特集

医療IT化の推進に向けて

今月の視点

わが国の医療が重大な転換点を迎えている現時点において，医療における情報処理通信技術(IT)の果たすべき役割について総括する必要がある．現代医療の抱える問題とその根本的な原因を明らかにして，システム論的観点に立って，その最適な解決計画を定め実行していく，いわゆるPDCA(Plan-Do-Check-Act)サイクルを実践することが，いま医療の各レベルで求められており，その支援技術の一つとしてIT化の推進があるのではなかろうか？ しかし，わが国では，医療現場の電子カルテ導入や国レベルのレセプトオンライン化などIT化が個別に進行しつつあり，医療システム全体として，必ずしもその目的，方法，費用負担などについて，医療提供側と行政，生活者(患者)，IT産業界などステークホルダーとの間に合意形成されているわけではない．このままでは医療IT技術が無秩序に導入され，やがてこんなはずではなかったという不満が噴出して，医療ITが衰退をきたす危険もある．

今月の企画では，わが国の医療IT化について，その基本的な考え方と考慮すべき課題を医療現場の視点で明らかにし，診療所，病院および地域におけるIT化の多くの実例を紹介する．これらの掲載論文を通じて，本質的に労働集約産業である医療(ヘルスケア)サービスにおいても，医療現場レベルでは，ケアの質・経営管理機能・患者満足度などの向上に，さらに医療のマクロレベルでも公平性，効果性，効率性を同時に実現する日本型モデルの新たな創出に，システム志向の医療IT技術が役立つことを理解していただきたい．

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MEDINFO 2007
K. Kuhn et al. (Eds)
IOS Press, 2007

Template-based Data Entry for General Description in Medical Records and Data Transfer to Data Warehouse for Analysis

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Abstract

General descriptions in medical records are so diverse that they are usually entered as free text into an electronic medical record, and the resulting data analysis is often difficult. We developed and implemented a template-based data entry module and data analyzing system for general descriptions.

We developed a template with tree structure, whose content master and entered patient's data are simultaneously expressed by XML. The entered structured data is converted to narrative form for easy reading. This module was implemented in the EMR system, and is used in 35 hospitals as of October, 2006. So far, 3725 templates (3242 concepts) have been produced.

The data in XML and narrative text data are stored in the EMR database. The XML data are retrieved, and then patient's data are extracted, to be stored in the data warehouse (DWH). We developed a search assisting system that enables users to find objective data from the DWH without requiring complicated SQL.

By using this method, general descriptions in medical records can be structured and made available for clinical research.

Keywords:

medical records system, template, structured data entry, data warehouse, XML

Introduction

Recently, electronic medical record systems have been implemented and are used in many hospitals [1,2]. The medical staff expects data entered into electronic medical records (EMR) to be linked with a knowledge base for decision support, or used for assessment of medical activities and clinical research [3-5]. Medical records include patient profile data, diagnosis, chief complaints, patient histories, physical examinations, progress notes, records of orders, examination reports, operation reports, summaries and so on. Some of the patient profile data, diagnosis, records of orders, and laboratory test results are originally structured data, and have thus been stored in the clinical data warehouse (DWH) and previously used for clinical research [6-8]. However, most general descriptions in medical records are diverse and complicated, thus they are entered as free text. The valuable data for clinical research (e.g. stage of cancer, tissue type, side effects of medicine etc.) are usually entered as free text. Analysis of data in free text format is difficult. If these data are not available, the data in EMR declines in value.

In order to analyze the entered data, it must be structured, i.e. the description should be expressed by the assembly of data elements that consist of item and values with codes [9-11]. To get data into this format, an input template is the most practical method [12]. By using input templates, the entered data can be stored in the database and made available for data analysis. The descriptions in medical records are so diverse and complicated, however, that the template method is difficult to adopt. To overcome this problem, we developed a tree-structured template named 'dynamic template', whose basic concept was reported in 1998 [13].

It is usual to adopt a strategy of making templates based on their own database files [14,15]. This strategy makes it possible to analyze the data easily. Because of the lack of productivity and flexibility, however, it is difficult to produce templates for any possible description that might arise within broad specialties.

