decision support systems and reminder systems, and that diffusion of EMR is heavily influenced by attitudes of healthcare workers. However, targeted training of healthcare workers is needed to foster positive attitudes about EMR, and build confidence in the benefits of these systems.

**Keywords:** *Staff attitude; health personnel medical records; computerised medical record systems; medical informatics*

The potential benefits of using electronic medical records (EMR<sup>1</sup>) over paper records in improving the quality of healthcare delivery have been extensively studied (Mekhjian et al. 2002; Pizzi et al. 2005; Fung et al. 2004). The EMR promises rapid access to health information, which leads to improved healthcare outcomes and more efficient use of resources; for example, the US Institute of Medicine has presented information technology (IT) based operations such as EMR as essential technology for healthcare in the 21st century (US Institute of Medicine 2001). The Institute of Medicine report emphasises the critical role played by IT in achieving patient safety, effectiveness, patient centredness, timeliness, efficiency and equity of healthcare.

Although EMR has many advantages over paper records, its adoption in healthcare has been slow. A survey conducted by the Japan Hospital Association (JHA) (Japan Hospital Association 2001) reports that only 30% of hospitals in Japan have adopted EMR and cites the high cost of computerisation as the major barrier to EMR adoption. Other authors have also cited the high cost of healthcare computerisation as being the greatest impediment to EMR adoption (Leung et al. 2001; Johnston et al. 2001; Loomis et al. 2002; Lee 2000). There is, however, emerging evidence that even large healthcare institutions that possess the capacity to adopt EMR choose not to (Middleton et al. 2005; Japan Hospital Association 2001). In recognition of this, the Japanese Government recently issued a policy paper requiring larger healthcare institutions with 400 beds or more to implement EMR. While the government did not offer direct incentives to encourage adoption of EMR, the benefits are expected to arise out of faster filing of insurance claims and efficiency of patient care leading to retention of clients (patients).

The following questions concerning the introduction of EMRs into the Japanese healthcare system have been addressed in this study:

- Could the observed reluctance by hospitals in adopting EMR be a result of other factors besides financial cost?
- What is the effect of human factors, particularly behavioural factors, on the adoption of EMR?
- To what extent do IT skills and the present level of computerisation affect the desire to adopt EMR?

We hypothesised that the present status of computerisation and IT skills will enable healthcare workers to form unique beliefs towards use of computers in healthcare. The beliefs then influence the healthcare workers' attitudes resulting in their decision to desire to use or not to use a computerised system. An understanding of these relationships can provide insights for effective EMR implementation and adoption into clinical practice.

The specific aim of this study was to examine the effect of three factors, namely: present status of healthcare computerisation, healthcare workers' IT skills, and attitudes towards computerisation on the diffusion of EMR.

## Methodology

### Research design

A cross-sectional survey design was used to meet the objectives of this study. Data were collected between November 2003 and January 2004.

### Study environment and subjects

The sample was derived from three Japanese healthcare institutions that are currently in different stages of implementing EMR. Two of the institutions were carefully selected to represent different sizes of hospitals (i.e., ≥400 bed category and <400 bed category).

<sup>1</sup> Also referred to as Computerised Patient Records (CPR) or Electronic Health Records (EHR), the EMR is a comprehensive paperless patient chart.

**1: Characteristics of participating institutions**

<b>Institution</b>	<b>Type</b>	<b>Beds</b>	<b>System type</b>	<b>System Age</b>	<b>Location</b>
Hospital 1	General hospital	556	EMR <sup>1</sup>	10 years	Tochigi Prefecture
Hospital 2	Teaching hospital	206	CPOE <sup>2</sup>	2 years	Tochigi Prefecture
Hospital 3	Health centre	Nil	CPOE & PHIS <sup>3</sup>	10 years	Kanagawa Prefecture

1: A more comprehensive electronic patient records including both an ordering system and clinical information.

2: A computerised physician order entry system for test ordering and result querying not integrated with clinical information systems.

3: A public health information system mainly for general public health use and follow-up of cases.

The third institution was implementing a government sponsored e-health project (E-Japan) at the time of this study and therefore presented an excellent opportunity to examine factors that influence transition to EMR. Box 1 shows some characteristics of the institutions that participated in the survey.

