A model approach to sharing electronic medical records between and within the state hospitals in Turkey

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Abstract

It has always been a research interest to solve hospital management problems with systematic approach by using modern management tools. Almost all the Hospital Information System (HIS) software packages in Turkey keep track of local transactions in administrative activities and material flow. In state hospitals in Turkey, very little medical information is processed and most of the records are still kept manually and archived on papers.

In this paper, a cost-effective, flexible and easy-to-use Hospital Information System model is proposed in order to give better diagnostic and treatment services. It is also demonstrated that this model makes it possible to exchange information between and within the hospitals over Transmission Control Protocol/Internet Protocol (TCP/IP) network. User needs are taken into consideration during model development and the benefits of model implementation to the hospital administration are stated. According to the model proposed in this paper, only a single health care record number (HCRN) is required for a patient to access all her/his medical records stored in different locations, from any state hospital in Turkey.

Keywords: Health care record number; Cost effectiveness; Sharable medical records; Hospital information system

1. Introduction

Hospitals are very complicated organizations which are hard to manage and control. Health care organizations, especially state hospitals in Turkey, are confronted with a late introduction to the computer and information technologies due to the resource and personnel restrictions. Turkish Ministry of Health has been intensively working in finding solutions to the health care problems of the country since early 90s. Parallel to these activities, special efforts have been made to migrate to computer supported automation and as a result of these studies some pilot implementations have been

Fig. 1. Conventional work flow of health care process in the state hospital in Turkey. R: registration desk; S1–S4: registration desks at polyclinics; T1,T2: registration desks at laboratory and radiology units, 1–9: process steps.

developed [1]. Having looked into the results of the inspections carried out in health organizations, it is found that HIS implementations had not been widely utilized by hospital administratives.

Hospital information system mainly consists of the activities such as patient registration, fulfilment of diagnosis-treatment and billing processes. The hospitals in Turkey attach great importance to the automation in administration and inventory control for short term profit and they also use applications which minimize financial loss. Storing and archiving the information about physician–patient relationship which improves diagnosis and treatment performance and giving this information back to the system is ignored, because long term nature of these activities which do not have a value directly added to the hospital administration.

The importance of keeping any kind of medical data in digital environment is well accepted by Health Care organizations. However, what is more important than keeping track of patient records electronically is to have longitudinal access to this medical information fast, whenever and wherever needed. The researches carried out and the applications developed to make the patient information in different regions both sharable and accessible emphasize the importance of the effectiveness, resulted by longitudinal access to the information, in diagnosis and treatment processes [2–7].

In Turkish state hospitals, diagnosis and treatment processes start with patient check-in at registration desk (R), which is step 1 as shown in Fig. 1. The demographic information of the patient, in each application, is written onto a paper application form. The patient is sent to the related

department, step 2, for diagnosis and treatment and some of her/his demographic information are rewritten in the registration book of that department, represented by S1–S4, step 3. After the physician’s examination, the patient goes back to the department registration desk and diagnostic results and the medicine prescribed for her/him is recorded in a registration book of the department and her/his health card, step 4. If a physician needs to have some laboratory diagnosis or X-ray films, the patient is sent to laboratory or radiology unit, step 5. Once again, some demographic information of the patient is also written in a registration book of that unit, which are T1 or T2, steps 6 and 7. Results of laboratory analyses are recorded in a registration book by bio-specialist and onto the forms manually; then the forms are given back to the patient herself/himself for circulation, step 8. Similarly, at the radiology unit, output is given either to the patient herself/himself or archived in a file prepared for her/him and kept in the hospital. Then, if there is any diagnostic result given by either the laboratory or radiology unit, the patient goes to the polyclinic directly by skipping steps 2 and 3. If the patient is sent to other polyclinics to undergo further examinations, process steps from 2 to 8 are again implemented. As a consequence, when the past medical information of the patient is needed, it is almost impossible to get any concrete information except that in the health card of the patient and in her/his own words.

As is seen, in the Turkish state hospitals, the information obtained in each stage of the above processes is kept as a paper work in hospital archive rooms or on the patient herself/himself, which makes it almost impossible to access this information immediately when needed. The statistical reports are prepared by entering some numerical data obtained by manual scanning of the hardcopy records.

