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The Impact of the Health Information Exchange System for the hospital management in Japan

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Recently Health Information Exchange (HIE) has been gradually spreading in Japan. In this study, the effect against the hospital management of the HIE named the Ajisai-net of Nagasaki prefecture in Japan was evaluated through investigations of both the number of the first visit patients and hospitalized patients. The first visit is classified into three types. The first type is the reserved first visit bringing the introduction letters, 2nd type is the non-reserved first visit bringing the introduction letters and 3rd type is non-reserved first visit not bringing the introduction letters. The total number of hospitalized patients was 12,237/32,398 (37.8%) on the first type, 8,764/ 24,549 (35.7%) on the second type and 1,277/7,167 (17.8%) on the third type, and there were significantly differences among 3 types. ($p<0.01$) The number of hospitalized patients of the reserved new patients bringing the introduction letters who had been registered to the Ajisai-net was 1,008/2,201(45.8%), significantly more than the number of hospitalized patients of any other 3 types of the first visit patients. ($p<0.01$)
The number of the first visit patients registered to the Ajisai-net was also significantly more than that are not registered to the Ajisai-net. ($p<0.01$) The increase of the number of the new patients and newly hospitalized patients is the most important factor of the high hospital income in Japan. In conclusion, Japanese type of HIE has a positive effect of the Hospital management was showed in this study.

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Key words: Health Information Exchange, HIE, EHR, hospital management

Introduction

Electronic medical records have been spread around the world in these decades, and the progress of the next step of the medical informatization is usage of the Health Information Exchange (HIE) . In HIE Medical records, care reports and other medical information were shared among many hospitals, clinics, pharmacies, nursing care stations and other medical institutions. Although HIE also spread all over the world especially in Northern Europe, it is not popular to use the HIE in daily clinical medicine in Japan. The effect of HIE should be understood to spread it. The cost benefits and effect for fine medical quality by means of usage of the HIE has been reported from Northern Europe[1,2], and it is also reported to be more useful on the emergency medicine[3-5]. Because some reports pointed out that there was no clear evidence for the positive effect of HIE usage and the cost benefits was still not sure[5-8], more reports for the effect of HIE are necessary. On the other hand, after Electronic Medical Records had been officially certified as a public medical record in Japan in 1999, Electronic Medical Records were gradually used at the big hospitals and medical educational hospitals[9]. The usage rate of Electronic Medical Records at the hospitals whose number of beds were over 400 was reported

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as 76.3% in Japan in 2017 [10], then HIE in Japan has constructed since 2000. On the HIE of Europe and the United States, medical information of each hospital is generally collected and used in the data center of their HIE, but on HIE medical information is not generally collected in Japan. The medical information is temporarily collected from each hospital through gateway server which is set within each hospital, because large storage server in the data center is not necessary on this system. Its feature is we can reduce both the initial costs and running costs. These Japanese type of HIE were few reported now. Nagasaki University Hospital belongs to the Ajisai-net in Nagasaki Prefecture. The Ajisai-net is one of the most famous and wide area HIE in Japan[11,12]. In this study, Japanese type of HIE in Nagasaki prefecture was valued for the effect for the hospital management through the increase of the number of the first visits patients and hospitalized patients.

Materials and methods

Our HIE

The HIE in Japan has spread since about 2000. The HIE of Nagasaki Prefecture named 'the Ajisai-net' was established at the Omura city which was populated about 90,000 people and located the east of Nagasaki Prefecture in November of 2004[13]. Only 2 public hospitals are in Omura city. The Electronic Medical Records of the National Hospital Organization Nagasaki Medical Center, one of these hospitals were shared among 31 clinics of Omura city via Virtual Private Network (VPN). After many clinics, hospitals, pharmacies and other medical institutions has gradually joined since 2004, the Ajisai-net has been used at all area of Nagasaki prefecture and developed to be one of the largest HIE network in Japan. The Electronic Medical Records of the 37 major hospitals of their local area are able to share among 380 medical institutions though the Ajisai-net. The Electronic Medical Records is only shared, when doctor or medical staff explained and got patient's consent to register to the Ajisai-net. All the subscribing medical institutions have hardware VPN devices, and are connected to a domestic network management center via IP-VPN or Internet VPN with IPsec + IKE protocol. The network management center is also connected to other data centers via the IP-VPN, and one of the connected data centers is a medical information relay center. When the medical records are queried to relay center under patient's consent, the medical information relay center requests these medical records from the appropriate gateway server, then the gateway server requests these medical records from their Electronic Medical Record server. Then the web application of medical information relay center temporarily displays medical records collected from several hospitals in time series. For mobile access only Apple Computer's iPad is allowed via software VPN. The total number of patient consent and sharing is about 100,000 in January 2019, about 1,000 a month has increased. Nagasaki University Hospital joined the Ajisai-net in April 2009, and the total number of patient's consent and sharing is about 10,000. The staff of medical institutions can use the Ajisai-net through internet browsers on the computers in their clinics, hospitals and other institutions or iPad after registration as a paid member. The total paid member is about 1,400 in January 2019.