Hospital 1 ('Hosp 1') is a semi-governmental general hospital with a total of 592 healthcare workers. The hospital has an average daily bed occupancy of 85.5% and sees an average of 900 patients daily at the outpatient department (OPD). The institution is currently upgrading its EMR to a filmless state (all radiological images are captured and stored digitally using Picture Archival Communication Systems (PACS)). Already, some neighbouring healthcare institutions are connected to the EMR through a network capable of transmitting digital images.

Hospital 2 ('Hosp 2') is a private teaching hospital with about 400 healthcare workers. It has average daily bed occupancy of 78.6% and 749 patients visit the OPD daily. It is currently in the process of upgrading the ordering system to EMR.

Hospital 3 ('Hosp 3') is a primary healthcare facility managed by local government. It employs a total of about 103 healthcare workers. The hospital screens healthy members of the community for chronic diseases such as diabetes, hypertension, high cholesterol levels, and obesity. In the year 2003, 16 746 people were screened for various chronic diseases. Nine hundred and ninety-seven people were found to be at high risk of developing chronic diseases and were enrolled into a community health service program to monitor and improve their health status. All data relating to the program, dubbed *New Health Promotion Fujisawa 21st Century* (NHP21), are stored and maintained in a computerised system (Ogata, Onoda & Kobori 2004).

The initial sampling plan targeted doctors, nurses and healthcare administrators only. However, we received reports from the staff overseeing the survey in respective hospitals that other healthcare workers, including physical therapists (PT), occupational therapists (OT), medical lab technologists (MLT), medical imaging technologists (MIT) and pharmacists (Pharm) were also interested in the survey. Questionnaires were distributed to a cross-sectional sample of 390 healthcare workers in total. Only healthcare workers who were full-time employees and had worked for a period of six months in the respective hospitals were

included in the survey. The questionnaires were completed anonymously.

### Theoretical framework

The Theory of Reasoned Action (TRA) described by Ajzen & Fishbein (1980) was used to inform this study. This theory describes how people develop beliefs, which ultimately determine their behaviour. A person develops beliefs based on observations, reflection and experiences (Davis, Bagozzi & Warshaw 1989; Hebert & Benbasat 1994). Behavioural intentions, such as desire to have computerised systems (in the case of this study), are the immediate antecedents to behaviour; the stronger a person's intention to perform a particular behaviour, the more successful they are expected to be (Ajzen & Fishbein, 1980). TRA has been used successfully to examine behaviours in technology adoption in information management sciences (Liker & Sindi, 1997).

Rogers (1983) defined diffusion of innovation (such as EMR) as the 'process by which an innovation is communicated through certain channels over time among the members of a social system (e.g., an hospital)', having two dimensions – extent of diffusion and extent of infusion (Ash 1997a). As discussed by Ash, extent of diffusion is the spread in breadth of innovation. On the other hand, infusion is the spread in depth of innovation. In this study, we looked at the infusion dimension of EMR diffusion and we define EMR diffusion as 'the extent to which the full potential of EMR should be embedded within patient care processes'.

Four constructs were measured in this study. *Desired status of computerisation*, the dependent variable, was measured using dichotomous adoption (should it be computerised?). Three independent variables were also included:

- *Present status of computerisation* was also measured using dichotomous adoption (has it been computerised?).
- *IT skills of healthcare workers* were measured using self-reported knowledge of computer application in healthcare and frequency of use of common application programs, including email, Internet browsers and word processors.
- *Attitudes of healthcare workers* were measured using their attitude towards the use of computers in patient care.

## Instruments

The survey questionnaire was designed following Leung et al. (2001) and Johnston et al. (2001). The survey consisted of five sections:

- Two items on IT skills with response options ranging from none/never to a great deal/always.
- A list of 16 functions in patient care where respondents were asked to check whether each had been computerised (present status) or whether they should be computerised (desired status) were included.
- A 10-item attitude scale assessing the healthcare workers' attitude towards the use of computers in patient care, where response options were: strongly disagree, disagree, neutral, agree and strongly agree.
- An open-ended section that welcomed comments from respondents.
- One item asking the respondents to indicate their professions.

A draft of the questionnaire was translated into Japanese, and pre-tested for clarity and relevance on a group of doctors and nurses familiar with EMR. The result of the pre-test was used to adjust the length and improve wording and layout of the questionnaire.

## Data collection

In order to obtain permission from the institutions, a letter was sent to the president of each institution explaining the purpose of the study. The researchers visited the institution once permission was obtained. During the visits, the details of the study were discussed with the president and assigned staff from each hospital. An adequate number of questionnaires (as determined through consultation with each individual facility) was then provided to the staff overseeing the survey. All questionnaires were returned within six weeks.

