F.研究発表

1. 論文発表

1) Otieno G O, Hinako T, Daisuke K, Motohiro A, Keiko N. EMR Effectiveness: Development and statistical validation of a survey instrument to measure use of, quality of and user satisfaction with EMR from the viewpoint of Physicians. Japan Journal of Medical Informatics, 2006; 26(5): 323-332

2) Otieno G O, Hinako T, Motohiro A, Daisuke K, Keiko N. Sophistication of information technology in healthcare: A comparison among a sample of hospitals in Japan. *Electronic Journal of Health Informatics, [In Press].*

6.知的財産権の出願・登録状況(予定を含む。)

1. 特許取得

なし

2. 実用新案登録

なし

3.その他

なし

付録：正規化の手法を用いたデータの変換方法

複数の目標とする達成度を同一の尺度でレーダーチャート上に明示して比較検討するためには、データの正規化は重要である。夫々の基本的な電子カルテ・システムの有効性と構成要素の値を、共通の尺度に変換するために、比較検討するデータを、最高値を1とし、最低値を0とするように変換し、正規化した。他の病院の達成度の値は、その尺度の範囲（0から1）内に位置する。例えば、その尺度上での複合指標（CI）または構成要素の値が0.5である場合は、その病院の達成度は最高達成者（病院）と最低達成者（病院）の中間に位置することになる。したがって、本論文で報告したレーダーチャートの値は、比較検討するグループ内の最高値と最低値との相対値となっている。このような尺度法では、最高達成度、すなわち最高達成者（病院）は主要な参照点（目標点）となる。

本文中の表3に掲げた構成要素および複合指標（CI）の元の値（x）を下記の計算式により変換したレーダーチャートの値（r）を下表に記載した。

$$r = 1 - ((max - x) / max) * F)$$

但し、　F = max / (max — min)

x = 元の値

r = 正規化された値（レーダーチャートの値）

したがって、x = max値は、r = 1−0 = 1

x = min値は、r = 1−1 = 0.

表: 本文表3の正規化データ（サービスの質の構成要素は除外）

No	病院	システム	情報	使用状況	満足度	複合指標(CI)
1	B34	1.00	0.81	1.00	0.60	1.00
2	D11	0.33	1.00	0.77	1.00	0.86
3	D23	0.93	0.60	0.89	0.40	0.83
4	D29	0.85	0.71	0.85	0.37	0.82
5	D40	0.98	0.52	0.92	0.25	0.80
6	C35	0.96	0.56	0.79	0.39	0.80
7	D20	0.77	0.58	0.80	0.45	0.76
8	B10	0.68	0.62	0.74	0.36	0.70
9	D24	0.58	0.62	0.65	0.54	0.68
10	D33	0.71	0.51	0.67	0.38	0.66
11	D37	0.81	0.41	0.75	0.19	0.65

12	D16	0.60	0.45	0.70	0.33	0.60
13	B43	0.67	0.39	0.69	0.23	0.58
14	D28	0.58	0.41	0.66	0.19	0.54
15	C22	0.60	0.39	0.45	0.20	0.47
16	D17	0.06	0.40	0.33	0.42	0.31
17	C38	0.23	0.26	0.15	0.25	0.23
18	C12	0.33	0.00	0.37	0.00	0.21
19	A27	0.40	0.06	0.16	0.01	0.18
20	D14	0.00	0.00	0.00	0.11	0.00

Ⅲ　添付資料

電子カルテシステム導入が診療記録の質に与えた影響と
その結果としての医療の質の改善の評価に関する研究

-アンケートによる電子カルテシステム利活用調査報告-

「ユーザー視点から見た電子カルテシステム機能」
40病院調査結果報告

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小出大介	東京大学 大学院　医学系研究科
内藤恵子	（社）高邦会　高木病院　予防医学センター

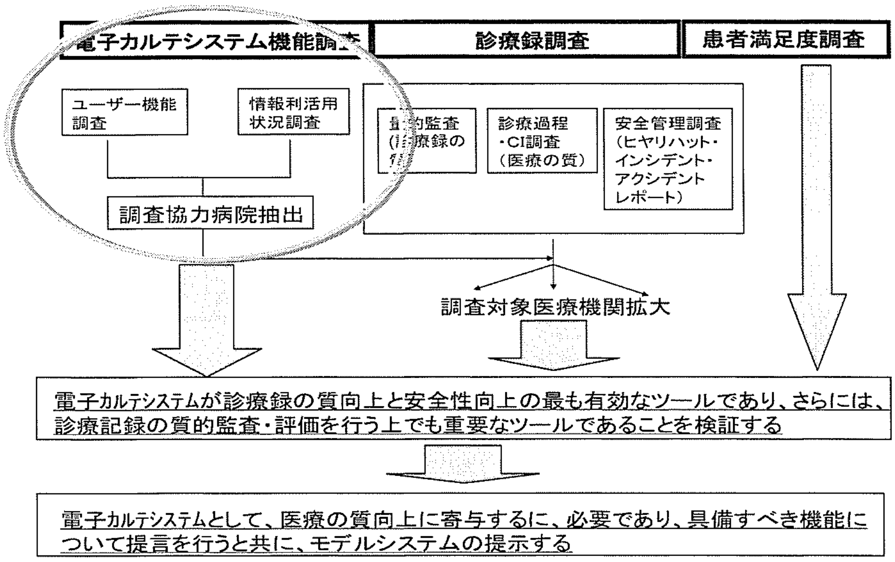
研究の目的

診療記録としての電子カルテシステムはどのような機能をもって、医療の質の向上に貢献できるのか？

電子カルテシステム導入及び活用を標榜している医療機関で、具備している機能やデータの利活用の実態調査を行い、診療記録・オーダリングシステム・さらに統合機能としてどのようなものが装備活用されているかについて検討をアンケート調査を用いて行った。

本調査は、厚生科研「電子カルテシステム導入が診療記録に与えた影響とその結果として医療の質改善の評価に関する研究の一環として行ったものである。

研究のプロセス



今回報告内容の調査方法

平成１７年度の調査は前回平成１５年度厚生科学研究班「電子カルテシステムの導入が医療及び医療機関に与える影響及び効果」においてアンケート調査に協力していただいた６０病院を中心に計７１病院に対して行い４０病院（回答率５６.３%）から回答を得た。

