Ⅱ　研究成果の刊行に関する一覧表

研究成果の刊行に関する一覧表

雑誌

発表者氏名	論文タイトル名	発表誌名	巻号	ページ	出版年
Inokuchi R Sato H Nakamura K Aoki Y Shinohara K Gunshin M Matsubara T Kitsuta Y Yahagi N Nakajima S.	Motivations and barriers to implementing electronic health records and emergency department information systems in Japan	*Am J Emerg Med*		In press	2014
Inokuchi R Sato H Nakajima S Yahagi N.	Current Policies on Informed Consent in Japan Constitute a Formidable Barrier to Emergency Research.	*Resuscitation*	85	e27	2014
佐藤　元 井口　竜太	救急医療における被験者同意を要件としない臨床試験に関する米国の規制：歴史的経緯、現行の法令・ガイドラインと課題	保健医療科学		In press	2014
佐藤　元 井口　竜太	救急医療における臨床試験・治験に係わる倫理と法令・規則	*Crinical Research Professionals*		In press	2014
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Original Contribution

Motivations and barriers to implementing electronic health records and ED information systems in Japan☆,☆☆,★

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ABSTRACT

Background: Although electronic health record systems (EHRs) and emergency department information systems (EDISs) enable safe, efficient, and high-quality care, these systems have not yet been studied well. Here, we assessed (1) the prevalence of EHRs and EDISs, (2) changes in efficiency in emergency medical practices after introducing EHR and EDIS, and (3) barriers to and expectations from the EHR-EDIS transition in EDs of medical facilities with EHRs in Japan.

Materials and methods: A survey regarding EHR (basic or comprehensive) and EDIS implementation was mailed to 466 hospitals. We examined the efficiency after EHR implementation and perceived barriers and expectations regarding the use of EDIS with existing EHRs. The survey was completed anonymously.

Results: Totally, 215 hospitals completed the survey (response rate, 46.1%), of which, 72.1% had basic EHRs, 4.2% had comprehensive EHRs, and 1.9% had EDISs. After introducing EHRs and EDISs, a reduction in the time required to access previous patient information and share patient information was noted, but no change was observed in the time required to produce medical records and the overall time for each medical care. For hospitals with EHRs, the most commonly cited barriers to EDIS implementation were inadequate funding for adoption and maintenance and potential adverse effects on workflow. The most desired function in the EHR-EDIS transition was establishing appropriate clinical guidelines for residents within their system.

Conclusion: To attract EDs to EDIS from EHR, systems focusing on decreasing the time required to produce medical records and establishing appropriate clinical guidelines for residents are required.

1. Introduction

Developed primarily for use in general inpatient and outpatient care, electronic health record systems (EHRs) have improved patient care worldwide [1-3]. However, extending EHRs to the emergency department (ED) setting has been a challenge due to differences between the requirements of general medical practice and those of an ED. Specifically, EDs must routinely treat several patients simultaneously, and many patients do not schedule their visits [4-6]. Therefore, EDs require customized emergency department information systems (EDISs) that reflect the unique procedures and treatments performed in emergency care settings [4,7].

First proposed in 1975 [8], EDISs are now defined broadly as "EHRs designed specifically to manage data and workflow in support of ED patient care and operations [9]." Cumulative evidence indicates that EDISs have improved workflow and patient care in the ED [10]. However, to the best of our knowledge, although there has been only one report on the prevalence of EDIS from the United States [11], the prevalence of EDISs in Japan is not known.

In Japan, EHR adoption started in the 1990s [12,13], but it is assumed that the prevalence of EDISs remains low [14,15]. Considering the shortage of medical staff and the increasing number of patients visiting EDs, widespread adoption of user-friendly EDISs is urgently needed to improve workflow and the quality of patient care

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☆☆ Author contribution: RI conceived the study. RI, HS, YK, and SN designed the analysis plan. RI and HS performed the statistical analyses. RI wrote the first draft of the study. KN and YA contributed to draft of the study. RI, KN, MG, TM, YK, NY, and SN obtained the data. YA, KS, and NY critically reviewed the manuscript. All authors contributed to the design, interpretation of results, and critical revision of the article for intellectually important content.

★ Conflicts of interest statement: The authors declare that they do not have any conflicts of interest.

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[13]. To facilitate hospitals' adoption of such systems (thereby supporting prompt, safe medical treatment in the ED), it is particularly important to determine why hospitals with EHRs hesitate to introduce EDISs. The aim of this multicenter survey was to identify current problems with EHR and the barriers to EDIS adoption in Japan. To this end, we conducted a questionnaire survey on (1) the prevalence of EHR and EDIS adoption, (2) the changes made after EHR introduction, and (3) the barriers to and expectations for EHR-EDIS transitions in Japanese emergency medical facilities with existing EHRs.

2. Method

2.1. Setting: emergency medical facilities in Japan

In Japan, emergency medical facilities are designated as primary, secondary, or tertiary care facilities [16], and paramedics choose the appropriate health care facilities depending on the patient's condition. Primary care facilities do not have beds, as they are designed for walk-in patients who do not require in-hospital care. Secondary care facilities provide inpatient care to both walk-in patients and those transported by ambulance; these facilities are used to examine and treat patients with moderately severe conditions. Tertiary care facilities offer intensive treatment to critically ill or injured patients in all medical specialties [17].