## Analysis

The responses from the completed questionnaires were entered into a computer using a double entry method to ensure accuracy. Data were 'cleaned' and then analysed using SPSS v10. IT skills were measured on a four-point scale ranging from 'none/never' (1) to 'a great deal/always' (4). Level of computerisation was on a 3-point scale ranging from 'no' (1), 'not sure' (2) to 'yes' (3) for computerised functions (present status) and desire for computerisation (desired status). Attitudes were measured on a 5-point scale ranging from 'strongly disagree' (1) to 'strongly agree' (5). A copy of the questionnaire is available from the authors on request.

The data were explored in three stages: description of the sample, comparison between professional groups, and comparison between healthcare institutions. Between-group differences were analysed using Kruskal-Wallis tests. We also used exploratory factor analysis to generate 'factor scores' representing values of IT skills, present status, attitudes and desired

## 2: Distribution of all healthcare workers in the three hospitals according profession\*

<u>Professional groups</u>	<u>Percent of sample</u>	<u>Percent of healthcare workers</u>
Doctor	8.5	13.0
Nurse	49.2	54.5
Administrator	19.6	15.6
Others (PT, OT, MLT, Pharm, MIT)	22.7	16.9
Total	100	100

\*Source: Data supplied by individual hospitals.

status for use in the multivariate analysis. Aggregate scores of the variables were computed by summing the product of the first principal component coefficient of the factor analysis with each corresponding respondents' answer of each variable separately for each institution. The scores were standardised, then entered for analysis. Test of significance for multivariate analysis was decided based on the conventional alpha ( $P$  value) of 0.05 at 95% level of confidence.

## Results

### The sample

Hosp 1 had a response rate of 67.7% (129/190), Hosp 2 a response rate of 67% (67/100) and Hosp 3 99% (99/100) giving an overall response rate of 75.6% (295/390). Doctors produced a response rate of 29.4% (25/85), nurses a response rate of 91.2% (145/159), administrators a response rate of 76.3% (58/76) and the others (PT, OT, MLT, Pharm, MIT) category had a response rate of 97.1% (67/69). The respondents therefore comprised 25 (8.5%) doctors, 145 (49.2%) nurses, 58 (19.7%) administrators and 67 (22.7%) others. Since the survey was completed anonymously, we could not adequately compare the respondents and the non-respondents. As shown in Box 2, representation of staff based on professional groupings was somewhat similar.

### IT skills of healthcare workers (whole sample)

Of the respondents, 138 (46.8%) reported that they sometimes use common computer application programs such as emails, word processing and Internet browsers. A further 136 (46.1%) reported that they usually or always use these common application programs. When asked to assess their level of knowledge about computer application in clinical medicine, 174 (59.0%) reported their knowledge to be 'a little' and 93 (31.5%) of the respondents reported their knowledge to be a moderate amount or a great deal.

### Attitudes of healthcare workers (whole sample)

In response to the attitude statements, it was found that at least 50% of respondents *agreed* with the following statements:

**3: Differences between the professional groups on five attitude statements**

		<u>Profession</u>			
		<u>Doctors</u>	<u>Nurses</u>	<u>Administrators</u>	<u>Others</u>
1. Using computers means longer consultation	Disagree	9 (36.0%)	30 (20.7%)	21(36.2%)	30 (44.8%)
	Neutral	9 (36.0%)	76 (52.4%)	31(53.4%)	26(38.8%)
	Agree	7 (28.0)	39 (26.9%)	6 (10.3%)	11(16.4%)
2. Computers interfere unduly with doctor-patient consultation	Disagree	13 (52.0%)	44 (30.3%)	20 (34.5%)	35 (52.2%)
	Neutral	8 (32.0%)	76 (52.4%)	27(46.6%)	28 (41.8%)
	Agree	4 (16.0%)	25 (17.2%)	11(19.0%)	4 (6.0%)
3. Cost of computerisation is prohibitive	Disagree	2 (8.0%)	6 (4.1%)	6 (10.3%)	3 (4.5%)
	Neutral	12 (48.0%)	89 (61.4%)	23 (39.7%)	21(31.3%)
	Agree	11(44.0%)	50 (34.5%)	29 (50.0%)	43 (64.2%)
4. Training of staff is of too much effort	Disagree	4 (16.0%)	9 (6.2%)	15 (25.9%)	12 (17.9%)
	Neutral	6 (24.0%)	52 (35.9%)	24 (41.4%)	20 (29.9%)
	Agree	15 (60.0%)	84 (57.9%)	19 (32.8%)	35 (52.2%)
5. Electronic clinical records are of more value than paper files	Disagree	0 (0.0%)	10 (6.9%)	7 (12.1%)	0 (0.0%)
	Neutral	12 (48.0%)	77 (53.1%)	23 (39.7%)	24 (35.8%)
	Agree	13 (52.0%)	58 (40.0%)	28 (48.3%)	43 (64.2%)

