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Devices for Structured Data Entry in Electronic Patient Record

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Abstract

Electronic patient record is expected to have edit, data analysis, and decision supporting functions. To realize these functions, the entered data should be structured. We made a template based data entry system with some devices. We defined a template for each describing unit, i.e., symptom, physical finding and examination report. Template is composed of several describing elements (a pair of property and value), which form tree structure in general. When a template is selected, the top layers of the elements are displayed at once allowing data entry. When the data qualified by other elements is entered then system presents the second layer about this data at once. This enables users to skip entering some unnecessary items. Users can constitute a form by combining some templates frequently used in a situation. Furthermore, at the second patient visit, the system can present the templates used in the former patient visit to check the different point. These templates and forms can be made easily by editing the master data using template master maintenance program. The entered patient data are presented in progress note and flow sheet. In progress note, the entered data are translated into natural language. In the flow sheet, representative data of each template are present in the cell of the matrix whose line indicates the describing unit and column indicates date. If the cell is clicked, then the details are presented. Using this system, we made templates and forms for cardiovascular field and entered the data about an actual patient with angina pectoris. The time taken by inputting data is shorter than that by handwriting and the content is enough for a patient record. This system is practical for structured data entry in electrical patient record.

Keywords

Electronic patient record; Template; Progress note; Flow sheet

Introduction

In electronic patient record, the entered data should be structured [1,2], because it is expected to have the following functions.

1. Edit function: Entered data should be edited from the user's viewpoint to understand the patient history quickly.
2. Data Analysis function: Entered data are stored into database and should be analyzed for various purposes [3].
3. Decision supporting function: In order to criticize the doctor's action by the system, knowledge base should be retrieved automatically by the entered data [2,4].

To realize the structured data entry we developed a template base data entry system, in which users entered the data according to the form presented by the system [5]. The template base data entry tends to limit what users intend to enter in general. To overcome this limitation, our system uses some devices. This paper describes the data entry system developed to realizing structured data entry in electronic patient record and its relevant systems [6].

Methods

We developed data entry system for the data describing the patient state, i.e., symptom, physical finding, examination report and so on. We defined a describing unit as the data set whose elements are scarcely described separately. For example, description about "blood pressure" consists of the data as to systolic pressure, diastolic pressure, measured portion and posture. These describing elements are scarcely described separately. Thus, "blood pressure" is defined as a describing unit. A describing unit contains some describing elements. There are some cases in that a describing element is qualified by some other elements. Thus, the describing elements usually form tree structure in the describing unit. For example, description as to heart sound contains heart murmur. If the patient has a systolic murmur, then a description as to the systolic murmur is required.

We made the data entry form for each describing unit. We call this entry form as "template". A template composed of some pairs of item presenting part and data entry part. Thereare two types of data entry method, one is free text data entry and another is data entry by selecting options. In selecting options, if sole data must be selected, radiobutton or combobox are available, if pleural options allow to be selected, checkbutton or list box are available.