アンケートの内容は平成１５年度、１６年度行われた厚生労働省の「標準的電子カルテシステム推進委員会」で議論された、大江班作成の『ユーザー視点による電子カルテシステム機能』の各項目の機能の有無について、各医療機関の医療情報部門責任者に対してアンケート用紙を用い、郵送方式に配布、他の関連アンケートと一緒に回答依頼を行った。

ユーザー視点からみた電子カルテシステム機能調査 ≒診療情報処理機能（CIO II）　評価項目

1	患者指向のシステム情報の管理機能
1.1	患者の登録に関する機能
1.2	患者を指定する機能
1.3	患者の診療情報を出力する機能
1.4	患者の診療情報を登録する機能
2	患者指向の診療支援機能
2.1	医療安全確保支援機能
2.2	意思決定支援機能
2.3	教育的指導管理機能
2.4	指示実施支援機能
3	患者指向のシステム情報の管理機能
3.1	アクセスログ管理
4	臨床統計機能
5	治験・臨床研究支援機能
5.1	治験支援機能
5.2	自主臨床研究機能
6	教育研究支援機能

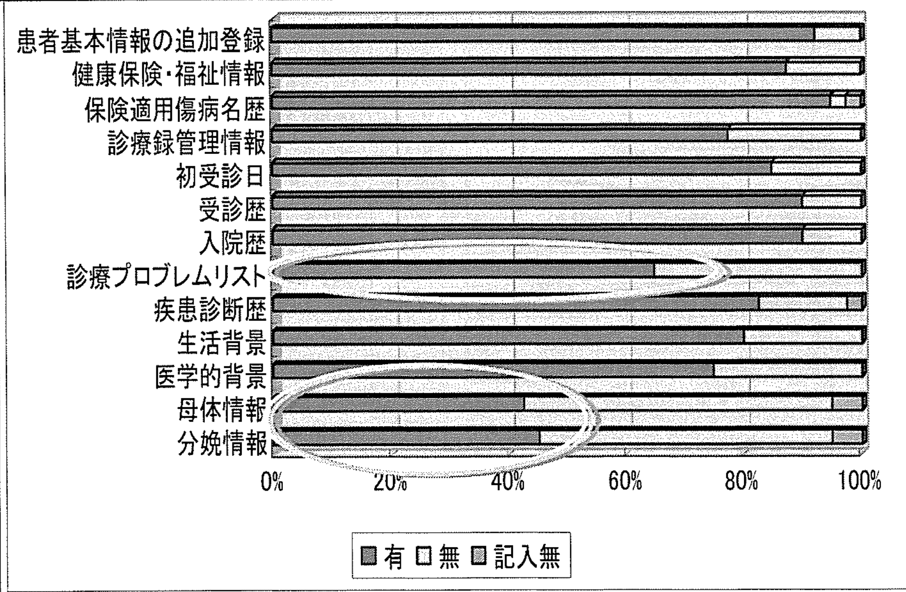
7	医療機関運営支援機能
7.1	医療の質評価指標
8	医療機関ネットワーク支援機能
9	行政・保険当局報告支援機能
10	アクセス制御管理機能
10.1	利用者認証
10.2	利用履歴管理機能
10.3	利用者ー患者関係管理機能
11	システム運用支援機能
11.1	システム管理
11.2	入院業務支援
11.3	外来業務支援
12	他システムとの連携機能
12.1	部門系システムとの連携ができる機能
12.2	レセプト作成システムとの連携ができる機能
12.3	患者サービス用システムとの連携ができる機能

アンケート調査の概要

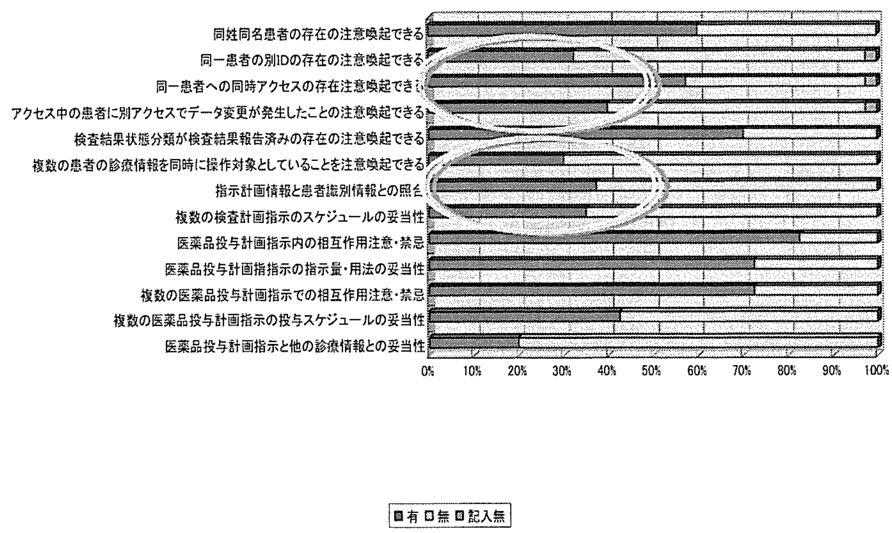
７１病院中回答が得られたのは４２病院であったが欠落部分の多い２病院を除き、
４０病院での分析を行った。質問内容は大項目１２種よりなっており、
①「患者指向の診療支援基本機能（７２問）」
②「患者指向の診療支援機能（３２問）」
③「患者指向のシステム情報の管理機能（２問）」
④「臨床統計機能（４問）」
⑤「治験・臨床研究支援機能（２３問）」
⑥「教育研究支援機能（４問）」
⑦「医療機関運営支援機能（２問）」
⑧「医療機関ネットワーク支援機能（５問）」
⑨「行政・保険当局報告支援機能（１問）」
⑩「アクセス制御管理機能（９問）」
⑪「システム運用支援機能（１４問）」
⑫「他システムとの連携機能（３問）」
全項目１７１問について回答を得た。

回答を得た病院の電子カルテシステム化レベルに相違があるため、
JAHISレベル３以上を電子カルテシステム導入と定義した。
４０病院の内３０病院（７５％）が電子カルテシステム導入病院となり、
１０病院（２５％）がレベル３以下の病院であった。