- EMR is a necessity in clinical practice (83.1%).
- EMR can significantly improve the quality of patient care (61.1%).
- Computers are more beneficial for administrative than clinical functions (53.9%).
- Training staff is too much effort (51.9%).

It was further noted that more staff remained *neutral* on the following statements than those who *agreed* or *disagreed*:

- Computers create a good impression with patients (55.6%).<sup>2</sup>
- Using EMR means longer consultation (48.1%).
- Computers interfere unduly with doctor-patient consultation (47.1%).
- Cost of computerisation is prohibitive (49.2%).
- Privacy issues have been dealt with adequately in EMR (55.9%).

**Comparisons between professional groups**

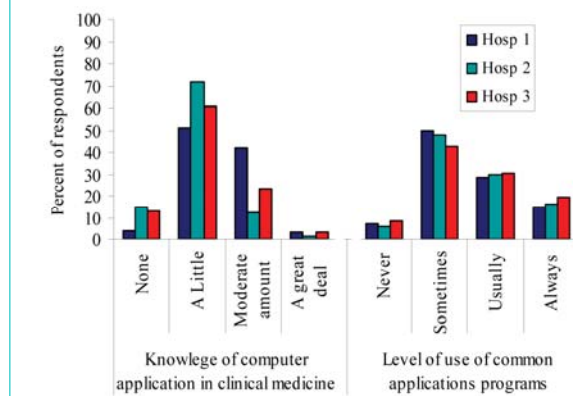
Differences between different professional groups were observed for five attitude statements. In most instances, where nurses tended to agree or remain neutral, the category of others tended to disagree or remain neutral, with doctors and administrators being in between. Box 3 shows items where differences were observed between professional groups. Overall, 'Others' tended to be extremely positive compared with the rest of the professionals. As a whole, nurses tended to remain neutral to the attitude statements.

**Comparisons between the hospitals**

**IT skills of healthcare workers**

Box 4 shows how the respondents rated their IT skills. Hospitals were similar in terms of their use of common computer application programs such as

**4: Respondents' IT skills self-rating**



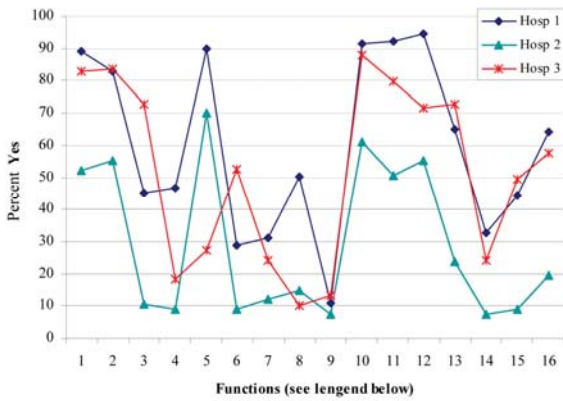
email, Internet browsers and word processing. However, in response to the question 'What is your level of knowledge of computer applications in clinical practice?' the hospitals differed. Hosp 1 had better knowledge of computer application in clinical practice. Less than one half (45.0%) of respondents in Hosp 1 reported their knowledge as moderate or great. The percentage of respondents that felt they had moderate to great knowledge of computer application in medicine was even lower in Hosp 2 (13.4%) and in Hosp 3 (26.3%).

**Present status of computerisation**

Box 5 presents results of analysis of the status of computerisation of clinical and administrative functions in each institution. The functions considered by the highest number of respondents to be computerised were 'scheduling of appointments' in Hosp 1 (94.6%), 'writing prescriptions' in Hosp 2 (70.1%) and 'registration of patients' in Hosp 3 (87.9%).

<sup>2</sup> Percentages refer to the respondents who remained neutral to the statements.

**5: Present status in the three hospitals**



Legend: Are the following functions computerised?