In this paper, we report on the dynamic template module and the method for analyzing the entered data by the template. In our method, the contents of the templates are independent of the database schema, thus the template can be easily produced and freely revised. We have produced many templates in broad specialties in every department. Furthermore, any data entered by the templates can be searched through DWH with the assistance of the searching system.

Methods

Structure of descriptions in medical records

In this paper we term a cluster of descriptions a 'describing object', which is a record about a certain property of a patient at a certain point in time. A medical record can be

considered as an aggregate of describing objects about one patient. A describing object has the attributes of patient ID, object name, observation time, description time, writer, department, and contents. In our model, contents of a describing object are expressed by the assembly in tree structure of data elements consisting of items and values.

Template module

We developed the input template module to get the data in this structure. The template contents can be considered as a union of the possible descriptions of patients regarding a certain describing object, i.e. each description of a patient is a subset of the template contents. Thus the structure of the template must be the same as that of the describing object.

The template content is the assembly of data elements consisting of items and options or text boxes, which are arranged in a tree structure. The template module displays all the elements in the same layer at once. When a value that has some subordinate elements is selected, these elements are displayed under the selected value. Because the template form changes according to the selected values, we call it 'dynamic template' (Fig. 1).

Although the structured data is processed easily by computer systems, it is difficult for users to understand. Therefore, we adopted a strategy of converting the structured data into narrative form, using the following rule: Each item and value has 4 types of character string: prefix, body, conjunction, and suffix. Linefeed can be set after each character string. If several values are selected for one item, conjunction is set between these values. If there are several items linked with one value, conjunction is set between these pairs of item and value, and the suffix of the value is set after those [16].

We adopted XML for the expression of the template contents master. This master includes the information about a structure of describing element, a way for expression on template of these elements, and a way for conversion of entered data to narrative form.

The main part of the elements in DTD of the template master is as follow.

<!ELEMENT ATOM-LIST (ATOM-STYLE,ATOM*)>

<!ELEMENT ATOM (ATOM-TYPE,DISPLAY-STRING,DOCUMENT-STRING,VALUE-LIST?)>

<!ELEMENT VALUE-LIST (VALUE-STYLE,VALUE*)>

<!ELEMENT VALUE (VALUE-TYPE,DISPLAY-STRING,DOCUMENT-STRING,ATOM-LIST?)>

<!ELEMENT DOCUMENT-STRING (DOC-BODY?,DOC-PREFIX?,DOC-CONJUNC-TION?,DOC-SUFFIX?)>

<!ELEMENT DOC-PREFIX (#PCDATA)>

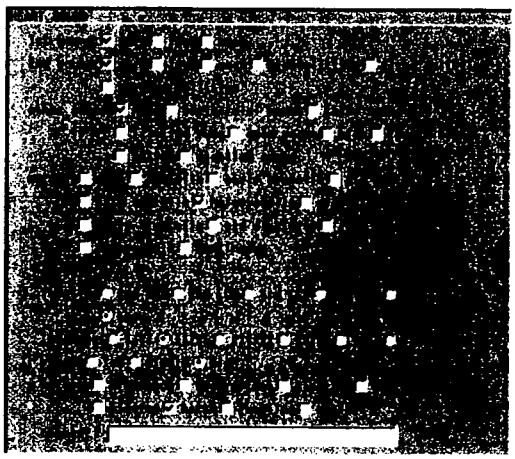
<!ELEMENT DOC-BODY (#PCDATA)>

<!ELEMENT DOC-CONJUNCTION (#PCDATA)>

<!ELEMENT DOC-SUFFIX (#PCDATA)>

DISPLAY-STRING is the character string expressed on the template. DOCUMENT-STRING is the character string on the narrative form, which consists of DOC-PREFIX, DOC-BODY, DOC-CONJUNCTION and DOC-SUFFIX. ATOM is an item of the describing element. ATOM-LIST includes ATOM, and ATOM includes VALUE-LIST. VALUE-LIST includes VALUE, and VALUE includes ATOM-LIST. In this format, the nested structure is presented.

Because the entered patient data is sometimes recalled with the original template and then revised, we adopted a method in which entered patient data is included in the template contents master. We put the SELECTED attribute of VALUE-LIST element in the template master. Before the value is selected, no is set to SELECTED attribute. When the value is selected, it changes to yes. When a character string is entered in a text box, it is set as the element of DISPLAYSTRING and DOCUMENT-STRING of VALUE-TYPE.