1.4 患者の診療情報を登録する機能

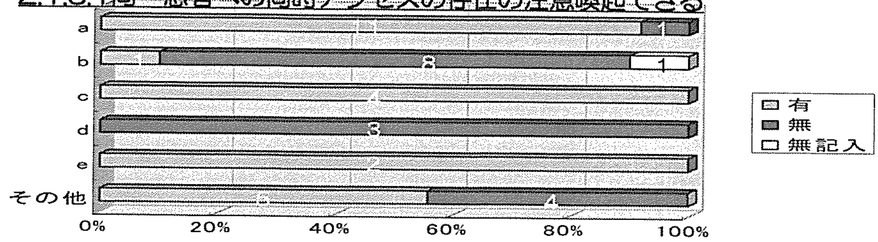


2.1 医療安全確保支援機能

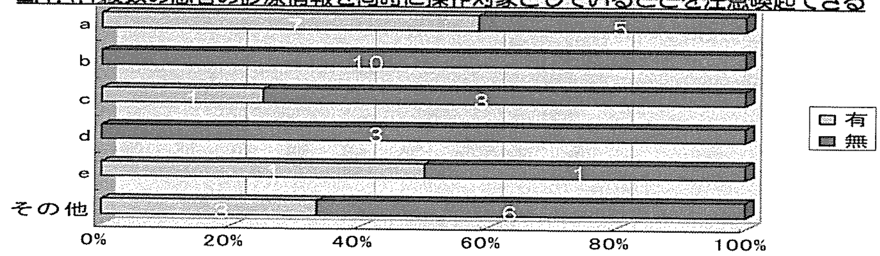


医療安全確保支援機能・ベンダー別比較

2.1.3.1同一患者への同時アクセスの存在の注意喚起できる

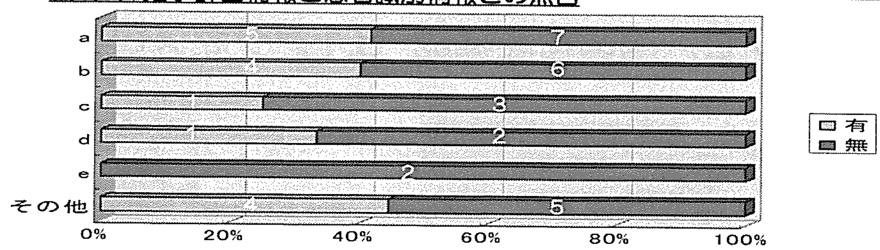


2.1.4.1複数の患者の診療情報を同時に操作対象としていることを注意喚起できる

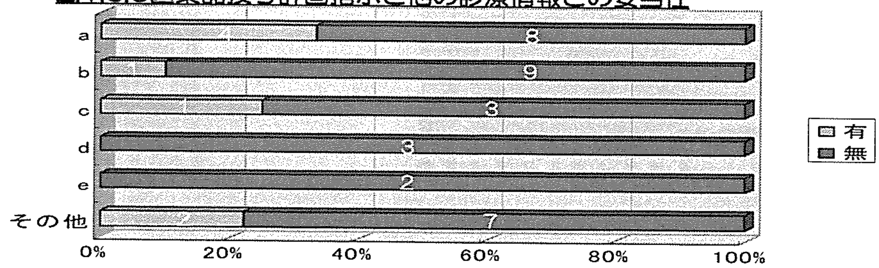


医療安全確保支援機能・ベンダー別比較

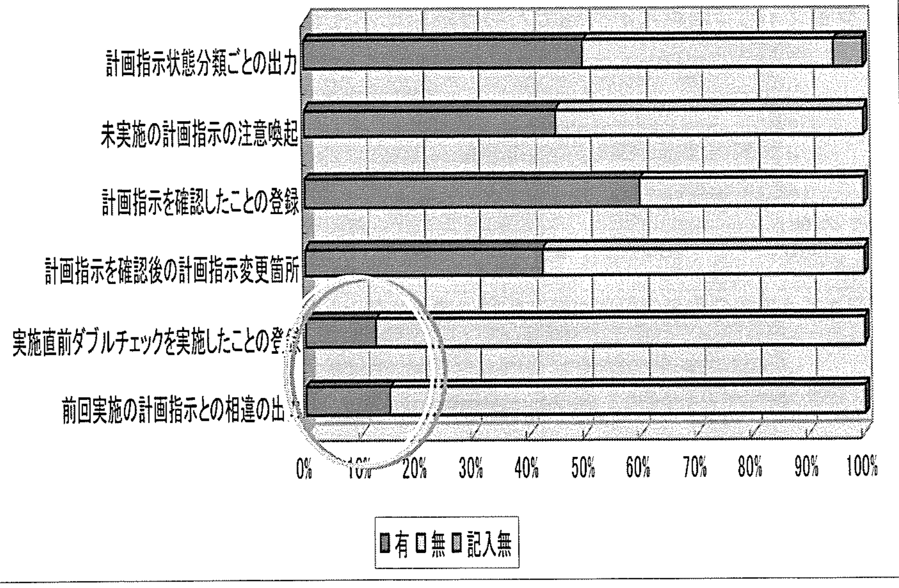
2.1.5.1指示計画情報と患者識別情報との照合



2.1.6.6医薬品投与計画指示と他の診療情報との妥当性

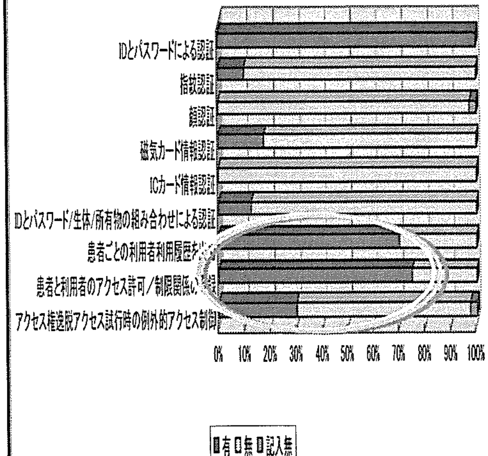


2.4指示実施支援機能

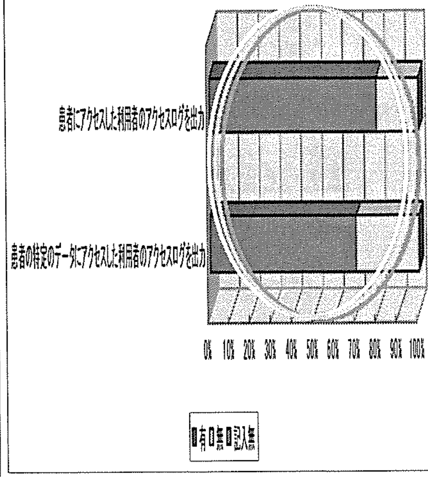


システム利用管理面の対応

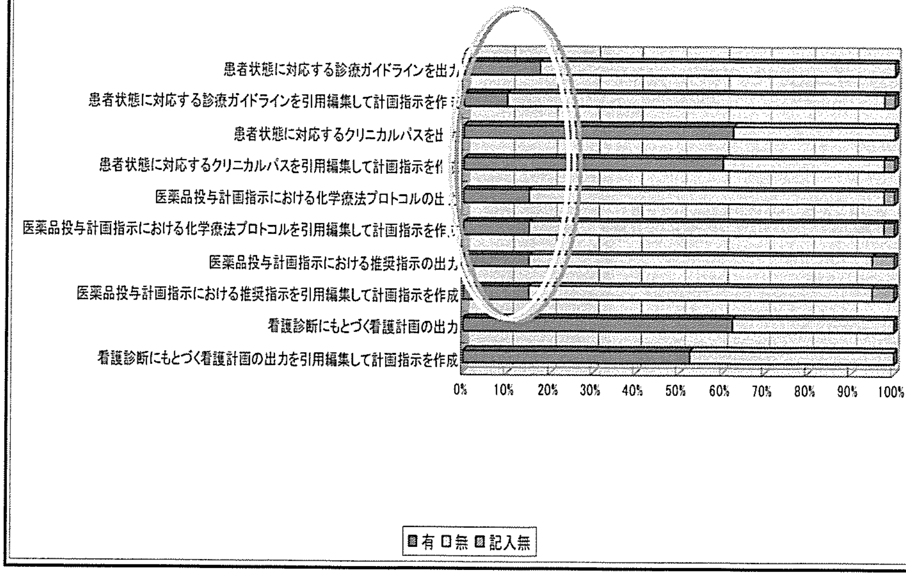