**Clinical functions**

1. Writing patients' summaries
2. Storage of patient information
3. Storage of patients' image files
4. Preparation of referral letters
5. Writing Prescriptions
6. Recording consultations
7. Accessing educational materials
8. Recall system (that reminds patients that they are due for routine tests)
9. Decision support system (to assist doctors to solve diagnostic or treatment problems)

**Administrative functions**

10. Registration of patients
11. Billing and payments
12. Scheduling of appointments
13. Staff payroll
14. Stock and stores control
15. Finance management
16. Making insurance claims

Using decision support was reported by the least number of respondents as being computerised in all the three hospitals.

Overall, the present status score (defined as the average number of respondents indicating the functions have been computerised expressed as a percentage of the functions) was higher in Hosp 1 (76.6%) followed by Hosp 3 (71.6%). Hosp 2 had a present status score of 53.1%.

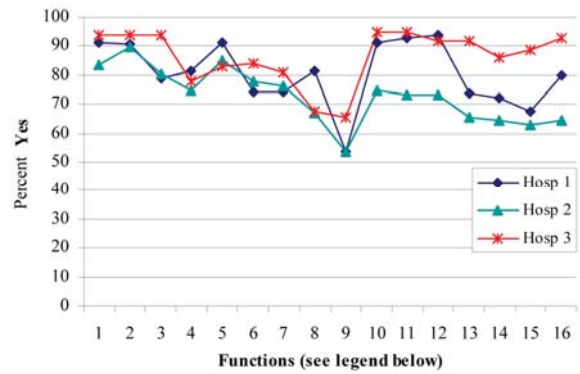
**Desired status of computerisation**

Box 6 summarises the proportion of the respondents who indicated that the functions in the survey should be computerised (desired status).

The functions most respondents would want computerised were 'appointments scheduling' in Hosp 1 (93.8%), 'patient information' in Hosp 2 (89.6%) and 'registration of patients' and 'billing and payments' in Hosp 3 (94.9%).

In all the three healthcare institutions, the function the least number of respondents would want computerised was 'using decision support' with only 53.5% (Hosp 1), 53.7% (Hosp 2) and 65.7% (Hosp 3) of the respondents interviewed feeling that using decision support should be computerised.

**6: Desired status in the three hospitals**



Legend: Should the following functions be computerised?

**Clinical functions**

1. Writing patients' summaries
2. Storage of patient information
3. Storage of patients' image files
4. Preparation of referral letters
5. Writing Prescriptions
6. Recording consultations
7. Accessing educational materials
8. Recall system (that reminds patients that they are due for routine tests)
9. Decision support system (to assist doctors to solve diagnostic or treatment problems)

**Administrative functions**

10. Registration of patients
11. Billing and payments
12. Scheduling of appointments
13. Staff payroll
14. Stock and stores control
15. Finance management
16. Making insurance claims

Even though there were individual item variations in terms of the desired level of computerisation (Box 6), there were remarkable similarities in the overall desired status score, obtained using similar calculations as for present status scores. Hosp 3 had desired status of computerisation of 99.1%, while Hosp 1 had 98.6% and Hosp 2 had 98.5%.

**Attitude**

Box 7 summarises the attitudes and perceptions of respondents in each institution about EMR. Generally, respondents tended to agree with positive statements on computerisation (items 1, 2, 3 and 9) and disagree with negative statements (items 4 and 5). However, a large majority of respondents across the institutions considered computers to be more beneficial for administrative functions than clinical functions (62.8% in Hosp 1; 59.7% in Hosp 2 and 38.4% in Hosp 3). Most respondents also agreed with the statement that cost of computerisation is too high. However, very few respondents agreed with the statement that 'privacy issues have been dealt with adequately' (20.2% in Hosp 1; 14.9% in Hosp 2 and 33.3% in Hosp 3).

As shown in Box 7, items 2, 5, 6, 7, 8, and 10 had differences between the hospitals. Respondents from

Hosp 3 tended to be more positive towards these items than respondents from the other two hospitals.

**Multivariate analysis**

**Correlation analysis**

The results of correlation analysis for the institutions are summarised in Box 8. Pearson’s correlation coefficients indicated low and sometimes nearly nonexistent correlations between the variables for each institution, except between present status and desired status in Hosp 1. However, attitude was the only variable that was significantly correlated with desired status in all three institutions.

**Research question**

Box 9a indicates the results of the regression analyses completed to answer the research question based on the TRA model. The variables entered were present status and IT skills against attitude and then attitude against desired status separately for each hospital. The results were then plotted to reflect a path model based on TRA (Box 9b). F tests were significant in all of the models except between present status and IT skills against attitudes in Hosp 2.