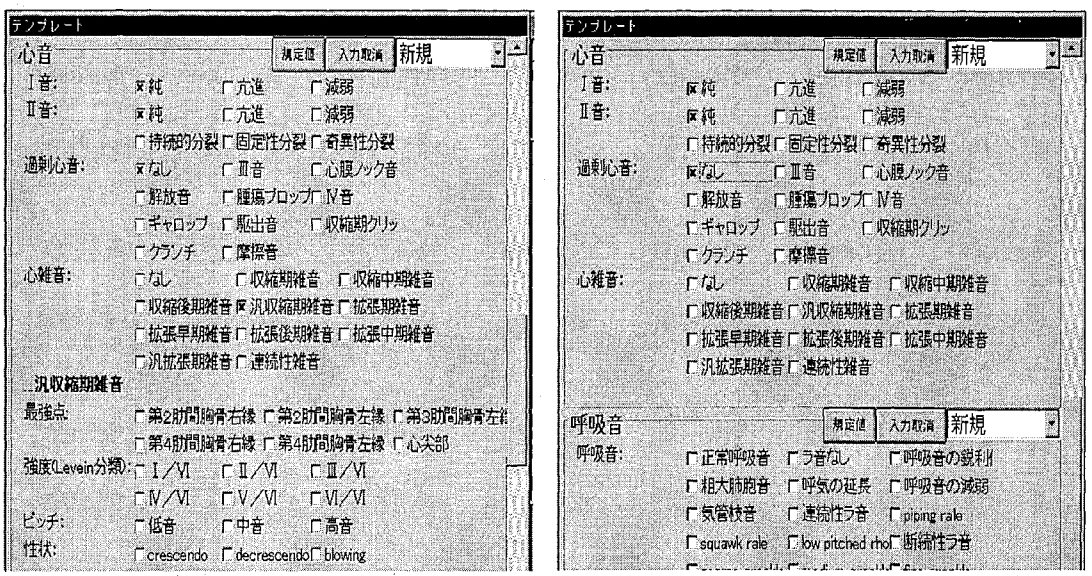

Figure 1 - Example of template. At first, the top level of items are shown (A). After inputting data, the qualifing items about the data are shown (B).

Because the describing elements form a tree structure, the system initially presents top layer elements of the structure at once and allow the user to enter data, after inputting the data which qualified by some elements, it presents the second layer elements about the data at once. For example, after selecting the template about heart sound, the system presents the items in this template, i.e. "first heart sound", "second heart sound", "other heart sound" and "heart murmur". If "holosystolic murmur" is entered in "heart murmur", then the system presents the items as to "location of the murmur", "loud", "pitch" and "nature". If two kinds of murmurs are entered, the system presents two sets of these items for each murmur (Fig. 1).

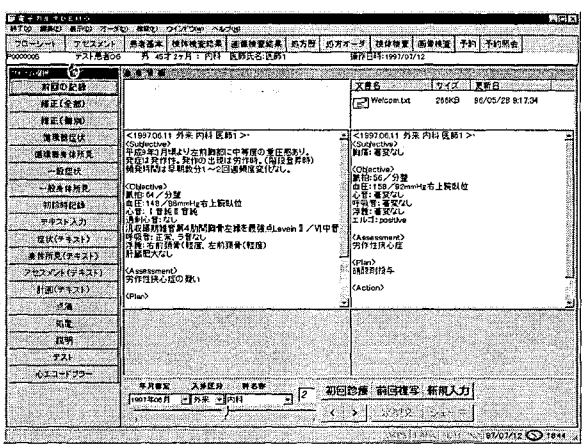

Figure 2 - Example of progress note

It is not convenient if users have to select several templates individually during consultation of each patient especially in entering physical findings. In this system, a user can constitute a form by combining some templates frequently used in a situation, so that the user can enter most of the data by using few forms. In entering a symptom, users have to select the suitable one from many templates. In this system, groups can be defined which include some templates or child groups, so that a user can search the template according to the hierarchy of the groups.

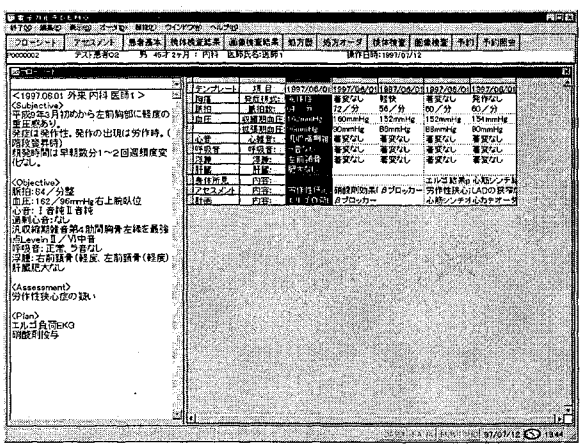

Figure 3 - Example of flow sheet

At the second visit, doctor checks changes in patient state compared to those observed in the former consultation. This system has a special form for succession in which the templates used in former consultation. In some data entry field in each template, the former data are presented, and the user checks them whether they change or not. If none of the elements of a template changes, then the user enters "no change". If the user does not check as to the data of a template (this case occurs about physical finding), or the subject of a template has been diminished (this case occurs about symptom), then the user enter "no check" or "diminish" respectively.