10.アクセス制御管理機能



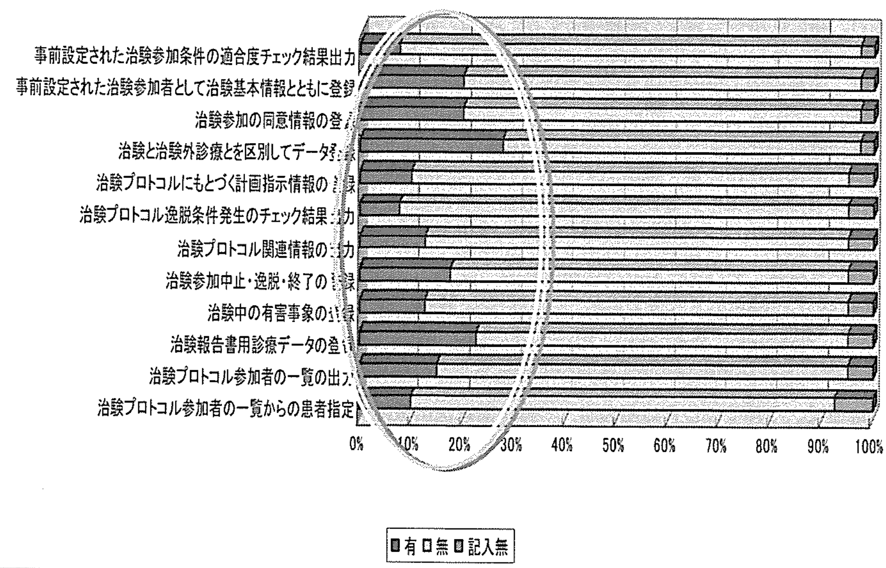
3.1アクセスログ管理



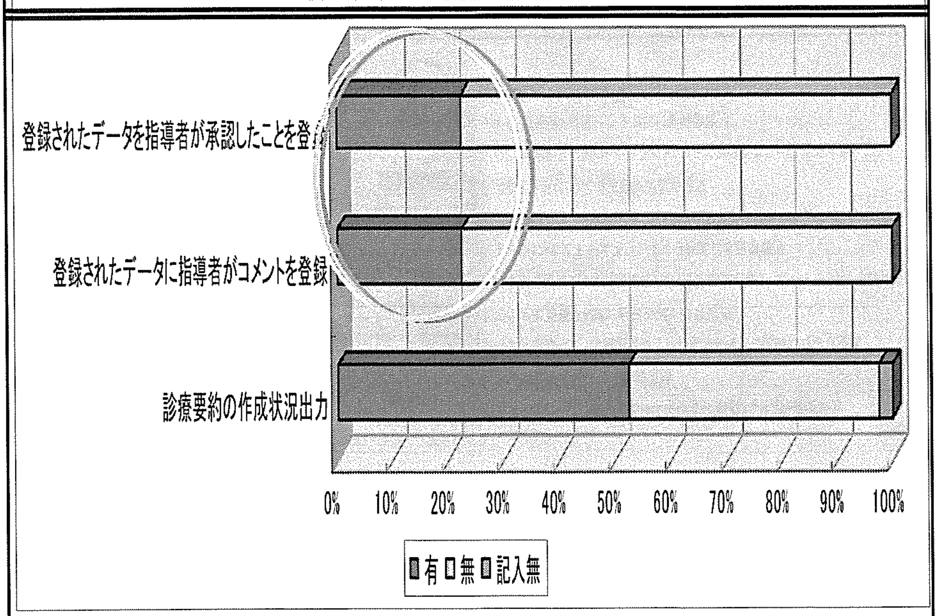
2.2 意思決定支援機能



5.1治験支援機能



2.3 教育的指導管理機能



今回報告の考察

一概に電子カルテシステムといっても、**各々の医療機関が保有する機能の格差は歴然**としており、特に医療安全確保の支援機能に関しては、従来から電子カルテシステム導入のメリットとして論じられ、多くの導入効果の発表が行われているが、**研究班メンバーの予想を下回り、**「同一患者の別ＩＤの存在を注意喚起できる機能」や「アクセス中の患者に別アクセスでデータ変更が発生したことの注意喚起できる機能」「複数の患者の診療情報を同時に操作対象としていることを注意喚起できる機能」「指示計画情報と患者識別情報との照合できる機能」「複数の検査計画指示のスケジュールの妥当性のチェックが出きる機能」「複数の医薬品投与計画指示での相互作用注意・禁忌のチェックができる機能」「複数の医薬品投与計画指示で他の診療情報での妥当性のチェックができる機能」などでは、導入稼動レベル３以上の病院でも、その**機能装備率が40％を下回るものとなっている。**