2.2. Sample

The questionnaire was sent to the ED directors of 466 hospitals listed as accredited training institutions by the Japanese Association for Acute Medicine in 2012 [18]. The survey was initially mailed in February 2013; all hospitals received reminder letters, and responses were accepted until the end of April 2013. The survey was completed anonymously.

2.3. Survey content

Electronic health record systems interact with clinical documentation, computerized provider-order entry (CPOE) [19], and clinical decision-support system (CDSS) [20]. The CPOE is communicated over a computer network to the medical staff or to the departments (eg, prescription, laboratory, or radiology) responsible for fulfilling the order. A CDSS is an interactive decision-support system designed to assist physicians with decisions such as patient diagnosis. Thus, we divided EHR functions into 4 categories: "clinical documentation," "test and imaging results," "CPOE," and "CDSS."

Respondents were first asked whether their hospital (1) had EHR for all departments, (2) had an EHR only for general inpatient and outpatient use but not in the ED, or (3) had no EHR for any hospital department. If they reported having an EHR in place for the ED, they were asked to specify the type of EHR according to the classification system of Jha et al [21]: "basic EHR" (demographic information, CPOE, and laboratory and imaging results) or "comprehensive EHR" (the functions listed for the basic system as well as electronic prescribing, radiographic image display, and CDSS). Detailed information regarding the classifications is presented in Table 1. Accordingly, we divided the hospitals into 4 categories: hospitals with comprehensive EHR, those with basic EHR, those with EHR for inpatient or outpatient departments but not for the ED, and those with no EHR in the hospital. Respondents with EHR were further asked to specify whether (1) their EHR had been developed exclusively for use in an ED or (2) their EHR was designed for general inpatient and outpatient care and was partially customized for use in an ED. We defined the former as EDIS because there are no standardized definitions or required functions in EDIS [22].

Second, respondents with EHR and EDIS were asked whether they thought that introducing the EHR had improved the efficiency of their emergency practices. Items in this section were rated as "improved," "no change," or "worsened."

Third, respondents with EHR were asked to identify factors that they considered to be (1) major barriers, (2) minor barriers, or (3) no barriers regarding "cost," "ED practice," "introducing an EDIS," and "data privacy." Items in this section were rated as "major barrier," "minor barrier," and "not a barrier."

Finally, respondents with and without EHR were asked to rate their expectations for EDIS as "essential," "very desirable," "desirable," or "no need." The questions and response categories used are listed in the Supplementary file A and B.

Table 1
Requirements for the 2 types of EHR systems

Requirements	Comprehensive EHR	Basic EHR
Clinical documentation		
Demographic characteristics of patients	✓	✓
Physician notes	✓	✓
Nursing assessments	✓	✓
Problem lists	✓	✓
Medication lists	✓	✓
Discharge summaries	✓	✓
Advance directives[a]	✓	
CPOE		
Laboratory tests	✓	
Radiology tests	✓	
Medications	✓	✓
Consultation requests	✓	
Nursing orders	✓	
Test and imaging results		
Laboratory reports	✓	✓
Radiology reports	✓	✓
Radiology images	✓	
Diagnostic test results	✓	✓
Diagnostic test images	✓	
Consultant reports	✓	
CDSS		
Clinical guidelines	✓	
Clinical reminders	✓	
Drug allergy alerts	✓	
Drug-drug interaction alerts	✓	
Drug-laboratory interaction alerts[b]	✓	
Drug-dose support[c]	✓	

[a] That is, do not resuscitate.
[b] For example, digoxin and low level of serum potassium.
[c] For example, renal dose guidelines.

2.4. Statistical analysis

2.4.1. Difference in hospital size between respondent and nonrespondent hospitals

First, we conducted Pearson χ^2 test to investigate differences between respondent and nonrespondent hospitals in terms of hospital size.

2.4.2. Adoption of EHRs and EDISs

We then calculated the percentage of respondent hospitals with and without EHRs. The former was further divided into the 2 types of EHRs (basic or comprehensive EHR), and the latter was divided into 2 types (EHR in the inpatient or outpatient departments but not in the ED and no EHR in the hospital). Next, we explored bivariate relationships among key hospital characteristics (hospital size, ownership, teaching status, and medical facility classification) and adoption of basic or comprehensive EHR using Pearson χ^2 or Fisher exact tests, as appropriate.

2.4.3. Impact of introduction of EHRs and EDISs

Second, we carried out Kruskal-Wallis tests to compare the effects of introducing EHR on the respondent hospital emergency practices, as measured by 7 questions.