Narrative form

1st sound pure, 2nd sound pure, no other sound

holosystolic murmur (apex Levein II/IV high pitch harsh)

diastolic murmur (2nd LCS Levein I/IV high pitch regurgitant)

Figure 1 - An example of the dynamic template.

When the user selects "holosystolic" in " murmur", then the portion under "...holosystolic" appears. After data is entered by this template, the narrative form is generated.

Storage of data into the EMR database

In the EMR database, all kinds of patient data are stored. We call a cluster of information a 'medical event', which is stored in one record of the database. The describing object is one of the medical events. The data in XML and narrative text data are stored in each field, respectively.

EMR database is not suitable for data analysis, because the procedure for such analysis affects the response of the daily online transaction procedure. Furthermore, the patient data is included in the XML. Thus, in order to

search the objective data, all the records have to be checked. To overcome this problem, the data in EMR is transferred to the DWH. In this process, the XML data is parsed to extract patient data, which is stored in the database of DWH (Fig. 2). The structure of the database of DWH is quite simple. One record is made to correspond to one value. The main fields of this database file are as follows: patient ID, date, template name, xPath name, xPath code, value code, value name, suffix. The xPath code and the xPath name indicate the traced items and values in the tree structure. The xPath code (or the xPath name) is expressed by the traced items and values codes (or names) connected with "\", e.g. \A01\V0101\A02.

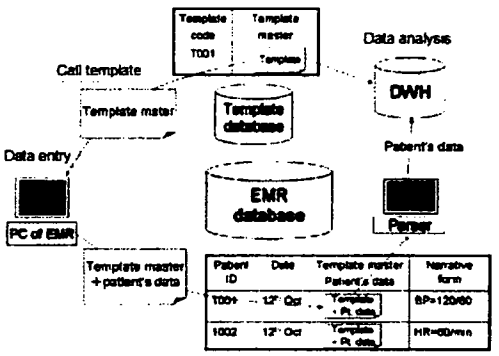


Figure 2 - Flow of template master and patient's data

Search assisting system

We developed an application system for searching the objective data from this database of DWH. In this system, users easily designate the objective data using a GUI. When users select an objective template, the system shows the names of items and values in the template. Thus, users can easily set the combination of search conditions in one template. The character string entered in the text box can also be the object of a search. In the case of numerical values, the conditions "more than" or "less than" can be set. The application system makes a SQL request according to the user's designation and searches the objective data from the DWH database. When the system finds the description that meets the condition, a progress note including the description is shown. Additionally, the system shows the progress notes of other days for the same patient.

Results

Availability of template

Preparation of input templates that are useful and convenient for every member of the hospital staff is essential before a hospital initiates an EMR system. The task is so large for each hospital that we formed an organization to support the preparation of template contents and their supply. The template contents that are developed for hospital use are then stored in the database, from which the staff of the hospital can select useful ones for their practice. The dynamic template module is used in 35 hospitals as of October 2006. Different styles of templates were sometimes produced for a concept. As of that time, 3725 templates (3242 concepts) had been produced and stored in the database. The numbers of template in each class are shown in Table 1. In the description of progress notes, the number of templates for "physical findings" is much greater than the numbers for "symptom", "assessment" or "plan". Not only doctors, but also nurses, pharmacists and nutritionists used templates. Templates are frequently used in examination reports, operation reports, and summaries.

Table 1 – The classification of templates

Classification of Template	No. of Concepts	No. of Template
Symptom	37	46
Physical finding	399	494
Assessment	157	168
Plan	24	26
Disease relating description	618	766
Patient history	184	211
Summary	62	64
Examination report	267	313
Operation report	55	62
Medical checkup	79	92
Description for rehabilitation	134	157
Description by social worker	23	23
Description by nurses	956	1013
Description by pharmacists	12	12
Description by nutritionists	44	44
other	191	234
Total	3242	3725

We examined 100 templates randomly selected from the database. When we count the same item linked with multiple values as 1, the average number of items in one template is 34.8. The average number of layers in one template is 8.1. We examined the maximum depth of layers in one template, and found 1 layer in 17%, 2 layers in 43%, 3 layers in 24%, 4 layers in 25%, and 6 layers in 1% of templates. The total number of items in the database is estimated as about 112,800.