As shown by Box 9, attitudes had a significant positive effect on desired status of computerisation in all three institutions.

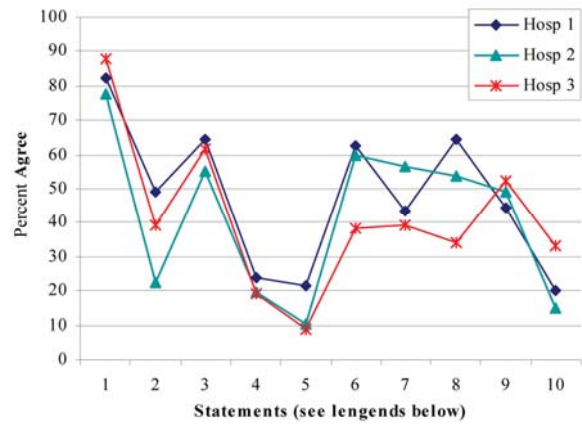
**Discussion**

The purpose of this study was to examine the influence of three factors on the diffusion of EMR in the healthcare environment, namely: IT skills of healthcare workers, present status of computerisation, and attitudes of healthcare workers to computerisation. The analysis provided evidence from a sample of healthcare workers drawn from three healthcare institutions in Japan that are at various stages of computerisation.

The results show that IT skills of healthcare workers are moderate. Given the IT infrastructure in Japan (International Telecommunication Union 2003), we doubt whether the results reflect the actual level of IT skills of the respondents. Formal examination and direct observation would have given a better picture of the level of IT skills of healthcare workers. Nevertheless, our findings are a good pointer to the fact that most healthcare workers already have computer skills.

We discovered that most of the functions already computerised are administrative in nature. In particular, these functions are either clinical or general administrative (Simpson & Gordon 1998). Our findings confirm the trend that adoption of computer technology in healthcare is driven largely by a desire to streamline administrative functions (Japan Hospital Association 2001; Leung et al. 2001). Functions that purely support management of patient care such as reminder systems, decision support systems and ac-

**7: Attitudes of health professionals in the three hospitals**



1. EMR is a necessity in clinical practice
2. Computers creates good impression with patients
3. EMR can significantly improve quality of patient care
4. Using EMR means longer consultation
5. Computers interferes unduly with doctor-patient consultation
6. Computers are beneficial for administrative than clinical functions
7. Cost of computerisation is prohibitive
8. Training of staff is of too much effort.
9. Electronic clinical records are of more value than paper files.
10. Privacy issues have been dealt with adequately in EMR

**8: Correlation results of the major variables**

	<u>Major variables</u>			
	<u>Present status</u>	<u>Desired status</u>	<u>Attitude</u>	<u>IT skills</u>
<b>Hosp 1</b>				
Present status	1	0.642*	0.314*	0.094
Desired status		1	0.377*	0.122
Attitude			1	0.346*
IT skills				1
<b>Hosp 2</b>				
Present status	1	-0.011	-0.168	-0.143
Desired status		1	0.361*	-0.005
Attitude			1	0.130
IT skills				1
<b>Hosp 3</b>				
Present status	1	0.063	0.008	-0.050
Desired status		1	0.335*	0.220**
Attitude			1	0.428*
IT skills				1

\* Correlation is significant at the 0.01 level (2-tailed)  
 \*\* Correlation is significant at the 0.05 level (2-tailed)

cessing educational materials for patients have not been computerised to the same extent as the administrative ones. It was encouraging to note, however, that all the institutions have already computerised some of these functions.

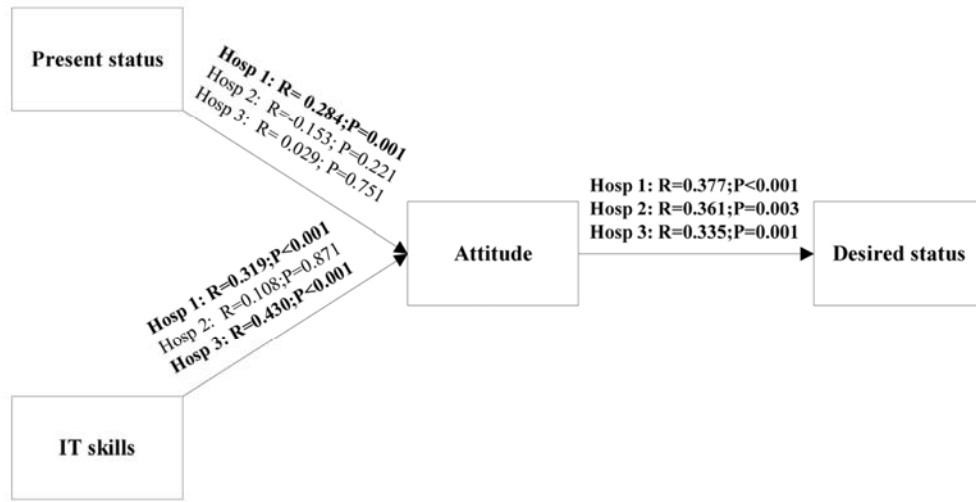
9: Results of regressions completed to answer the research question