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Table 2
Characteristics of survey respondents and all survey hospitals

	Respondents, n = 215 (%)
Size	
Small (<100 beds)	5 (2.3)
Medium (100-399 beds)	48 (22.3)
Large (≥400 beds)	149 (69.3)
Unknown/no response	13 (6.0)
Ownership	
National	38 (17.7)
Municipal	49 (22.8)
Public	47 (21.9)
Private	72 (33.5)
Unknown/no response	9 (4.2)
Teaching status	
Teaching	185 (86.0)
Nonteaching	10 (4.7)
Unknown/no response	15 (7.0)
Total hospital beds (mean ± SD)	551 ± 248
Total observation beds (mean ± SD)	5.4 ± 3.1
Total ambulance admissions per year (mean ± SD)	4007 ± 2074
Medical facility classification	
Tertiary care	117 (54.4)
Secondary care	94 (43.7)
Primary care	0 (0)
Unknown/no response	4 (1.9)

2.4.4. Barriers to EHR-EDIS transition

Third, we analyzed the scores of 11 questions regarding barriers, rated as 2 ("major barrier"), 1 ("minor barrier"), or 0 ("no barrier"). We divided these questions into 4 categories and compared the difference in categories by using the Kruskal-Wallis test.

2.4.5. Expectations regarding the functionality of EDISs

Finally, we compared the characteristics of hospitals with and without EHR by using univariate comparisons of reported expectation scores, with either Student *t* test or the Wilcoxon-Mann-Whitney *U* test, as appropriate.

We compared the characteristics of respondents with all survey hospitals using STATA software, version 13 (Stata Corp, College Station, TX). For all analyses, statistical significance was set as 2-tailed $P < .05$.

3. Results

Among the 466 hospitals contacted, 215 completed the survey (46.1% response rate) (Table 2). There were no significant differences in hospital size between respondent and nonrespondent hospitals.

3.1. Adoption of EHRs and EDISs

Among the 215 respondent hospitals, ~~155 (72.1%)~~ had EHRs in their EDs. Only 9 hospitals (4.2%) had comprehensive EHRs, but ~~160 (74.4%)~~ had basic EHRs in their EDs (Table 3). Teaching hospitals were more likely to use EHRs. We found no relationship between hospital size, ownership status, or medical facility classification and level of adoption of EHRs. With regard to EDISs, 4 hospitals (1.9%) had EDISs; all were large teaching hospitals with basic EHRs.

3.2. Adoption of CPOE and CDSS functionality

As shown in Table 4, all EHRs (>95%) included all the expected functions in the categories of "clinical documentation," "CPOE," and "test and imaging results;" a smaller percentage of hospitals reported that they already had "advanced directives" (73%) and "nursing orders" (88%) functions. The lowest scores belonged to the CDSS category. Most hospitals had alerts for "drug-allergies" (77%), "drug-drug interactions" (60%), and "drug-dose support" (59%); however, a minority of hospitals had functionality related to "drug-laboratory interactions" (28%), "clinical guidelines" (18%), or "clinical reminders" (11%).

3.3. Impact of introduction of EHRs and EDISs

Respondents were asked to describe how EHR or EDIS implementation had affected patient care (improved, no change, or worsened). As presented in Table 5, the survey shows that the directors felt that EHRs and EDISs improved information sharing (95.1% ± 1.7%; mean ± SD), providing explanations (82.7% ± 3.0%), access to previous patient information (81.6% ± 3.4%), and medical safety (73.4% ± 3.7%), but that time spent on medical records (36.9% ± 3.9%) and overall medical care (31.4% ± 3.7%) were worsening.

Table 3
Use of comprehensive and basic EHR according to hospital characteristics

	Total respondents (n = 215)				
	EHR in ED (n = ~~171~~)		No EHR in ED (n = 40)		*P*
	Comprehensive EHR (n = 9)	Basic EHR (n = ~~155~~)	EHR for inpatient/outpatient departments (n = 12)	No EHR within hospital (n = 28)	
	% ~~Of~~ hospitals				
Size					.507
Small (<100 beds)	0	50.0 ± 28.9	0	50.0 ± 28.9	
Medium (100-399 beds)	4.5 ± 3.2	75.0 ± 6.6	4.5 ± 3.2	15.9 ± 5.6	
Large (≥400 beds)	4.9 ± 1.8	76.3 ± 3.6	6.9 ± 2.1	11.8 ± 2.7	
Ownership					.541
National	3.1 ± 3.1	68.8 ± 8.3	12.5 ± 5.9	15.6 ± 6.5	
Municipal	2.1 ± 2.1	80.9 ± 5.8	6.4 ± 3.6	10.6 ± 4.5	
Public	4.2 ± 2.9	85.4 ± 5.1	2.1 ± 2.1	8.3 ± 4.0	
Private	4.4 ± 2.5	70.6 ± 5.6	5.9 ± 2.9	19.1 ± 4.8	
Teaching status					<.001
Teaching	5.0 ± 1.6	77.7 ± 3.1	5.6 ± 1.7	11.7 ± 2.4	
Nonteaching	0	30.0 ± 15.3	0	70.0 ± 15.2	
Medical facility classification					.581
Tertiary care	4.5 ± 2.0	72.3 ± 42.4	6.3 ± 2.3	17.0 ± 3.6	
Secondary care	4.5 ± 2.2	79.5 ± 4.3	5.7 ± 2.5	10.2 ± 3.2	

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Table 4
Functionality of EHR system in the ED