Data warehouse and search assisting system

The DWH and search assisting system were implemented in Osaka University Hospital, and their usefulness was

evaluated. Without the search assisting system, users have to examine the xPath code of the value they want to search beforehand. Furthermore, it is quite difficult to write SQL for a combination of search conditions in one template. Contrasted with this, users can now search the objective data easily by this searching system.

Discussion

General descriptions in medical records, such as progress notes, examination reports, operation reports and summaries, are so diverse and complicated that these data are generally entered as free text in EMR. In order to use these data for research, clinical evaluation and so on, natural language processing is one of the possible methods [17,18]. However, to achieve good results by this method, all of the words in the entire medical field, including abbreviations and frequent typing errors, have to be entered into this system beforehand. This would entail tremendous amount of work.

The strategy of template-based data entry is a practical method from the viewpoint of data analysis [12]. The simple templates that are generally adopted, however, limit what users wish to express, and users have no choice but to tolerate these limitations.

Descriptions in medical records are the observation records of patients. When the observation object is normal, the user just enters "nothing particular". However, when something abnormal is found, they describe the object in detail. For the observation records, a tree structure is suitable: an abnormal object is described by several features, which may be further described by other properties [19,20]. Thus, a tree structure is necessary for the template. If the structured data is expressed as it is in EMR, it is not acceptable for users because it is quite different from the expression in free text. A person prefers an expression in which obviously understandable words are omitted, rather than a strictly redundant expression. To overcome this problem, we convert the structured data into narrative form [16]. By using this template, users can enter what they want to record in shorter time without the risk of typing errors. This strategy is quite acceptable for users.

The dynamic template is implemented in the EMR system produced by NEC and 35 hospitals actively use this module. Before starting to use EMR system, hospital staff prepared templates useful for their daily practice. During operating the EMR, templates were revised and new ones were added according to the users' requirement. More than 3725 templates have been produced and more than 100,000 items were entered in the template master. More templates about physical findings or examination reports have been produced than those about symptoms. Template-based data entry is suitable for actively acquired data. On the other hand, it is not suitable for passively acquired data such as symptoms. The concept, which has many options (e.g. portion of skin in dermatology), is difficult to handle with templates. Although the dynamic template is not effective for every type of description in medical records, its popularity and practical accomplishments show that the strategy of dynamic templates, i.e. tree-structured template and conversion of structured data into narrative form, is acceptable in many fields.

For general descriptions in medical records, many types of template have to be prepared. To bring this about, trial and error is inevitable, even after active use in daily practice [21]. Thus, it is necessary to have a system that enables users to produce templates easily and revise them even after releasing. Generally a template is made based on its own database file [14,15], which must be set on each occasion to produce a new template. If the template is revised, the corresponding database file must also be revised. Because this method disperses a patient data in many database files, it is not suitable for EMR system, which must enable users to refer quickly to any patient data.

In our method, the template content master that regulates the content of a template and the patient's data are simultaneously expressed in XML. After entering patient data by the template, the XML data and the narrative form of patient data are stored in the EMR database. Although this schema is practical for EMR systems, data analysis is virtually impossible. Thus, we developed a parser system that retrieves the data in XML from the EMR database and extracts patient data from it. The parser system then stores the patient data in the DWH database, in which one record corresponds to one value. Because patient data is originally in tree structure, xPath code and name is used to designate each property. This database schema is independent from the template contents; therefore, the user can produce and revise templates freely without thinking of the database schema.

Using this DWH, data entered by the template can be used for analysis. It is, however, difficult for users to find the xPath code of the objective data. Furthermore, in this database schema, it is difficult to execute combined search conditions in one template. Accordingly, we developed a search assisting system which assists in finding the xPath code in the template, and thus enables the user to easily set combinations of search conditions. Although this database schema is not the best for data analysis, the user can search the objective data from the database with the support of the search assisting system.

By using this method, general descriptions in medical records can be structured and analyzed. Although it has been said that structured data entry is essential for advanced functioning in EMR, there are a few reports that it succeeded when limited to a few a fields [14,15,22] or a few department [23,24]. We achieved active use of the structured data entry system in every department in many hospitals.