Hosp 1			Hosp 2		
Attitude		Desired status	Attitude		Desired status
Variables	beta	P value	Variables	beta	P value
Present status	0.284	0.001	Attitude	0.377	0.000
IT skills	0.319	0.000	Present status	-0.153	0.221
			IT skills	0.108	0.387
R.Sq. = 0.200			R.Sq. = 0.040		
Adjusted R.Sq. = 0.187			Adjusted R.Sq. = 0.010		
Set is significant at P<0.05			Set is not significant at P<0.05		

Hosp 3		
Attitude		Desired status
Variables	beta	P value
Present status	0.029	0.751
IT skills	0.430	0.000
R.Sq. = 0.184		
Adjusted R.Sq. = 0.167		
Set is significant at P<0.05		

a Regression analyses based on TRA



b Path model based on TRA

There is, however, a gap between what respondents desire to be computerised and what actually is computerised. For instance, the functions reported by less than 30% of respondents as being currently computerised, are desired by over 50% of the respondents. In other words, there is a demand for expanded EMR capabilities. The results show that healthcare workers desire to have functions that support clinical management, such as recall (reminder) and decision support systems, computerised. Computerised recording of consultations and writing of patients' summaries at the point of care make patient information immediately available for use by other healthcare workers. Electronic patient information should be integrated with computerised reminder and decision support systems as indicated by healthcare workers in this study, to enhance healthcare delivery.

Evidence continues to support the effectiveness of a computerised reminder system and decision support in improving patient care. A recent meta-analysis of published articles between 1966 to 2003 revealed that automatic provision of decision support as part of clinical workflow, provision of reminder systems, and

recommendations at the time and location of decision making are strong predictors of improved clinical practice (Kawamoto et al. 2005). Therefore, if these functions are computerised, healthcare workers are more likely to deliver safe and efficient healthcare.

Those healthcare workers interviewed in the study have positive attitudes towards computerisation in healthcare. Contrary to other previous studies (Leung et al. 2003), the healthcare workers did not believe that use of computers interferes with the doctor-patient relationship, neither does it lengthen the consultation period. However, they agreed that the cost of computerisation, and the associated efforts needed to train healthcare staff, are prohibitive. The high cost of computerisation continues to be a major impediment to EMR adoption (Leung et al. 2003; Japan Hospital Association 2001). Nevertheless, these barriers will in all probability be overcome soon, as the costs of computer software and hardware are falling (Berndt, Dulberger & Rappaport 2000). At the same time, more healthcare workers are becoming computer literate through health informatics training.

This study also finds that privacy and confidentiality issues still remain major concerns of healthcare workers. Most respondents did not agree that privacy issues have been dealt with adequately. Although technologies that can be used to protect privacy and security of patient records already exist (Osion, Peters & Stewart 1998; Kibbe & Bard 1997), respondents are not persuaded that these technologies can protect privacy and confidentiality of patient records. Consequently, privacy issues remain a major barrier to adoption of EMR. Even though privacy and security of patient data are no longer technological limitations (Leung et al. 2003), ensuring appropriate access is still a problem faced by many hospitals (Lederman 2005).

Despite the high demand for EMR, respondents tended to be neutral to statements that portrayed computers negatively. Kirshbaum, in a survey of healthcare workers in two acute hospitals in the United Kingdom, also reported large numbers of respondents, particularly among nurses, who recorded 'uncertain' options for attitude statements (Kirshbaum 2004). This trend may indicate that healthcare workers do not have faith in the effectiveness and efficiency of computers in supporting patient care, particularly the view that privacy and confidentiality have not been dealt with adequately in the computerised environment, and the belief that computers are more beneficial for administrative functions than clinical functions. These beliefs are likely to discourage use of computer systems in daily patient care.