Methods

The number of first visit patients to Nagasaki University Hospital and hospitalized patients were investigated for 5 years from January 2013 to December 2017. Emergency visit patients and Dental visit patients were excluded in this study. There are 3 types of the first visit patients to Nagasaki University Hospital. First type is a reserved visit in advance bringing introduction letters from other hospitals or clinics. The patient's waiting time get shorter and a medical consultation failure because of the wrong specialty selections is only a few, because all the preparations and procedures for first visits is finished before their visits because of reservation in advance. Second type is not reserved visit bringing introduction letters. The third type is not reserved visit and not bringing introduction letters. Japanese Government is facilitating to reduce this third type visit, because there are not a few patients who had mild illness like a common cold in this type, and increase of these patient's visits have been much burden of medical staff. The number of hospitalized patients was compared among these 3 types. These data were extracted from the First Visit Management System of Nagasaki University Hospital. The number of the first visit patients and hospitalized patients who had registered to the Ajisai-net was also investigated for the evaluation of effect of the Ajisai-net for the hospital management. The number of the registered patients to the Ajisai-net of our hospital was investigated on the Ajisai-net Management Data Base of our hospital. Then we regarded it as the 'effective use' when the introducing doctor or the other staff of his clinics had registered to the Ajisai-net, but we regarded it as the 'simple use' whenever another doctor or staff at another clinics registered to the Ajisai-net. Next after we extracted the patients who had been introduced from clinics located in Nagasaki City,

we compared the number of the introduced first visit patients between the member of the Ajisai-net and the nonmember. (The member of the Ajisai-net means the doctor who is able to use the Ajisai-net.) For statistical analysis chi-square test was used.

Results

The evaluation of the number of first visit patients and hospitalized patients among 3 first visit types

The total number of first visit patients to Nagasaki University Hospital from January 2013 to December 2017 was 64,114, of which 22,278 were hospitalized. (hospitalization rate 34.7%) (Table 1) Although both the number of the first visit patients and hospitalized patients has increased every year except 2014, the hospitalization rate increased every year. And comparing among the three types, on the first type (reserved visit in advance bringing introduction letters from other hospitals or clinics) both the number of the first visit patients and hospitalized patients had also increased every year except 2015. On the second type (not reserved visit bringing introduction letters from other hospitals or clinics) the number of the first visit patients had decreased in 2014, 2016 and 2017, and the number of hospitalized patients had also decreased in 2014 and 2016. The result of the third type (not reserved visit not bringing introduction letters from other hospitals or clinics) was the same results as the second type. The total number of the first visit patients for 5 years had been 32,398 on the first type, 24,549 on the second type and 7,167 on the third type, and the total number of hospitalized patients is 12,237 (37.8%), 8,764 (35.7%) and 1,277 (17.8%). There was a statistically significant differences between the number of hospitalized patients of the first type and the second type, ($p<0.01$) the second type and third type ($p<0.01$) and first type and third type ($p<0.01$) by mean of chi-square test.

The effect of the number of the first visit patients and hospitalized patients after first visit who had been registered to the Ajisai-net

The total number of the hospitalized patients in 5 years after first visit who had been registered to the Ajisai-net was showed and compared against all the first visit patients on the Table 2. The 4th column of the Table 2 is the same data of the last column of the Table 1. On the 'simple use' of the Ajisai-net, in which the different doctor or staff from introducing the medical institutions registered to the Ajisai-net, the number of the reserved first visit patients bringing introduction letters who was registered to the Ajisai-net was 2,201, and the hospitalized patients after their first visit were 1,008. (hospitalization rate 45.8%) On the 'effective use' of the Ajisai-net in which the doctor or staff of the introducing medical institutions registered to the Ajisai-net, the number of the reserved first visit patients bringing introduction letters who was registered to the Ajisai-net was 1,101, and the hospitalized patients were 440. (hospitalization rate 40.0%) There was significant difference on the number of hospitalized patients of both the 'simple use' and the 'effective use' against all the reserved first visits with introduction letters. ($p<0.01$) The number of the not reserved first visit patients bringing introduction letters who was registered to the Ajisai-net was 1,050 on the 'simple use', and the hospitalized patients after their first visit were 473. (hospitalization rate 45.0%) And the number of the not reserved first visit patients bringing introduction letters on the on the 'effective use' was 414, and the hospitalized patients after their first visits were 184. (hospitalization rate 44.4%) There was also significant difference on the number of hospitalizations of both the 'simple use' and the 'effective use' against all the reserved first visit bringing the introduction letters. ($p<0.01$) On the first visits not bringing the introduction letters, the number of the first visits of the 'simple use' of the Ajisai-net was 143, and the number of the hospitalized patients after their first visits was 56. The number of hospitalized patients of the 'simple use' of the Ajisai-net was significantly more than the number of all the first visit bringing the introduction letters. ($p<0.01$)