There are two systems to displaying the entered data. One is progress note, in which data are presented by natural language like a paper based medical record (Fig.2). The structured data entered into the system are translated into natural language according to some simple rules. The other displaying system is flow sheet. Flow sheet is a matrix whose line indicates describing unit, and the column indicate date, and the cell present the representative data of the corresponding describing unit and date. By clicking the cell, the details of the data are shown, and by clicking date, the corresponding progress note is shown (Fig.3). When the subject name is clicked, the data corresponding to the describing unit are shown successively.Because data and program are completely separated in this data entry system, the template or form can be constituted by editing the master data. There are four types of master data; i.e., form master, template master, property master, and value master. To support the user to edit this master data, we created the master data maintenance program. Using this system, users can easily constitute a template or a form as what they desire (Fig.4).

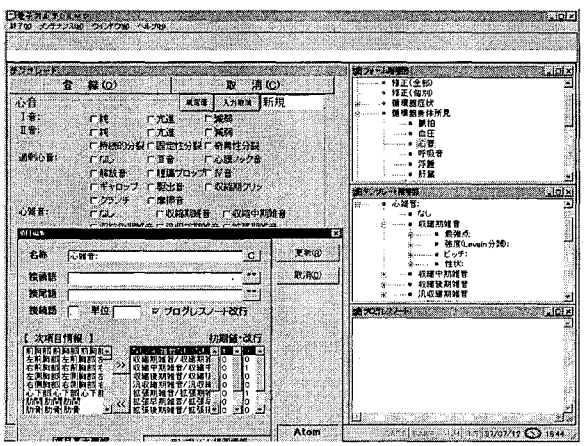

Figure 4 - Example of template master maintenance program

The patient data entered by this system is stored into four types of databases.

1) DB for used template
2) DB for entered data
3) DB for flow sheet
4) DB for progressnote