	Fully implemented in ED	Implementation within 1 y	Implementation under consideration	No implementation, with no specific plans for ED
	% of hospitals			
Clinical documentation				
Patient information[a]	97.7			
Physician notes	97.1			0.6
Nursing assessments	96.6	0.6		0.6
Problem lists	97.1			0.6
Medication lists	97.7			
Summary	97.7			
Advance directives[b]	73.1	0.6	1.1	21.7
CPOE				
Blood test order	97.7			
X-ray order	97.7			
CT, MRI order	97.7			0.0
ECG order	96.0		0.6	0.6
Echocardigram order	97.7			
Prescribed medication	97.7			
Consultation requests	95.4		0.6	1.1
Nursing orders[c]	88.0		1.7	6.9
Test and imaging results				
Laboratory reports	97.7			
X-ray images	97.1			
CT, MRI images	97.1			
ECG images	93.1	0.6	1.1	2.9
Echocardigram images	94.3	0.6	1.1	1.1
Radiology reports	97.1			
Echocardigram reports[d]	94.9	0.6	1.1	0.6
Consultant reports	95.4			1.7
CDSS				
Clinical guidelines[e]	17.7	1.1	8.0	66.3
Clinical reminders[f]	11.4	1.1	8.0	68.6
Drug-allergy alerts	76.6		7.4	12.0
Drug-drug interaction alerts	60.0	0.6	6.9	25.7
Drug-laboratory interaction alerts[g]	28.0		8.0	56.6
Drug-dose support[h]	59.4		5.1	30.3

Abbreviations: *CT*, computed tomography; *MRI*, magnetic resonance imaging; *ECG*, electrocardiogram.

[a] Age, sex, address, etc.
[b] Do not resuscitate.
[c] For example, call order.
[d] For example, echocardiogram.
[e] For example, β blockers after myocardial infarction.
[f] For example, pneumococcal vaccine.
[g] For example, digoxin and low level of serum potassium.
[h] For example, renal dose guidance.

3.4. Barriers to EHR-EDIS transition

Among hospitals with EHRs, the most commonly cited barriers to transitioning to EDIS from EHR were inadequate capital for purchasing the system, concerns about maintenance costs, and future support from the providers (Table 6). Among ED practices, the most cited barrier to implementation was potential adverse effects on workflow ($P < .0001$).

Table 5
Impact of introduction of EHR system

	EHR in ED (n = 171)				EDIS in ED (n = 4)			
	Improved	No change	Worsened	*P*	Improved	No change	Worsened	*P*
	% of hospitals				% of hospitals			
Effects on medical care in ED				<.001				.0045
Clinical documentation								
Shortened time for clinical documentation	36.9 ± 3.9	29.2 ± 3.6	33.8 ± 3.8		0	66.7 ± 33.3	33.3 ± 33.3	
CPOE								
Shortened time for imaging and laboratory orders	57.2 ± 3.9	28.9 ± 3.6	13.8 ± 2.7		66.7 ± 33.3	33.3 ± 33.3	0	
CDSS								
Improved medical safety	73.4 ± 3.7	25.9 ± 3.6	0.7 ± 0.7		100	0	0	
Others								
Shortened time for overall medical care	31.4 ± 3.7	48.1 ± 4.0	20.5 ± 3.2		0	66.7 ± 33.3	33.3 ± 33.3	
Improved access to previous patient information	81.6 ± 3.4	7.3 ± 2.1	11.0 ± 2.5		100	0	0	
Improved providing explanations to patients	82.7 ± 3.0	16.0 ± 2.9	1.2 ± 0.9		100	0	0	
Improved sharing patient information with staff	95.1 ± 1.7	3.7 ± 1.5	1.2 ± 0.9		100	0	0	

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Table 6
Perceived barriers regarding the adoption of EDIS for hospitals with and without EHR

	EHR in ED	P
	Score (mean ± SD)	
Barriers[a]		
Cost		.145
The amount of capital needed to purchase and implement an EDIS	1.8 ± 0.4	
Concerns about the ongoing cost of maintaining an EDIS	1.7 ± 0.5	
Concerns about a lack of future support from vendors in upgrading	1.7 ± 0.5	
ED practice		<.0001
Resistance to implementation from ED physicians	0.6 ± 0.7	
Resistance to implementation from other staff (eg, RNs, NPs, PAs)	0.8 ± 0.7	
Concerns about adverse effects on workflow	1.1 ± 0.7	
Introducing EDIS		.589
Lack of interoperable IT systems on the market	1.3 ± 0.7	
Lack of adequate IT staff when trouble occurs	1.6 ± 0.6	
Finding an EHR that meets hospital needs	1.2 ± 0.7	
Data privacy		.956
Concerns about inappropriate disclosure of patient information	1.2 ± 0.8	
Concerns about illegal record tampering or "hacking"	1.2 ± 0.8	

Abbreviations: *RNs*, registered nurses; *NPs*, nurse practitioners; *PAs*, physician assistants; *IT*, information technology.

[a] In hospitals with EHR, we asked the extent to which these items were a barrier in adopting EDIS. Possible multiple-choice responses to each item were 2, "major barrier; 1, "minor barrier;" and 0, "not a barrier."