現在稼動している電子カルテシステムはデータギャザリングの基本部分においてはほぼ十分な機能を具備していることが確認できたが、**医療安全確保への取り組みは不十分で、更なる機能強化が図られるべきである。また利用者管理に関する不十分さは大きな問題である！**

また、基本機能と考えられている中でも、**データ検索機能、例えば患者の診療データ値による条件検索」など、診療サイドが必要と考える検索機能が不十分であることも判った。**

更に、電子カルテデータの後利活用に関しては、統計処理・研究・教育で軒並み機能の装備率は低く、今後ではＤＰＣ用の導入や臨床研修医の教育体制の強化が急務であるが、この分野の機能不全は今後問題となろう。一部の病院では、医師や情報部門等が独自のシステムを作成し、ベンダー提供のパッケージの外付けプログラムとして利用しているが、まだまだ不十分と言わざるを得ない。

一部、設問に理解困難な項目も含まれていたため、現在回答病院に対する追加問合せや、一部病院では現地調査を行い、分析の精査を行っている。

今後、本分析を通して、電子カルテシステムの機能強化の為のガイドラインを示したい。

A Composite Index for Evaluating Electronic Medical Records Systems: Work in Progress

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A Composite Index for Evaluating Electronic Medical Records Systems: Work in Progress

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Abstract: Objective: As the number of hospitals using Electronic Medical Records (EMR) systems in Japan continues to rise, there is a need to develop an evaluation framework that can allow comparison of efficiency of EMR within and between hospitals.

Methods: Principal component analysis (PCA) was used to summarize survey data into a composite index that can provide the most scientific and credible interpretation of reality. The process included selecting relevant variables, condensing the data into factors relevant to each construct and calculating the index by summing up the product of each component with its respective factor score.

Measures: Five constructs were used to develop the index: system quality, information quality, service quality, use and user satisfaction.

Results: 42 hospitals responded to the survey. Preliminary results show that the composite index can discriminate between hospitals that are in the same stage of IT maturity and that the ranking of the hospitals using the index is strongly correlated with hospital's IT maturity.

Conclusion: The index can be used as a diagnostic tool for hospitals that are implementing EMR systems as well as hospitals that want to benchmark their systems against other hospitals. Further validation of the index is in progress.

Keywords: Hospital Information systems, EMR Systems, EMR System Composite Index, Principal Component Analysis

1. Introduction

Recent research has shown that information technologies and electronic medical records (EMR) systems can improve adherence to clinical guidelines, patient safety, and the delivery of preventive health services, thereby potentially improving health outcomes for patients. Despite these evidences, wider adoption of EMR systems remains limited[1)]. However, the government of Japan has initiated several programs that are likely to enhance wider adoption of these systems. For example, the government policy targeting at least 60% of hospitals with 400 beds or more to computerize their records by 2006[2)], and the introduction of prospective payment system based on diagnosis procedure combination (DPC)[3)] are expected to enhance wider adoption of EMR systems in the coming years.

As the number of hospitals using EMR systems in Japan continues to rise, there is a need to develop an evaluation framework that can allow comparison of efficiency of EMR systems within and between hospitals. In this paper we propose a framework for generating a composite index for evaluating the efficiency of EMR system within and between hospitals. The framework involves: 1) identification of factors that contribute to the efficiency of EMR systems; 2) development of a set of measures that can be used to quantitatively score the efficiency of EMR systems based on the factors in 1) above; and 3) provision of an overall theoretical framework that incorporates these factors toward developing a composite index for EMR systems.

2. Methods

2.1 Factors contributing to the efficiency of EMR systems

Researchers from information sciences have long studied various factors that would impact the use of information systems (IS). Although there have been no comprehensive studies that would propose a general model for evaluating effectiveness of EMR systems, the DeLone & Mclean's model[4] of IS success provides the most extensive and comprehensive framework for identification of factors contributing to the success of EMR systems. We adopted five constructs (Table 1) from the model, guided by the ability of the construct to be measured quantitatively using survey data and can be synthesized into a single composite score (Index) for evaluating EMR system in a hospital.

2.2 Item generation

We compiled items measuring each target construct (Table 1). In order to improve the validity of the index, multiple sources of evidence on the efficiency of EMR system was needed. To this end, five target respondents, namely, chief information officer (CIO), chief medical officers (CMO), chief nursing officer (CNO), doctors (Dr) and nurses (NS) were surveyed. The category of users surveyed are the most likely to be knowledgeable about the EMR system in their hospitals and whose work is the most likely to be affected by the introduction of EMR system. Overall, five instruments targeting each of the five categories of users was developed.

2.3 Data collection

As part of a large nationwide survey assessing the improvement of quality of health care services as a result of the introduction of EMR systems, questionnaires, together with a covering letter, were sent to 71 healthcare institutions (69 hospitals and two clinics). Data were collected over a period of six weeks starting the month of February 2006.

2.4 Data analysis and Index computation

Overall, 42 institutions (41 hospitals and 1 clinic) responded to the survey. For the purposes of this analysis, we excluded clinics making the effective response rate to be 59.4% (41/69). We further excluded hospitals where the entire professional group were not represented and where only less than 10% of Dr and/or 10% of NS responded.

2.5 Data validation and Index computation

In calculating the index, the process included data transformation, condensing the data into factors relevant to each construct, and calculating the index by summing up the product of each of the five constructs with their corresponding principal component analysis (PCA) scores. In summary, data preparation involved condensing items that were on a scale of yes/no to distinct sections and recoding the negatively worded items of the Likert scales before carrying out factor analysis. Each of the resultant factors was analyzed for reliability using Cronbach's alpha. Items were deleted where necessary to achieve an alpha of at least 0.7. A second factor analysis was conducted on each of the sub-index. The Index was then calculated by summing up the product of each of the sub-index with the corresponding factor scores. A detailed description of the Index computation process is available from the first author (Otieno George Ochieng) on request.