The evaluation of the number of the introduced patients from clinics located in Nagasaki City who had been the member of the Ajisai-net or nonmember

The total number of the introduced patients from the clinics located in Nagasaki City was 24,404 from 2013 to 2017. Although these patients had been introduced from the 501 clinics, the number of the introduced patients per one clinic was 48.7. And the total number of the introduced patients from these clinics who had been not members of the Ajisai-net was 18,330 in these 5years, and the total number of the clinics and the introduced patients per one clinic was 415 and 44.2. And the total number of the introduced patients from these clinics who had been member of the Ajisai-net was 6,074 in these 5years, and the total number of the clinics and the introduced patients per one clinic was 86 and 70.6. There was significantly difference on the number of intro-

duced patients per clinics between the member of the Ajisai-net and the nonmember. ($p<0.01$)

Discussion

The hospitalization days has grown shorter year by year all over the world. The earlier the patients discharge, the more important the early treatment or care. Pharmacists and General Practitioners had tended frequently to use HIE was reported[14], HIE is guessed to be useful for their treatment or dispensing after discharge. It is quite reasonable that HIE has been gradually spreading all over the world[15-17], because Electronic Medical Records are also spreading at many hospitals all over the world, and it had made many important medical information the electronic data. However, on the other hand, there are many countries where HIE is not sufficiently popular.[18-20], and Japan has been one of these countries, yet. According to the several questionnaire studies most the patients and their families who had visit the emergent hospitals had been also hope to share their medical records under their informed consents[21], the widely and immediate spread of the HIE is necessary for not only the United States or European Countries, but also necessary for Japan. The reason why the HIE had not been easy to be spread are reported as high costs, official policies, technical problems, local law restrictions, ICT literacy of staff or etc.[22-24], so the merit or effect of HIE must be reported. Although the definite effect of HIE is not reported enough yet in United States or Europe, but lesser in Japan. The usage of HIE is expected for the improvement of medical quality, assist of emergency medicine, correct medical information communication, medical cost reduction, improvement of the hospital management or etc. Especially the effect for the hospital management is only a few reported except medical cost reduction effect on the emergency hospitals[25,26]. In this study the effect for the hospital management through the increase of the first visit patients and new hospitalized patients was examined. Recently the hospital management has been grown harder and harder in Japan, because of the Government policy of the suppression against the increasing total medical costs. The increase of the newly hospitalized patients is one of the most important factor of hospital management in Japan, because the hospital income increases according to the number of newly hospitalized patients. The increase of the number of the first visit patients is also important for the hospital management, because over 30%, as the Table 1 showed, of the first visit patients need to hospitalize as newly hospitalized patients. There are generally 4 types on the first visit patients in Japan. These are the reserved visits patients bringing introduction letters from clinics or the other medical institutions, the not reserved patients bringing introduction letters, not reserved patients not bringing introduction letters and the emergent visit patients. Three types except the emergency visit patients of these were compared in this study. It was revealed that the number of the hospitalized patients after first visits bringing

Table 1. The number and rate of the first visit and hospitalization to Nagasaki University Hospital for recent 5 years

			2013	2014	2015	2016	2017	total	
with introduction letter	reservation	First visit	5,106	5,652	5,485	7,353	8,802	32,398	
		Hospitalization	1,905	2,106	2,045	2,623	3,558	12,237	※
		rate	37.3%	37.3%	37.3%	35.7%	40.4%	37.8%	
	no reservation	First visit	5,884	4,592	4,849	4,631	4,593	24,549	
		Hospitalization	1,891	1,580	1,709	1,663	1,921	8,764	※ ※
		rate	32.1%	34.4%	35.2%	35.9%	41.8%	35.7%	
without introduction letter		First visit	1,538	1,050	1,746	1,499	1,334	7,167	※
		Hospitalization	143	110	342	321	361	1,277	
		rate	9.3%	10.5%	19.6%	21.4%	27.1%	17.8%	
total		First visit	12,528	11,294	12,080	13,483	14,729	64,114	
		Hospitalization	3,939	3,796	4,096	4,607	5,840	22,278	
		rate	31.4%	33.6%	33.9%	34.2%	39.6%	34.7%	

※ $p<0.01$

The total number of admitted patients was compared among 3 first visit types to our hospital. 1st type is the reserved first visit patients bringing introduction letters, 2nd type is non-reserved first visit patients bringing introduction letters and 3rd type is non-reserved first visit patients not bringing introduction.