3.5. Expectations regarding EDIS functionality

As shown in Table 7, hospitals without EHRs in the ED had significantly higher expectations than those with EHR for a system developed exclusively for use in the ED setting ($P = .0018$). In addition, hospitals with EHR in their EDs had higher expectations for showing appropriate clinical guidelines for residents ($P = .033$).

4. Discussion

To the best of our knowledge, this is the first comprehensive national survey of EHRs and EDISs in Japanese hospitals to explore barriers to and expectations for EDISs implementation in hospitals with existing EHRs. First, the current survey identified that only 9 hospitals (4.2%) had comprehensive EHR, and only 4 hospitals (1.9%) had EDIS. Second, ED directors reported that the introduction of EHR did not change the time required to create medical records and did not reduce overall clinic hours. Finally, the survey also revealed that the most common barriers against transitioning to EDIS from EHR were cost and potential adverse effects on workflow. However, ED physicians expect that EHR-EDIS transition will provide clinical guidelines for resident physicians.

4.1. Adoption of EHRs and EDISs in Japan

Although most hospitals surveyed had EHR, very few had comprehensive EHR. Our analysis also revealed that most hospitals in Japan with a fully implemented EHR in the ED do not have efficient CDSS. This low prevalence may be the result of a previous ban on selling separate CDSS software and that CDSS functionality such as flagging drug-laboratory interactions, providing clinical guidelines, and clinical reminders were seldom present. Although most nonparticipating hospitals have no plans to adopt these features in the near future, the Ministry of Health, Labour and Welfare lifted the ban on the sale of separate CDSS software in February 2013; this may boost the development of CDSS software and increase its use. In contrast, the advantages of CPOE were well understood early on in Japan, spurring the adoption of this function [23]. Today, CPOE has a higher rate of adoption in Japan [24]. Consequently, comprehensive EHR should increase in Japan.

4.2. Impact of introducing EHRs

According to the present survey, hospitals recognized that although CPOE shortened time for imaging and laboratory orders and CDSS improved medical safety in emergency care, it did not lead to a noticeable change in the time required to create medical records or overall clinic hours after the introduction of EHR. A previous study showed that physicians did not expect that EHR would decrease documentation time in ED settings [25], but emergency physicians would expect this function [26]. Our study showed that hospitals without EHR in the ED had significantly higher expectations for a system developed exclusively for use in ED than hospitals with EHR, suggesting that they have more expectations for this function. Thus, emergency physicians and providers should match the expectation by specifically focusing on systems that decrease the time required to create medical records.

4.3. Barriers to the EHR-EDIS transition

The survey identified that, among hospitals with EHR, the most commonly cited barriers to introducing an EDIS system were

Table 7
Expectations regarding the adoption of EDIS for hospitals with and without EHR

Expected functions[a]	EHR	No EHR	P
	Score (mean ± SD)	Score (mean ± SD)	
Allows for cooperation with other facilities	2.3 ± 0.9	2.2 ± 0.9	.55
EHR was developed exclusively for EDs	1.5 ± 1.1	2.1 ± 1.0	.0018
Provides explanation sheets to patients (eg, exercise caution after head trauma)	2.0 ± 0.9	2.0 ± 0.9	.95
Clinical decision support system (eg, drug-overdose alerts)	2.3 ± 0.8	2.4 ± 0.8	.65
Provides clinical guidelines for resident physicians	2.2 ± 0.9	1.9 ± 0.9	.033

[a] Hospitals were asked to identify desired functions in EDIS. Possible multiple-choice responses to each item were 3, "essential;" 2, "very desirable;" 1, "desirable;" and 0, "not needed."

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inadequate funding for the initial purchase and maintenance costs. Importantly, we also found that they believed that the transition of EHR to EDIS would have a negative effect on workflow. These negative findings may indicate a failure to attend to workflow changes created by the system, which may have severe consequences in an ED [27]. For example, Han et al [28] reported an increase in mortality after the introduction of EHR, and an Australian study found a significant increase in patient waiting times, treatment time, and total time to discharge patients after the implementation of an EDIS created in the United States [29]. Thus, it is important to develop EDISs to match each ED, including country.

4.4. Expectations regarding the functions of EDISs

Hospitals without EHR in the ED had significantly higher expectations for a system developed exclusively for use in the ED setting. This is important to note because it suggests that these hospitals would not implement their present EHRs in their EDs. In addition, hospitals with EHRs in their EDs have higher expectations for showing appropriate clinical guidelines for residents to make better use of their systems. Thus, for an EDIS to be successfully adopted in a hospital without EHR, its integration into routine clinical workflow within the ED must require no extra work on the part of clinicians [30,31]; providing appropriate clinical guidelines for residents would strongly stimulate EDIS adoption by hospitals with EHRs.