Acknowledgments

This work was supported by a grant-in-aid for scientific research from the Ministry of Education, Culture, Sports, Science and Technology of Japan (7) to Y.M. (15500341)

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今後の展望

わが国の医療と医療情報システムの展望

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SUMMARY

重大な転換期にあるわが国の医療では，システム志向的に医療体制を再構築することにより，公平性，効果，効率を同時に実現することは可能であろう．その一つとしてヘルスケア・デリバリ・システムと診療情報共有モデルを提案する．個々の医療機関においても，システム志向の観点からバランスドスコアカードによる複数視点の重要業績評価指標をもとに，PDCAサイクルを利用したマネジメントを行うことが重要である．

はじめに

国民皆保険制度下における医療へのフリーアクセスを保障した公平性，診療所機能と病院機能を地域医療計画のもとで整合した効果的な医療の提供体制，マクロレベルでは国民総生産の7%台で世界最高レベルの平均寿命を達成した効率のよさは，これまでわが国が誇る医療の特徴として高く評価されてきた．しかし，経済の停滞，高齢化社会の加速などにより総医療費が伸び，抑制する政策が施行されるにつれて，日本の医療制度の問題点も浮き彫りになってきている．医療費が伸びないと，医療の公平性，効果，効率の3つは同時に実現できなくなるのであろうか？ 本稿では医療情報学的観点からシステム化について考察する．

Ⅰ．わが国の医療のシステム化

地域基幹病院や特定機能病院にも患者の自由意志で外来受診可能な現状は，医療の公平性という面から見れば理想的であるが，患者の診療情報が十分に共有されていなければ，重複受診による過剰検査や二重投薬などが増加する．また医療効果を高めるために，診療所も病院もたとえばMRIのような高額医療機器を装備し，医療供給が医療需要を逆に喚起して医療費の増大を招き，医療資源の活用が非効率との指摘もなされている．たしかにわが国では，これまで性善説にたった診療側の自由な意志決定が保障されてきたが，現状では社会全体の動的な変化に適応できずに秩序を失いかけている．結果として生活者(患者)，医療提供側，医療費支払い側の3者がすべて満足していないという状況に至っている．この問題を解決するには，限界条件のもとに最適な解を得る論理，すなわちシステム思考を医療に導入し，真の医療システムを実現することが必要である．

医療へのニーズは質的に多様化し，量的に拡大している(図1)．一方，現在の医療は，基本的に顕在化した疾病を有する病人を対象としたものであり，医療需要と医療供給の不適合を生じてい

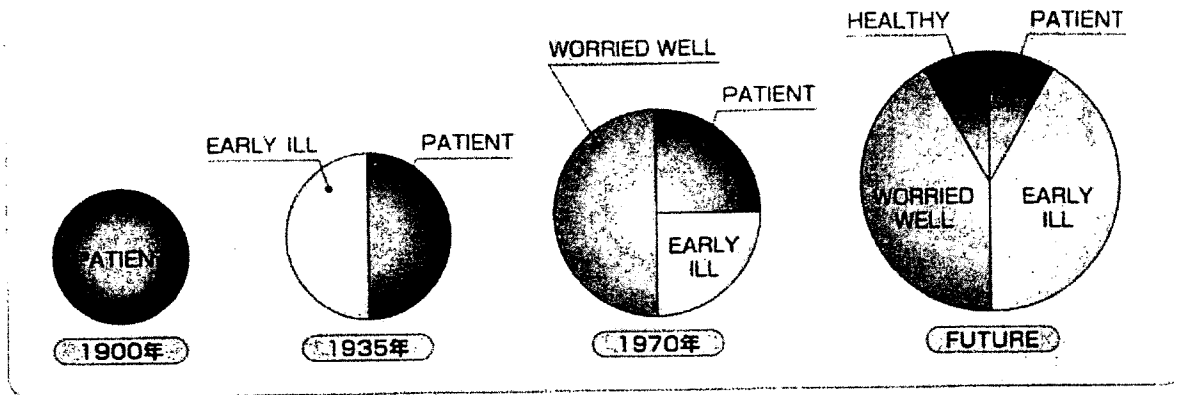

図1　ヘルスケア需要の質的変化と量的拡大　(文献1)より)