Table 2. The number and rate of the reserved first visit with and without the Ajisai-net registered for 5 years

			All		Ajisai-net simple use	Ajisai-net effective use
with introduction letter	reservation	first visit	32,398		2,201	1,101
		Hospitalization	12,237		1,008	440
		rate	37.8%	※	45.8% ※	40.0%
	no reservation	first visit	24,549		1,050	414
		Hospitalization	8,764		473	184
		rate	35.7%	※	45.0% ※	44.4%
without introduction letter		first visit	7,167		143	0
		Hospitalization	1,277		56	0
		rate	17.8%	※	39.2%	

※ $p<0.01$

The total number of admitted patients was compared between the patients who had used the Ajisai-net or not.

Table 3. The number of the introduced patients from the member of the Ajisai-net and nonmenber

year		2013	2014	2015	2016	2017	total	
From the nonmember of the Ajisai-net	the number of the introduced patients	3,685	3,410	3,429	3,726	4,080	18,330	※
	the number of the clinics	340	304	318	310	297	415	
	the number of the introduced patients/clinics	10.8	11.2	10.8	12.0	13.7	44.2	
From the member of the Ajisai-net	the number of the introduced patients	1,101	1,011	1,166	1,333	1,463	6,074	
	the number of the clinics	80	70	72	75	77	86	
	the number of the introduced patients/clinics	13.8	14.4	16.2	17.8	19.0	70.6	
total	the number of the introduced patients	4,786	4,421	4,595	5,059	5,543	24,404	
	the number of the clinics	420	374	390	385	374	501	
	the number of the introduced patients/clinics	11.4	11.8	11.8	13.1	14.8	48.7	

※ $p<0.01$

The total number of introduced patients who had been introduced from clinics of the member of the Ajisaii-net and from clinics of the non-member of the Ajisaii-net was compared.

introduction letters is more than the patients not bringing introduction letters, and the number of the hospitalized patients after reserved first visits is also more than the patients not reserved first visits in this study. (Table 1) The reason of this result is guessed that the reserved first visit patients are more carefully selected introduction from introducing doctor than not reserved first visit patients. These 3 types of first visits which had registered to the Ajisai-net were investigated to evaluate the effect of the Ajisai-net usage. On the first visit patients bringing introduction letters the number of the hospitalized patients of both the 'simple use' and 'effective use' of the Ajisai-net is significantly higher than all the first visits. ($p<0.01$) (Table2) Every patient brought their introduction letters on the 'effective use'. The hospitalized patients of the 'simple use' was also significantly higher than all the first visits on the not bringing introduction letters. ($p<0.01$) These results indicate that the hospitalized patients after first visits had been more on the registered to Ajisai-net than on the not registered to Ajisai-net. The table 3 shows the number of the introduced patients from the clinics located in Nagasaki City was compared between the clinics had belonged to the Ajisai-net (the member of the Ajisai-net) and the clinics had not belonged. The number of introduced patients clinics was 44.2 from the clinics had not belonged to the Ajisai-net and 70.6 from the clinics had belonged to the Ajisai-net, and the total number of the introduced patients from the clinics

had belonged to the Ajisai-net was significantly more than the number of the introduced patients from the clinics had not belonged to the Ajisai-net. ($p<0.01$) This result shows the reserved first visit patients bringing introduction letters registered to the Ajisai-net tend to be hospitalized most. This result may show the patients whose introducing doctor hoped to know the clinical course in detail through the Ajisai-net tend to be hospitalized more. The further examination about which kind of the medical records were actually tended to be watched more is necessary for clear up of these hypotheses. On the other hand, although the sustainability of HIE caused by its running costs has occurred as new problem[27.28], this problem has also occurred in Japan. The further examination of the cost-effectiveness of the HIE must be also performed for this resolution. In this study the number of the newly hospitalized patients after first visits was most on the patients registered to Ajisai-net was indicated. The number of the newly hospitalized patients and tendencies of the hospitalization after first visit is one of the most important positive factors of the hospital management. In conclusion, this result indicated the Japanese HIE was also positive effect for the hospital management.

Conflict of interest

No authors declare any conflicts of interest.

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