5. Limitations

The present study has several limitations. First, we achieved only a 46.1% response rate, and the hospitals that did not respond to our survey were somewhat different from those that did respond. We found no significant hospital size difference between the hospitals that did and did not respond to our survey. However, because this survey was completed anonymously, it was difficult for us to follow the nonrespondents. According to the supplemental small-scale phone interviews after the survey, we have an impression that nonresponder hospitals tended not to have EHR systems, compared with those responding; therefore, we cannot deny the presence of some selection bias. Namely, the true prevalence of EHRs and EDISs might be lower than our results. Second, we did not ascertain whether EHR users were satisfied with them. Finally, few hospitals in our sample had EDISs in place that had been developed exclusively for ED use. There may not be enough information on the characteristics that predict EDIS adoption. We recommend that this portion of the study be repeated again with hospitals having EDIS in place, to gain a better understanding of the ED characteristics associated with EDIS adoption.

6. Conclusion

We found that very few hospitals have comprehensive EHR systems or EDIS in Japan. As EHR-EDIS transitions become faster, providers and emergency physicians together should focus on developments that decrease cost, shorten the time to create medical records, and incorporate clinical guidelines.

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Appendix. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.ajem.2014.03.035.

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Supplemental file A

Supplemental file B

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Development of information systems and clinical decision support systems for emergency departments: a long road ahead for Japan

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ABSTRACT

Emergency care services face common challenges worldwide, including the failure to identify emergency illnesses, deviations from standard treatments, deterioration in the quality of medical care, increased costs from unnecessary testing, and insufficient education and training of emergency personnel. These issues are currently being addressed by implementing emergency department information systems (EDIS) and clinical decision support systems (CDSS). Such systems have been shown to increase the efficiency and safety of emergency medical care. In Japan, however, their development is hindered by a shortage of emergency physicians and insufficient funding. In addition, language barriers make it difficult to introduce EDIS and CDSS in Japan that have been created for an English-speaking market. This perspective addresses the key events that motivated a campaign to prioritise these services in Japan and the need to customise EDIS and CDSS for its population.

INTRODUCTION

In recent years, the momentum of the technological revolution brought about by health information technology (HIT) has increased. Healthcare reforms, hospitals and regional healthcare alliances have increasingly taken advantage of HIT. Adoption and widespread use of electronic forms for record maintenance have led to increased convenience and easier access to medical records.

Digitisation of the information used in emergency departments has necessitated a consideration of the unique aspects of emergency department care and information handling. For example, general outpatient treatment and emergency care differ in terms of medical examinations and locations within the hospital. General outpatient treatment can vary in duration. In contrast, emergency care involves short-term treatment and efficient performance of complex tasks. Examinations must be completed quickly since many patients exist in highly critical situations. Interruption of examinations is common because of high patient volume. Therefore, the use of a common electronic health record system to meet these different needs could be problematic.[1–3] For this reason, hospitals in many countries use emergency department information systems (EDIS) designed specifically for use in emergency departments. In addition, clinical decision support systems (CDSS) that are designed to reduce medical errors are often used as part of the hospital electronic health record system, which also includes EDIS.

Electronic medical record systems in medical facilities in Japan are, however, mainly designed for use in general outpatient care wards. EDIS is not yet well known, and electronic health record systems designed specifically for use in emergency departments are not available. What follows is a discussion about the history of the development of EDIS and CDSS, their present use, an examination of the factors that impede the adoption of these systems in Japan and possible issues in the future based on the current situation in Japan.

DEFINING HIT, EMERGENCY DEPARTMENT INFORMATION SYSTEMS, AND CLINICAL DECISION SUPPORT SYSTEMS

HIT is mainly used in the following areas: the management of administrative and medical equipment; the maintenance of patient records, within and outside hospitals; the provision of information to patients; and the transfer of medical information. Countries throughout the world have adopted HIT to reduce medical costs and errors and to ensure safety.[4–6] HIT was developed primarily for use in general outpatient wards. However, emergency departments require customised systems that reflect the unique examinations and treatments required in emergency care,[3] which are EDIS.[1 3 7] EDIS is broadly defined as 'an electronic medical record system that increases the efficiency of emergency patient examinations and treatment'.[3] It is not simply a record of examinations but is also composed of several core functions to support clinical care, such as patient and order entry, triage, result reporting, document management, CDSS and risk management, patient and resource tracking, and discharge management.[3] Core administrative EDIS functions comprise hospital and departmental statistical metrics management; coding and billing, including interaction with insurance carriers and provision of information to third parties; integration with public health and other registries; disaster management; disease surveillance; and early detection and management during outbreaks of new infectious diseases or terrorist attacks. Thus, the responsibilities of EDIS include medical care, hospital administration and national policy making.[3 8]

CDSS improve medical safety by reducing errors in judgment, allowing information sharing that forms the clinical basis for decision making,[9–12] providing information about drug allergies, contraindications for drugs in combination, test results associated with drugs (eg, digoxin and low serum potassium levels), drug dosage adjustments (eg, opioids or insulin), medication characteristics, special considerations for elderly patients, imaging technique ordering for patients with pacemakers and proposal of a set of appropriate diagnoses.[13–15]