る．健康増進，一次予防，二次予防，医療，三次予防と介護は，本来人生においては一連の経過であり，施設ごとに分断されるのではなく，健康医療システム(ヘルスケア・デリバリ・システム)として構築されるべきであろう．Garfield[1]が提唱したシステム(図2)は，介護機能を追加すれば本質的に現在でも適用可能である．電子健康記録(electronic health record：EHR)の実装が議論されているが，その技術だけではなく，その技術を活用する医療システムのあり方については合意形成がなされていない．健康増進や一次予防を担当する保健所機能と医療機能の連携が不十分であり，プライマリ・ケアと高次医療との連携も不十分である．筆者は，現在存続の危機に瀕している地方自治体病院が，データセンターを有してヘルスケア・デリバリ・システムの中核機能を果たすべきであると提言している．

翻って，わが国の一次予防は「健康日本21」構想として開始されてが，成果を十分あげることができず，2008年からはメタボリックシンドロームに的を絞って，後期高齢者健康保険制度と連動させながら，保険者に管理を委ねる特定健診・特定指導[2]という形で実施が予定されている．しかし，健康保険組合がこれまで，このような機能を担う組織とは位置づけられておらず，専門家不在のなかで多くの保険者は業務委託とうい形で辻褄を合わせようしている．システム志向の欠如はけっして実りある成果を得られるものではなく，これまでの多くの構想の失敗を活かしていないことになり，わが国の健康・医療政策が機能していない証左であろう．

同様に，オンラインレセプト化[3]の事業が進行しているが，先行している韓国と比較するとわが国のシステム志向の欠如はあきらかである．韓国では，MPI(master patient identifier)が整備され，個人レベルでのデータ統合が可能であること，DRG(diagnosis related group)との連携による診療報酬体系のコード体系がシステム化されていること，院外処方箋の伝達が行われていること，KT(Korean telecom)の民間ベースのシステム開発・更新により，他業界のオンラインシステムとの共通コンセプト，インフラが医療と共有化できていることなど，行政と民間企業，医療機関，保険機関との連携の利点を印象づけられる．その結果，オンラインレセプト請求は，単に事務処理の効率化にとどまらず，データウェアハウス(DW)の構築による，業務レベルでの分析や，さらにはデータマイニングを活用した学会との共同研究協約に基づく全国単位の疾病疫学的根拠(エビデンス)の収集解析，保険者による疾病管理などの多彩な業務・研究に利用されている[4]．