Results show that the level and extent of computerisation varied across the institutions. This was expected: the hospitals are administered under different organisations, thus have different organisational leadership, goals and objectives; factors which directly influence the uptake of a computerised system (Ash 1997b). Hosp 1 and Hosp 3 are partly supported by the government, consequently they showed higher computerisation status than Hosp 2, which is a private institution.

Among the attitude statements that registered significant differences between the institutions, Hosp 3 reflected a more positive attitude towards computerisation in healthcare. Hosp 1 and 2 demonstrated somewhat similar attitudes. Unlike Hosp 3, Hosp 1 and 2 are acute hospitals, suggesting that the critical turnaround time needed in acute care services could be making healthcare workers less enthusiastic about the use of computers in clinical practice.

Pearson's correlation coefficients obtained in this study were acceptably low, indicating weaker but significant relationships among the variables. In past diffusion studies, 0.82 has been considered high and 0.47 low (Kimberly & Evanisko 1981). In the present study, only one alpha was above 0.50 with the rest being below 0.47.

The models, based on TRA, had very low R square values, consistent with the low coefficients obtained at the bivariate (correlation) tests, but the F tests were

significant in all the models except between IT skills and present status, and attitudes in Hosp 2. Compared with the other two hospitals, our model could not be explained in Hosp 2. This could be due to a number of reasons. First, Hosp 2 had the lowest level of computerisation and knowledge of computers application in clinical medicine. Secondly, unlike the other two hospitals, respondents from this hospital had used the system for about two years at the time of this survey, suggesting that the respondents could still be at the learning phase of the system. Individual models showed that IT skills had higher beta values than present status in the three hospitals, suggesting that IT skills are an important factor in influencing the attitudes of healthcare workers. The models between attitude and desired status were significant in the three hospitals; fitting well to our hypothesis that attitude will significantly influence adoption of EMR in clinical practice. The best model was obtained in Hosp 1 where present status and IT skills had a significant positive effect on attitudes of healthcare workers, which in turn had significant effect on the desired status of computerisation.

This study has provided fresh insights into factors that influence diffusion of EMR in healthcare. Despite the low R square values, the failure of our model to be fully explained in Hosp 2, and the low beta values, the results suggest that IT skills and present status of EMR will influence the attitudes of healthcare workers, which in turn influences the adoption of EMR. To enhance diffusion the EMR capabilities therefore need to be expanded, particularly those that add value to patient care, such as decision support and recall systems. EMR expansion should, however, be preceded by extensive training of healthcare workers to enable them to foster positive attitudes towards computer use in clinical practice.

The study has several limitations. First, the findings of this study reflect the opinion of respondents in three healthcare institutions in Japan and cannot be taken to be the view of all healthcare workers in Japan. Second, respondents were not randomly selected and their individual interest and enthusiasm for EMR could have influenced their responses. Third, the study reports data that are based on respondents' recall, which is subject to error and bias. However, the high response rate achieved in this survey makes it adequate to report these exploratory findings in the context of the environments where the study was conducted.

Although the results of this study may lack external validity, the study does provide a framework for future research. In particular, a natural expansion of this study would be to examine whether and how the attitudes of healthcare workers can actually be translated into work practice in a computerised environment.

### Implications and conclusion

The findings of this study have important implications for the implementation of EMR. First, if EMR is to be

used more widely, the functions that support clinical management of patients should be incorporated in the implementation program. These functions will enable healthcare workers to realise the potential benefits of EMR, hence encouraging the continued use of these systems.

Second, the overwhelming feeling among health workers that privacy and security of patient records have not been well addressed calls for more education and training to alleviate these fears. Targeted training geared towards educating these different groups of healthcare workers is needed to increase confidence in the use of EMR for healthcare delivery, and access to EMR systems must be limited to authorised individuals.

Third, overcoming the cost of computerisation will require a concerted effort that will bring together various healthcare stakeholders (system developers, insurers, healthcare providers and government) into a partnership to share the cost. The government can offer incentives at various levels to encourage adoption of EMR; for example, the government can increase reimbursements to hospitals that adopt EMR, or offer subsidies for its adoption.

EMR is important in promoting safe, patient-centred, efficient and effective healthcare. However, for these outcomes to be realised, targeted training and education of healthcare workers in order to foster positive attitudes about technology, and build confidence in the benefits of these systems should precede implementation of EMR.

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