BARRIERS TO ADOPTION OF EDIS AND CDSS

Although the merits of EDIS and CDSS are widely acknowledged in the medical profession, the USA has been slow in adopting these new technologies. Landman *et al* first reported the prevalence of EDIS in emergency departments in the USA;[16] they found that 1.7% of hospitals had a comprehensive EDIS system, which included an ordering system, an information interoperability function and CDSS, while 12.3% of hospitals had a basic EDIS with only some of these functions. Barriers were reported by the authors, including the costs of integration and maintenance, staff members reacting adversely to changes in their existing work conditions, uncertainty about system reliability, difficulty with use, suspicions that the technology would soon become outdated and concerns about maintaining confidentiality; all of these deterred the adoption of EDIS.[17 18] In addition, some studies have reported that CDSS can be difficult to use, causes inefficiencies and may increase medical errors and death rates.[7]

PRESENT STATUS OF HIT, EDIS AND CDSS IN JAPAN

The number of medical facilities in Japan switching from paper to electronic medical records has increased in recent years. According to a survey conducted by the Japanese Ministry of Health, Labour and Welfare, 969 of 8838 hospitals (11%) and 9077 of 98 609 clinics (9%) had adopted electronic medical record systems by 2008. In May 2010, the Japanese government's Information Technology Strategic Headquarters announced its new Information and Communication Technology Strategy. This strategy is supposed to offer a powerful stimulus for cooperation among healthcare facilities; work has already begun on standardising forms and terminology codes and on forming healthcare information networks.

Unfortunately, the concept of EDIS is not well known in Japan; as a result, no Japanese companies manufacture electronic medical record systems designed specifically for use in emergency departments. In addition, EDIS, which was first developed in English-speaking markets, was difficult to introduce in Japan because of language barriers. However, the value of EDIS is apparent when reflecting on past events. For example, in 1995 the members of the Japanese 'Aum Shinrikyo' cult released sarin nerve gas in the Tokyo subways during morning rush hour, causing 12 deaths and over 5500 injuries.[19] This acetylcholinesterase inhibitor can be fatal within minutes to hours. However, no electronic communication between hospital staff, the police or the government existed. An EDIS would have allowed early detection, diagnosis and a proper initial response to the situation.

CDSS is not widely used in Japan. Although several CDSS initiatives are currently underway, many are stand-alone, non-standardised systems. For CDSS to be more widely employed, EDIS that use standardised medical terminologies or are able to switch to a standardised system are required as information bases. CDSS must be compatible with EDIS and standardised within hospital systems and across medical facilities. Such systems aid the accumulation of valuable information for evidence-based clinical medicine. For example, the Systematised Nomenclature of Medicine Clinical Terms is one of the largest standardised computer terminology databases in the world. However, language differences make the system extremely difficult to adopt in Japan. Thus, a system suited to the unique needs of Japan is needed and is already in progress.[20] Other barriers to the adoption of CDSS from an English-speaking market are differences in the types of drugs, dosages and diseases. For example, Kawasaki disease is relatively common in Japan but rare in Western countries. Thus, systems for appropriate diagnoses developed overseas could not be used in Japan without modification.

Recently, the strategy has also been a stimulus for cooperation between healthcare facilities in prehospitals, where work has begun on standardising forms and terminology codes and forming healthcare information networks. The Canadian Triage and Acuity Scale[21] and the newly developed Japan Triage Acuity Scale are being used increasingly in prehospitals in Japan.

DEVELOPMENT OF EMERGENCY MEDICAL CARE SYSTEM IN JAPAN

Delays in the treatment of critical patients became a problem in Japan during the 1970s. The number of traffic accidents increased rapidly because of the increased use of automobiles, leading to many hospitals turning away ambulances and refusing care to accident patients. To counter this situation, emergency medicine was created as a distinct specialty in Japan. Before the establishment of emergency medicine in Japan, there were no emergency physicians; emergency patients were treated by surgeons and internists without specific training in emergency medicine in a multispecialist model.[22]

To prevent the concentration of patients in just a few emergency hospitals, emergency medical facilities were designated as primary, secondary or tertiary care facilities.[23] Patients who could not be treated at a primary care facility would be transported to a secondary or tertiary care facility. Paramedics were able to choose between healthcare facilities depending on the patient's condition. Primary care facilities are clinics without beds; these accept patients on a walk-in basis who do not require inhospital care. Secondary care facilities examine and treat patients with moderately severe conditions and provide inhospital care; they accept walk-in patients and those transported by ambulance. Tertiary care facilities offer intensive treatment in all medical specialties to critical patients; most emergency surgery is performed in such facilities. In 2010, there were 605 primary care, 4169 secondary care and 220 tertiary care facilities in Japan.