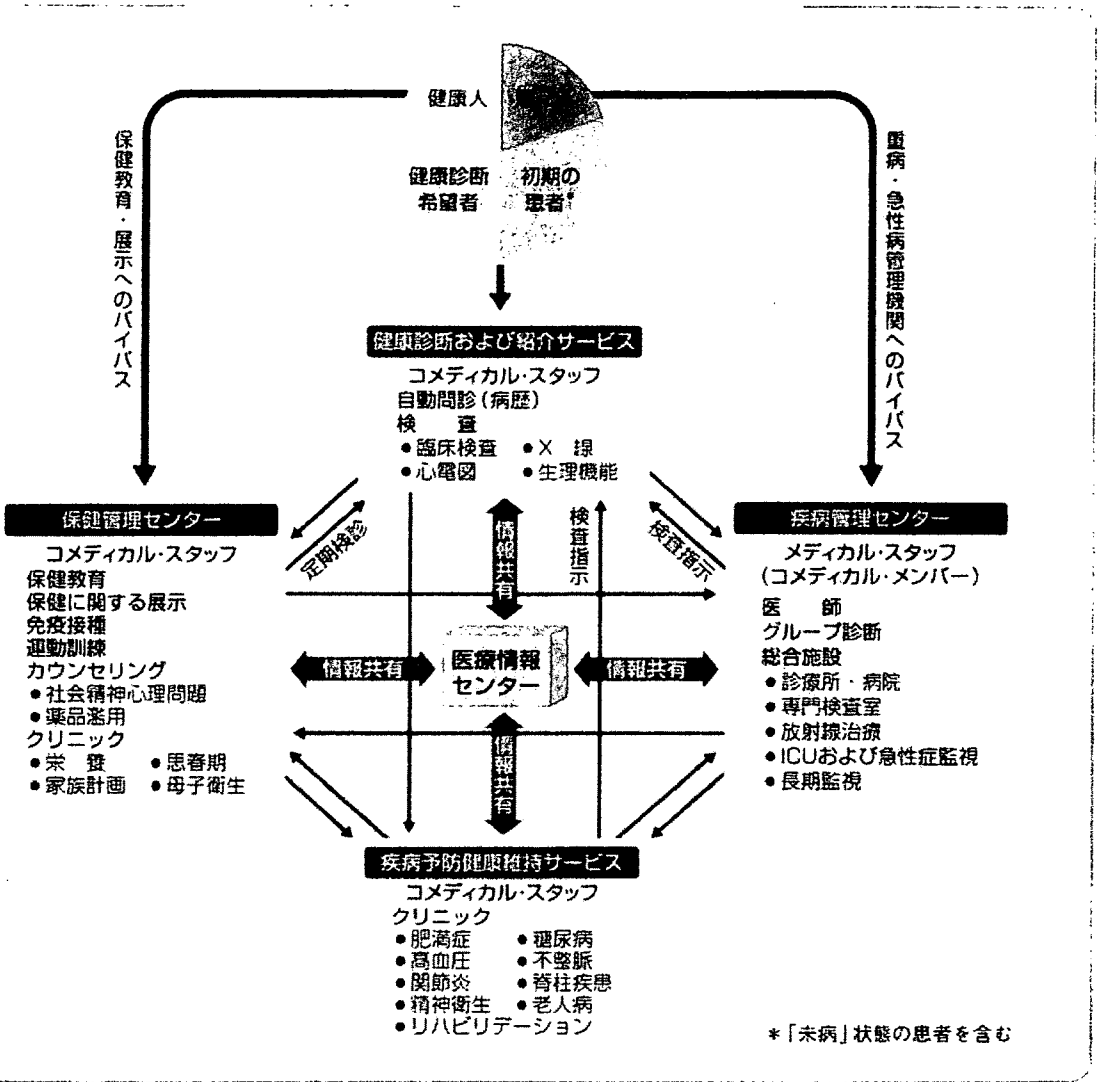

図2 ヘルスケア・デリバリ・システムの概念 （文献1）より改変）

わが国の医療システム化には，個人の健康管理・疾病の一次・二次予防に資するとともに，わが国の生活習慣病に関するエビデンスや医療効果，医療効率の評価などを目的として，すでに稼動中のオンラインレセプト・サブシステムと特定健診・指導サブシステムを包含する統合データベースの活用とヘルスケア・デリバリ・システムを基本とした医療供給のリエンジニアリングを図ることが必要条件である．システムが形成される過程においても，現在の医療の現状を認識でき，PDCA（Plan-Do-Check-Act）サイクルを実践ことにより，危機的な状況にある医療問題を解決することができると確信する．

Ⅱ．医療機関のシステム化

医療・保険施策が頻繁に改正される状況のもとで，医療施設側では，診療目標に即した医療マネジメント手法の確立が求められている．ここでも基本となるのはPDCAのサイクルを，施設の組織

レベル（全体，診療科（部），個人など）ごとに行うことであり，そのためのデータの収集，分析など医療施設を1つのシステムと見なした情報システム活用有無が成否を分けることとなろう．

これまでの病院管理は，財務経営を重視する傾向が強かったことは否めない．しかし，医療安全・質的向上などを適切に均衡をとりながら全体として成長するための病院管理を行うべきであり，ある種の最適解を常に求めていくことになる．その意味において，バランスドスコアカード（balanced score card：BSC）的に病院マネジメントを，財務・医療プロセス・患者・職員・成長の視点から捉え，病院のビジョン・目標の遂行のために，それぞれの視点で重要業績評価指標（key performance indicator：KPI）を設定し，病院の各レベルのPDCAを支援することになる[5]．病院情報システムなどによるマネジメント支援は，BSC全体のフレームワーク作りとKPI作成，ベンチマークの提示から始まる．

KPIの抽出に必要な診療情報マネジメント（clinical information management：CIM）はHISの根幹をなす診療行為から得られる情報をデータベースとし，病院管理（管理会計，人事など）データと結合しながら，データ統合・処理によりKPIなどを抽出し，意思決定支援を行う．