3. Results and Discussion

3.1 Internal consistency verification

Cronbach's alpha for the 5 constructs revealed an alpha of 0.827. However, service quality construct was found to be negatively correlated with the corrected Item-totals and suggesting that deleting it could improve the alpha to 0.924 (Table 2). The lack of positive correlation between service quality and the rest of the constructs could partly be due to the fewer number of items used in measuring it. Since we desired the model to be additive, we dropped the service quality construct from the final Index computation.

3.2 The composite Index for evaluating EMR systems

Table 3 presents the Index for hospitals. Six hospitals had Index above the average. Based on their performance, 4 categories of hospitals were identified by dividing the range (max-min) into four equal parts. Three hospitals are in the top range (64.0-70.4), 6 hospitals are in the second (59.2-64.0) and 2 hospitals in the bottom range (48.0-53.6). The top three hospitals can be considered as outstanding performers in the EMR system while the last two hospitals still require concerted efforts to improve the efficiency of the EMR systems as measured by the Index. The table also presents sub-indices, which can serve to identify key areas that a hospital is under or over-performing. Generally, hospitals registered lowest score on the information quality construct. The least performing hospital, D14, registered lowest sub-indices in almost all the constructs.

3.3 Validation of the Index

A literature search revealed no external standard that could be used to assess the criterion validity of the Index. We therefore assessed only the construct validity of the Index. The high correlation between the Index and the sub-indices may indeed represent accurate view of the level of efficiency of the EMR systems in the surveyed hospitals (Table 4). The Index was also strongly correlated to IT maturity -a scale developed by the Japanese Association of Healthcare Information Systems Industry (JAHIS), thus confirming at once the construct validity of the Index.

4. Conclusion

This is the first study that attempts to develop an Index for evaluating EMR systems. It proposes a framework for evaluating the efficiency of EMR systems of a hospital and identifies five constructs and surrogate measures that can be used in quantifying them. It then describes a procedure for calculating a composite index for evaluating EMR systems in hospitals. The Index is important because its level can be used as a strong predictor of how well a hospital can perform in the new healthcare environment. The Index can also provide policy makers with a detailed scorecard of their EMR systems relative to its peer counterparts. Further, a breakdown of the Sub-index allow policy analyst to pinpoint areas of strengths and weakness, thus providing a balanced perspective in guiding a hospital through the computerization. The framework developed here should be viewed as both descriptive and diagnostic: descriptive because it tends to explain the state of EMR system and diagnostic because it identifies problems areas.

Further work to validate the index is currently in progress.

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表1 Constructs used for Index computation

Constructs	Definition	# items	Scale	Target respondents [a]
System quality	Number of processes /activities that involve the use of computer-based applications and the level of integration of these applications in a hospital	269†	Yes/no	CIO, CMO, CNO
Information quality	The value and usefulness or relative importance attributed to the output of the EMR system by users	23	5-point Likert	Dr, NS
Service quality	The responsiveness of the systems' staff to users' requests, systems down-time and trouble-shooting of the system.	4	5-point Likert	Dr, NS
Use	The extent to which users are using the systems	68	5-point Likert	CIO, Dr, NS
User satisfaction	The extent to which users felt that the EMR systems are important in improving the quality of the care they provide	31	5-point Likert	Dr, NS

[a] CIO = chief Information officer; CMO = chief medical officer; CNO = chief nursing officer; Dr = Doctor; NS = Nurse

† The number shows the number of items in the questionnaire for the constructs

表2 Internal Consistency of the constructs

Constructs	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
System quality	.803	.928	.761
Information quality	.985	.983	.711
Service quality	-.122	.751	.924
Use	.869	.973	.712
User satisfaction	.811	.917	.761

表3 The Composite Index for EMR systems

No	Hosp Code	System quality	Information quality	Service quality	Use	User satisfaction	Index	JAHIS Level
1	B34	71.0	59.3	62.1	70.8	62.9	70.4	4.0
2	D23	68.8	54.7	54.6	68.6	58.1	66.7	5.0
3	C35	70.1	54.2	59.6	66.2	57.9	66.2	3.0
4	D16	63.7	51.8	57.4	65.0	56.3	63.1	3.0
5	D37	66.6	51.1	52.7	65.5	52.9	63.0	3.0
6	B43	64.6	50.8	56.5	64.4	53.7	62.3	3.0
			Average value				*61.1*	
7	D28	59.2	51.1	54.5	64.2	52.5	60.6	3.0
8	C22	62.2	50.6	62.4	60.6	52.6	60.3	3.0
9	D17	54.3	51.5	64.3	57.5	60.0	59.3	2.5
10	A27	52.1	44.0	55.8	52.6	48.1	52.4	2.5
11	D14	40.9	41.3	62.0	49.1	49.4	48.0	2.5

表4 Validation of the Composite Index

Variables	Index
System quality	.955(**)
Information quality	.893(**)
Use	.991(**)
User satisfaction	.802(**)
IT Maturity	.897(**)

** P-value > 0.01 level (2-tailed).

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Sophistication of information technology in healthcare: a comparison among a sample of hospitals in Japan

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Abstract
This study examines the level of clinical sophistication of information technology (IT) in a sample of hospitals in Japan and benchmarks the extent of clinical sophistication in Japan with the findings from similar surveys conducted at different points in time in the State of Iowa in the US and two provinces in Canada. Data for the study were collected using a validated instrument assessing three dimensions of IT sophistication: functional, technological and integration levels. Clinical areas that were assessed include patient management, patient care activities and clinical support activities. The results show that the majority of processes and activities that have been computerised in Japan are the basic patient management processes, such as admission, registrations and order entry systems. Telemedicine, expert systems and voice recognition systems for notes transcriptions were only available in less than 5% of the sample hospitals. Overall, there were no differences between the small hospitals and large hospitals in terms of functional and integration sophistication. However, large hospitals had higher technological sophistications than small hospitals. Functional sophistication was higher in Japan than Canada and the US. Technological sophistication in Japan was somewhat better than that of Canada but lower than that of the US. The results demonstrated that there exists substantial room for expanding clinical IT systems in the hospitals in Japan.