Secondary or tertiary care facilities are not limited to trauma or burn patients, but also include non-trauma patients. In addition, walk-in patients can seek medical attention at any facility. Because there are too many secondary care facilities against the number of emergency physicians, many secondary care emergency hospitals might not be able to deliver appropriate emergency care for all types of medical/surgical emergencies. Accordingly, the selection of appropriate hospitals to which to transport emergency patients is a critical issue that requires skill in differential diagnosis in emergency medical technicians, which may be difficult to apply at the scene. Moreover, most secondary care emergency hospitals are staffed by non-emergency specialists, whose specialties may not be appropriate for any given patient, during the night or on holidays. This

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may account for many refusals by emergency hospitals to accept some patients.[22]

Most tertiary care facilities have 10 to 30 beds in their Intentive Care Units (ICUs), and staff size ranges from several doctors to more than 30 doctors per centre. The principal mission of the physicians in the emergency departments in these centres is to provide trauma or non-trauma/critical care service to emergency patients (ICU-type model). Indications for admission to emergency medical service centres are deteriorating vital signs, as judged by emergency medical technicians. Thus, only the most critical patients are admitted and the admission rate is close to 100%. When non-critical patients visit an emergency medical centre attached to a hospital, they are guided to a separate emergency room (ER) where doctors belonging to other specialties provide care.[22]

In 2003, ER and Western-style models were introduced into Japanese emergency medicine. Thus, three styles of emergency medical care coexist: the multispecialist model, the ICU model and the ER model. In 2007, a national survey was conducted of Japanese Association for Acute Medicine emergency physician-designated facilities. Two hundred and forty-eight of 420 facilities returned valid questionnaires (88% response rate); 82 facilities (33%) reported that their emergency departments were functional 24 h a day and 68 (27%) reported that their emergency department operated only during certain times of the day. Of the 4230 emergency medical facilities throughout Japan, most operate on either the multispecialist or ICU model; only teaching hospitals in major cities use the ER model.[22]

Thereafter, the number of trauma patients decreased as a result of developments in automobile technology, mandatory use of seatbelts and increased penalties for driving under the influence of alcohol. At the same time, the number of patients with non-traumatic injuries admitted to emergency departments began to increase. In 2010, approximately half of these patients were older adults. All expenses were and continue to be covered by local governments via tax revenues, entailing no charge to patients for care and/or transportation. This has led to an increase in the volume of patients visiting hospitals by ambulances and has lengthened the time to reach hospitals and the waiting times once there.

Presently, there is a need to coordinate care for patients in the emergency departments in Japan. Care coordination has been defined as '... the deliberate organisation of patient care activities between two or more participants (including the patient) involved in a patient's care to facilitate the appropriate delivery of healthcare services'.[24] When a patient is brought to the hospital with disturbances of consciousness, the emergency physician is responsible for contacting potential primary care physicians and, after treatment, searching for suitable hospitals to transfer the patient to if there is no social worker available to do so. These administrative duties distract emergency physicians from their main duty, which is to provide emergency care. Therefore, EDIS and CDSS would be useful tools for improving the quality and efficiency of emergency care.

JAPANESE EXPECTATIONS FOR EDIS AND CDSS

The implementation of EDIS and CDSS in Japan must address issues specific to Japanese society with respect to the education of physicians. In emergency departments, rare diseases and medical complications must be considered. If not, serious consequences may result, even if the patient is seemingly well (eg, walk-in patients with subarachnoid haemorrhage or asymptomatic acute myocardial infarction on arrival at the hospital). The best approach emphasises ruling out serious and/or emergency presentations rather than using the traditional approach of reaching a diagnosis based on clinical observations, which is the main approach used in medical education in Japan. Emergency medical education, which emphasises ruling out critical diseases and those requiring emergency medical attention, has yet to have a serious impact as a method of education. In addition, according to the Japanese Ministry of Health, Labour and Welfare, only 1945 physicians (0.7%) of a total of 271 897 were practising emergency care in Japan in 2008. Therefore, in many hospitals, physicians from other medical departments who may not be adequately trained in emergency procedures are engaged in emergency practise.[22]

If CDSS were used in the future to guide examinations, provide updated treatment guidelines and standardise treatments, the quality of medical care would be improved. Residents could acquire the latest information and be educated in the field of emergency medicine, and emergency physicians could use CDSS to identify important points during a systematised examination to help residents distinguish easily confused diseases.

This would be complemented by implementing EDIS, which would improve the effectiveness and efficiency of the emergency department through prioritising and coordinating its activities as well as matching the ever-changing therapeutic needs with available resources for patient care. Since this decision, in its knowledge and practise, is part of the intellectual core of emergency medicine, CDSS and EDIS are thus expected to help embody the raison d'être of emergency medicine as a speciality. Furthermore, this knowledge and skill, when formulated and applied well, would help advance efficient use of medical resources in medical facilities, their networks, the wider context of medical service provision beyond an emergency department, and certainly in emergency situations, such as large-scale incidents and disasters.

After the 2011 earthquake and tsunami,[25] Japan realised that unnecessary tests and excessive medical treatments should be reduced when usable resources are scarce, especially in times of disaster. In such situations, all medical personnel are needed. The use of EDIS and CDSS may lead to increased awareness of the importance of physical findings and simple tests. If testing protocols based on the accumulated data of the Japanese population can be created and included in EDIS and CDSS systems, then unnecessary tests and unfortunate consequences would be reduced, which would allow medical personnel to use available resources more efficiently.

In conclusion, EDIS and CDSS are significant improvements for practising evidence-based medicine, which continuously gathers and revises scientific knowledge. They are useful tools that could improve the efficiency and quality of emergency treatment. Hopefully, both systems would be adopted more frequently at healthcare facilities, leading to an accumulation of knowledge and an advancement of epidemiological research in Japan.

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