Former two databases are to constitute templates used in the former consultation. For this purpose, full data are necessary, but these data need not be kept for a long time. The latter two databases are to present the entered data in progress note or in flow sheet. Data structure of these databases are simple, but they have to be kept for a long time. The structured data are stored in the DB for flow sheet. Thus, it can also be used for data analysis. The basic structure of this database except for patient ID, date, and template ID is as follows.

```
1, 0, I01-V01
2, 1, I02-V09
3, 2, I03-V12
4, 0, I01-V02
5, 4, I02-V09
6, 5, I03-V12
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Those are element No in template, parent element No, and property-value respectively. Using the attribute of parent element No, these data can be reconstituted in tree structure form.

Results

We made an electronic patient record system for cardiovascular field using this data entry system.

We made the templates about chest pain, palpitation, and dyspnea as symptom and heart rate, blood pressure, heart sound, breath sound, liver, edema as physical findings. We entered the data about an actual patient with heart disease using these templates. The basic information about the chest pain of this patient could be entered by this system, and it took 35 sec, which was less than the time taken by handwriting (95 sec). Thus, input using this system was not slower than by handwriting. However, the information heard from a patient was arranged to input them using a template, thus some comment by free text was need for complete record. As for record of physical findings, it was easy to input data and the contents were enough as patient medical record. It took 40 sec to enter these data, which was also less than that by handwriting (50 sec). Thus, regarding physical findings, users could record more quickly and completely by using template than by handwriting.

The record at the second patient visit, it took 45 sec to record by using the form for succession in this system, which was as long as that by handwriting.

The record data were transferred to natural language in progress note, which were quite natural. The data presentation by flow sheet was helpful in comprehending the history of the patient. This presentation is expected to be more effective in patients with a long history.

Discussion

A state of a patient is diverse. At a consultation, how fully a doctor records this is dependent on the situation and the problem set by the doctor. The most practical method to enter the diverse patient state into a computer is by free text like word processor. However, by taking this method, we have to abandon the important function expected on electronic patient record. On the other hand, however, template base data entry makes it possible to realize these functions, it is difficult to enter all of these diverse data using template. The difficulty in realizing the practical electronic patient record system is on how to balance between liberty and formula. We adopted a method of data entry using template, basically with some devices.

In this system, templates are made individually for each describing unit, and forms can be constituted easily by combining these templates. By taking this strategy, it is easy to cope with a variety of subjects in records among doctors. For example, records about physical findings usually made by a doctor is varied according to his/her specialty, however, some subjects are commonly recorded by some doctors. In this system, each doctor can constitute a form for his own by combining tem-

plates, most of which were defined commonly in the society, resulting the entered data could be standardized in the society.

Record in detail is not necessarily required in medical record. In some cases, abridged data can be allowed. To cope with both of these situations, the system presents the items broadly so that users can choose the items to input. However, it is troublesome if all items included in the template are presented at once when the template is selected. Thus, our system presents the first layer of the tree structure of the items at first. If the data, which should be qualified by some other elements, is inputted, then the system presents the second layer of the structure about the data. The following step is as the same way. This dynamic control of template makes users feel free to enter data efficiently.

The viewpoint of the patient is different between in the first patient visit and in the subsequent visit. Although in the first patient visit, doctors collect information helpful for diagnosis, in the second visit they check the differences from those observed in the former visit. We support the data entry in the subsequent visit by succeeding the template used in the former visit. Using this system, users can not only enter data easily but also they can enter the information about changes in the patient state. This information is important for medical record.

However, template is convenient for data entry, it is not suitable for data presentation, because it occupy the large area in the screen. Thus, we translate the structured data into natural language using simple rules set in the master. This helps users to see the entered data easily. However, presentation on screen is more difficult to comprehend the patient history than the present paper base patient record if the patient history is long. To support users to comprehend the patient history as a whole, we prepared the flow sheet presentation. In flow sheet, whose line indicates the describing unit and columns indicate date, the representative data is shown in the cell. In this way, more than 8 days record can be summarized in one screen, thus users can easily comprehend the patient history as a whole. The describing unit can be related to problems the patient has. Doctor can restrict the items shown in the flow sheet by the problem that he/she is concerned with. Thus, users can see the record from his point of view. Furthermore, the detail data can be shown by clicking the cell, date, or item, thus all kind of data can be seen from the flow sheet. This kind of data presentation is unique and impossible in paper based patient records, thus is expected to be effective to comprehend the patient history easily.

The effectiveness of the template based electronic patient record depends on the workmanship of the templates. In order to constitute a good template a trial and error process is inevitable. In our system, any templates can be constituted only by entering the master data. Furthermore, we prepared the maintenance program for the template master, which allows users to constitute templates more easily.

Using this system, the entered data are structured, thus the following function can be realized. First is edit function. The flow sheet presentation is one of the examples, in which the presenting data can be selected by the problem. We are going to make a more elaborate presentation; i.e., a problem oriented display in which each element is linked with each problem. Thus, the system can present the relevant information to the problem selected by the user, for example the basis of the problem, plan for the problem, and so on. Second is the data analysis function, which is possible using the database. In this database, each record has attributes of item, value, and the relation with other record. Although the structure of the template is varied, the structure of the entered data in the database is simple and unified, thus complicated analysis of the data for clinical study may be possible. Third is the decision support function. In the next step, we will combine a decision support system in which the knowledge base is retrieved automatically by the entered data, so that doctor's actions are criticized by the system.

Conclusion

We made a template base data entry system. Even using templates, users feel free to enter data because of the following devices; dynamic control of presentation of properties in template by the data so far entered, constituting a form by combining some templates defined for each describing unit, easy constitution of templates using the template master maintenance program. The entered data are presented in progress notes and flow sheets, which helps users to understand a patient history easily.

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