Keywords: Hospital information systems, information technology, computerised medical records, system integration, medical informatics, medical technology

1. Introduction

Evidence continues to show that information technology (IT) has significant potential to improve patient safety, organisational efficiency, patient satisfaction and quality of healthcare [1-3]. Despite such growing evidence, its adoption remains limited across many nations. In Japan, a survey conducted by the Ministry of Health, Labour and Welfare (MHLW) in 2002 reported that only 1.3% of hospitals (from a total of 8,023 hospitals) had the electronic medical records (EMR) system and that only 15.3% had the physician order entry systems (POES) [4]. Other developed nations also report a low level of the adoption of Health Information Technologies (HIT)[1]. Apart from Sweden (90%) and the Netherlands (88%) where adoption of EMR system by general practitioners is high, it is low in the US (17%), Canada (14%) and Australia (25%) [5-6]. In New Zealand and Britain, over 50% of hospitals have EMR systems [5]. As the demand for safe, effective, timely, patient-centred, efficient and equitably distributed healthcare systems continues, HIT will

[1] *HIT is used broadly here to refer to all computing technologies that are used to support healthcare including but not limited to electronic medical records systems and physician order entry systems.*

remain critical to the survival and competitiveness of healthcare institutions.

In the recent past, the government of Japan has initiated several programs that have generated a renewed interest in the adoption of HIT and, particularly, clinical IT systems. One initiative is the government policy paper targeting at least 60% of hospitals with 400 beds or more to computerise their records by 2006 [7]. The policy is based on the resource-based theory which argues that larger organisations have the capacity and resources to innovate [8]. Currently, there is no official survey done in 2006 regarding whether the policy was achieved or not. However, a survey conducted in the month of October 2005 by the ministry of health and welfare, government of Japan, indicated that the target has not been met. Only 20% of the hospitals with 400 beds or more had computerized their medical records (http://www.mhlw.go.jp/toukei/saikin/hw/iryosd/05/kekka1-3.html [in Japanese]). According to a new IT reform strategy released on 19th January 2006 by the government, it is expected that computerization in hospitals with 400 beds or more will be completed by 2008 and that all hospitals with less than 400 beds are expected to computerize their records by 2010 (http://www.kantei.go.jp/foreign/policy/it/ITstrategy2006.pdf). It must be noted, however, that government policy papers generally give directions, goals and visions which in most cases are too ideal to achieve. To what extent larger hospitals in Japan are more sophisticated in terms of clinical IT adoption remain unclear. Hence, it seems important to examine how the trends of adoption between small and large hospitals in Japan vary.

Another initiative is the introduction of a prospective payment system based on diagnosis procedure combination (DPC). In 2003, DPC was introduced into 80 hospitals in Japan to promote standardisation of healthcare and shorten hospital stay. DPC was expanded to other hospitals on a voluntary basis at the beginning of 2004 [9]. The DPC system is expected to make hospital services measurable, and provide valuable information for managing patient care based on evidence-based medicine (EBM). Though it is still on a trial basis, effective use of DPC will require patient information to be in electronic form to allow generation of useful indicators and faster filing of health insurance claims. These programs, together with several researches commissioned by the Government of Japan, are expected to spur wider adoption of clinical IT in the coming years.

In Japan, there is still no research outcome on the characterisation and operationalisation of the functions of the clinical IT systems and identification of the parts, which corresponds to the systems' units that would facilitate the utilisation of these systems [10]. One way to capture this baseline data is to examine the extent to which computerised processes/activities in each clinical area have been developed, the technologies to support them, and the extent to which the computer-based systems are fully integrated within and between healthcare institutions. In other words, there is a need to examine the degree to which information resources are fully developed and computer-based systems are fully integrated (clinical IT sophistication) in healthcare institutions.

In this paper, we analyse comprehensively the current state of clinical IT in a sample of hospitals in Japan. This study is different from the previous studies examining clinical IT adoption in healthcare in Japan, because we do not look at adoption as a binary variable (e.g., whether POE has been adopted or not [11]). We extensively examine processes and activities in each clinical section of a hospital to try to characterise adoption in a way that would help policy makers understand both the leverage available and the context required to achieve wider adoption objectives. We also make an attempt to compare the level of clinical IT sophistication in samples of hospitals in Japan, the US and Canada as a process of benchmarking the clinical IT sophistication in Japan. Benchmarking is important in measuring outcomes of policies, and monitoring progress in clinical IT diffusion. This will indicate how Japan is doing compared to the US and Canada in terms of extent of clinical IT sophistication in healthcare.

In summary, the objectives of this study were to (1) describe the sophistication of current clinical IT in hospitals that have adopted these systems, (2) assess whether the larger hospitals are more sophisticated in terms of clinical IT than the smaller ones, and (3) to benchmark the level of clinical IT sophistication in Japan with the results of similar studies in the US and Canada.

2. Method

2.1 Research Design

A cross-sectional survey was conducted as part of an ongoing nationwide longitudinal study whose aim is to evaluate the improvement of the quality of healthcare services as a result of the introduction of EMR systems. The overall goal of the nationwide study is to propose guidelines and self-evaluation methods for many medical institutions that plan to implement EMR systems in the near future.

2.2 Sample

In this study, a convenient sample of hospitals that had implemented some form of clinical IT was drawn as a follow-up to an earlier survey conducted to assess the costs of computerisation (both initial investment and running) according to system types and vendor support. The intention of the earlier survey was to build a business model for EMR system adoption. In that survey, 350 healthcare institutions were randomly selected to participate. Only 71 (20.3 %) healthcare institutions responded to that survey. The response rate was low but the results of the survey were very useful in meeting the intended analysis. Furthermore, the responding healthcare institutions did not significantly differ from the non-responding hospitals in terms of organisational characteristics such as ownership, hospital category (acute or long-term), bed size and bed category (small or large hospitals) (data not shown). For this follow-up survey, only the 71 healthcare institutions that responded to the earlier survey and had implemented some form of computerised applications in patient care management were invited to participate. The idea was to use the evidence of "success stories" of the adopters to understand the effect of clinical IT on the delivery of healthcare and also to convince other hospitals, which are yet to implement computerised systems. And since this survey was meant to provide evidence as a basis for characterisation of the clinical IT functions already deployed in healthcare rather than to measure the amount of adoption of these functions, we were satisfied that this sample would provide a good insight for the intended analysis. Besides, the hospitals that responded to this survey cover the spectrum of hospitals in Japan (university-affiliated, governmental, semi-governmental and private hospitals and clinics).