院内組織も重要である．CIMの責任者は，米国などではCMIO（chief medical information officer）と称され，わが国の医療情報部長のような役割が注目されている．HIS・EPRなど診療データから抽出された病院機能指標をもとにPDCAサイクルを基本とする病院マネジメントを支援するのはCIO（chief information officer）である．わが国では医師以外でこのような役割を担う職種は例外的であるが，CIO，CMIOを含めたチームの形成が医療マネジメント支援に必須であり，診療情報管理士や医療情報技師など情報マネジメントに携わる新しい職種がチームマネジメントに参加する環境作りが望まれる（**図3**）．

米国や欧米では，医療の質の確保と診療報酬請求を連動させる（pay for performance：P4P）[6]動きが浸透している．すでに米国ではJCAHOなどによるガイドライン遵守の審査を通らなければ，基本的にメディケア，メディケイドなど公的保険の給付を申請できない．さらに，P4Pは加速しており，2008年10月からは，手術後異物遺残，空気塞栓，輸血型不適合など予防可能な重篤医療事故を含む8合併症には，メディケアは支払いを行わないこととした[7]．また英国では，クリニ

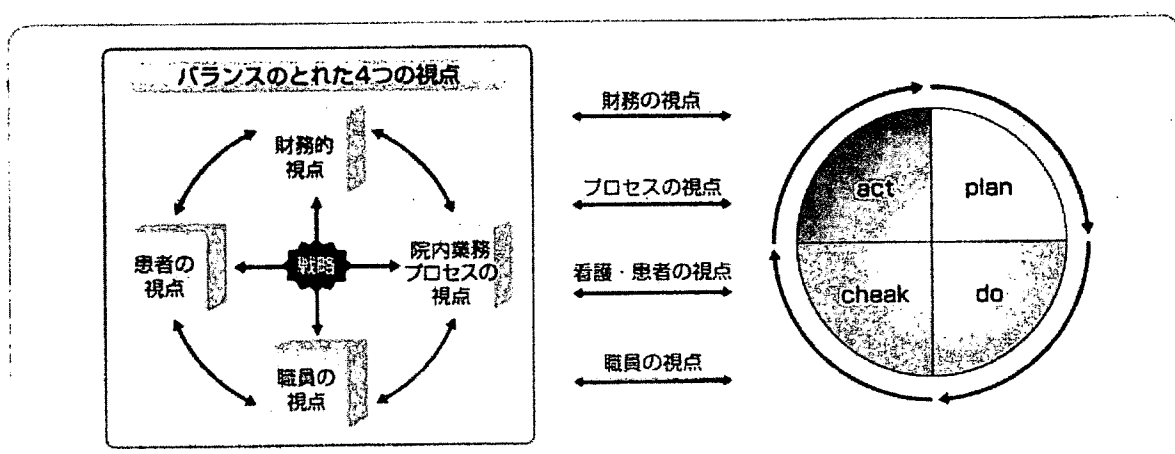

図3　医療機関管理のための戦略とPDCAサイクルの概念

カル・ガバナンス[6]のフレームワークのなかに，明確にP4Pが組み込まれている．欧米の医療機能評価は，効率性よりもむしろ効果（質の向上と医療安全）に軸足を移している．100Kプロジェクト（医療過誤による死亡を10万人減らす）は全米で多くの医療施設の賛同を得て，5Mプロジェクト（同500万人減）へ拡大され進行中である[9]．このために医療安全担当者（感染制御担当者を含む）と医療情報システム担当者との連携を強めながら，KPIを基にPDCAを実践している．やがてわが国の診療報酬請求制度にもP4Pが反映される可能性もあり，この動向を注視していくべきであろう．

おわりに

わが国の医療は大きな転換期にさしかかっている．公平性（Equity），効率（Efficiency）および効果（Effectiveness）のうちの何かを捨てるのか，またヘルスケア・デリバリ・システムの再構築など医療提供体制と情報共有化により最適な医療システムにより3つのEを再び実現するのか，世論にその回答を求めるべきであろう．「技術論」よりも「戦略論」を展開しなくてはならない．

医療におけるIT化の推進に向けて，電子カルテ（EPR）や電子健康記録（EHR）の導入が目的ではないはずである．医療は本質的に医療従事者が前面に立って診療行為を行う労働集約サービス産業である．しかし，その人を支援するIT技術，そして医療における構造，プロセスを最適化してよいアウトカムを得るシステムの構築が，混迷の医療を救う緊急かつ重点課題である．

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