2.3 Instruments

The instrument developed by Paré and Sicotte [13] was used to collect data for this study. The instrument is based on a strong theoretical framework, and extensively assesses the functional and technological sophistication and the level of integration of systems in three key areas of hospital operations: patient management, patient care activities and clinical support activities. In these key areas, the instrument measures several intersecting technologies and processes including but not limited to, tracking systems (bar codes and radio frequencies identifications), POES, decision support systems and the integration of these systems not only within the departments but also with other systems in the external facilities. Prior research had demonstrated that the survey instrument was a valid and reliable instrument for measuring the availability of IT applications in hospitals [13, 14].

The instrument[2] was translated into Japanese. This was then followed by a series of meetings involving health informatics experts to check the appropriateness of terminology as used in the items of the survey. Some minor changes were made to the original survey instruments to reflect the practice in Japan. For example, DRG was replaced with DPC. Also, one item examining the HIT architecture was restructured to conform to the Japanese Association of Healthcare Information Systems' (JAHIS) 5-level hierarchy of clinical IT [15]. One item examining transcription of orders by nurses was omitted because this is not a common practice in Japan. As far as possible, we tried to retain the originality of the instrument to allow the comparison of the results obtained in Japan and the results obtained in Canada [13] and the US [14]. A pilot test of the survey instrument in Japanese hospitals indicated that the IT applications were relevant for hospitals in Japan.

2.4 Data collection

All the chief information officers (CIO) of the 71 institutions (69 hospitals and 2 clinics) were contacted by telephone to request their participation in this study. None of the contacted CIO refused to participate. A letter, detailing the purpose of the study, along with a copy of the questionnaire, was then sent to the CIO. Data were collected over a period of six weeks starting in February 2006.

2.5 Analysis

Overall, 42 institutions (41 hospitals and 1 clinic) completed the survey questionnaire in Japan. For the purposes of this analysis, clinics were excluded, making the overall response rate to be 59.4%. Also, the data collected from hospitals in Canada and presented by Paré and Sicotte [13] and that collected from the hospitals in the US and presented by Jaana et al. [14] were used in the benchmarking process.

The responses from the completed questionnaires were entered twice into a computer and the dataset compared to ensure accuracy. Data were 'cleaned' and then analysed using *Statistical Package for Social Sciences* (SPSS version 12). The same scoring procedure for the variables applied by Jaana et. al. [14] was used to ensure consistency. In brief, functional sophistication was measured using binary questions where a score of '1' was assigned for each computerised process/activity and a score of '0 (zero)' otherwise. Technological sophistication was measured on a scale ranging from '0' (not available), '1' (barely used) to '7' (extensively used). The percent of hospitals that reported these computerised activities as available was determined in each clinical subsection and used for comparison between small and large hospitals in Japan. Finally, integration level was measured on a 1-7 scale ranging from "not at all" to "very much".

The organisational characteristics of the hospitals surveyed in Japan were compared to the non-responding hospitals using chi-square test for categorical variables and Kruskal-Wallis non-parametric test for non-normally distributed continuous variables. Reliability of the measures used in the Japanese survey was assessed using Cronbach alpha coefficients, and then compared to the same coefficients reported by Paré and Sicotte [13] and Jaana et al. [14]. The percent of hospitals that reported having specific computerised processes and technologies under investigation for functional sophistication and technological sophistication, and the means of the responses to questions assessing the integration level were computed. Only questions that were clearly identified in the study in Canada and the US were used in this analysis.

Significant findings on clinical IT variables between small and large hospitals in Japan were verified using chi-square and Cramer's V (p = value 0.05). The p-values of Cramer's V test are reported. Benchmarking data was plotted as the percent of hospitals reporting each of the items listed in the

[2] *A copy of the original instrument is available from the authors.*

Variable	Responding hospitals n = 41 n (%)	Non-responding hospitals n = 28 n (%)	p-value
Ownership[a]			0.268
University-affiliated	3 (7.3)	2 (7.1)	
Governmental hospitals	5 (12.2)	8 (28.6)	
Semi-governmental	5 (12.2)	1 (3.6)	
Private hospital	28 (68.3)	17 (60.7)	
Number of beds			0.057
Median	452.0	246.0	
Range	1373.0	798.0	
Age of systems[b]			0.152
Median	3.0	4.0	
Range	7.0	9.0	
Bed category[c]			0.061
Small	20 (48.8)	20 (71.4)	
Large	21 (51.2)	8 (28.6)	
Hospital category[a]			0.085
Acute	36 (90)	28 (100)	
Long term (chronic)	4 (10)	0 (0)	

Table 1: Characteristics of responding and non-responding hospitals in Japan.

Sources: [a] from reference [12]; [b] from reference [16]; [c] We define small hospitals as hospitals with fewer than 400 beds and large hospitals as hospitals with 400 beds or more in line with government's policy requiring hospitals with 400 beds or more to computerise their patient records by 2006 [7]. Clinics were excluded from this analysis.

Variable	Responding institutions n = 42 n (%)	Non-responding institutions n = 308 n (%)	(p-value)
Ownership [a]			0.331
University-affiliated	3 (7.1)	19 (6.2)	
Governmental hospitals	5 (11.9)	81 (26.3)	
Semi-governmental hospitals	5 (11.9)	32 (10.4)	
Private hospital	28 (66.7)	175 (56.8)	
Clinics	1 (2.4)	1 (0.3)	
Number of beds			0.248
Median	452.0	283.0	
Range	1373.0	1483.0	
Bed category (hospitals only)			0.155
Small	20 (48.8)	209 (68.1)	
Large	21 (51.2)	98 (41.9)	
Hospital category [a]			0.146
Acute	36 (87.8)	259 (84.4)	
Long term (chronic)	5 (12.2)	48 (15.6)	

Table 2: Characteristics of 42 hospitals as compared with the original 350 hospitals.

Source: [a] from reference [12]