In this study, a new HIS model approach is proposed which makes the following possible: The patient checks in a state hospital with a unique HCRN. The patient’s operations inside the hospital are processed across the Local Area Network (LAN) and all the past information about the patient can be gathered from different nodes across the Wide Area Network (WAN). This model will enable physicians to look into the diagnosis-treatment information of similar occurrence recorded in other state hospitals and make queries by accessing other hospital databases when needed. Thus, they will be able to utilize a system which helps diagnosis and treatment processes. With the use of this model, for example, a common disease in a region can be recognized earlier, disease statistics can be obtained easily, the information regarding the social security expenses of the country can be found out, and medical units can deal with problems immediately.

2. Materials and methods

For model software, Progress 8.3B relational database management and application development environment (ADE) is preferred, and client/server architecture and object-oriented methodology are used [8]. Normal Form principles are obeyed while forming the database tables [9].

Progress 8.2B is a 32-bit application development environment which is user friendly, easy to install, compatible with Windows applications, has 4GL features besides database management features, supports visual program development with Smart-Object applications and the most importantly creates portable object code. As the created object code can work with any type of hardware and operating systems, it also supports a heterogeneous structure. This feature reduces the risk of losing hospital archives and the investment for current automation system.
Model software is designed by taking into consideration 12 important criteria in hospital information systems, prepared by American Institute of Medicine (AIM), to meet the specifications for a well-written automation software and the conditions required in the phase of the transition to the Health Care information system [10]. The model works on Windows 95/98, Windows NT, AS400 and UNIX operating systems and over TCP/IP network environment.

Turkey is divided into seven geographical regions in terms of area size (Fig. 2). For this reason, hierarchical structure of a four layer model is formed by setting up a sub-server within each geographical region as shown in Fig. 3. At the bottom layer, all polyclinics of a hospital are equipped with workstations (level-1) and each hospital is equipped with a local server (level-2). Within each geographical region, there is a sub-center and each sub-center server is connected to the other (level-3) and to the main-center server (level-4). Polyclinic workstations are connected to the hospital local server via Ethernet 100 Mbit LAN connection; the local server in each hospital is connected to regional server over a TCP/IP WAN. Similarly, each regional server is connected to the main-center server via TCP/IP WAN. Moreover, information access is possible directly from the central server for level-2 servers by-passing the regional sub-servers if needed. The main server and sub-servers have Windows NT 4.0, while the workstations run Windows-98 as the operating system.

It is not easily accepted by the hospital personnel to leave old work flow processes and switch on to a new system, because of the insufficient program interfaces and lack of trained user personnel. However, the effectiveness of an information system is proportional to the range of its use. It may not be possible to make information system’s usage widespread unless the end-users are trained to use the system efficiently in the shortest possible period of time. Simple windows are prepared to prevent the users from getting lost between menus and user-friendly screens are prepared to easily adapt the users to the new system while forming the system. Instead of implementing a method which requires operator knowledge and experience for data entrance/change and cancellation on the database, a method in which the standard data is entered by only one source is used. When there is
Table 1
Training periods and subjects

<table>
<thead>
<tr>
<th>Period</th>
<th>Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2 day</td>
<td>System logic</td>
</tr>
<tr>
<td>1/2 day</td>
<td>S/W package, process windows and implementations with windows</td>
</tr>
<tr>
<td>1 day</td>
<td>Explanation of data items on windows and processes</td>
</tr>
<tr>
<td>1 day</td>
<td>System management and backup procedures</td>
</tr>
</tbody>
</table>

... a need for standard information, it is brought before the operator in tables from where she/he can enter the data in the selected field.

Effective usage of the model is provided by training the personnel in a very short period and making the training understandable to each member of the personnel. It is seen that a 3-day-period is enough for the training given, Table 1. Choosing the personnel to be trained among the ones that have basic computer knowledge and making the data entry possible by using tables and combo-box format has made the training period short and increased its effectiveness.
3. Application of the model

In this model, the patient is introduced to the system with a unique key HCRN. Unique HCRN is distributed by a central system in response to people’s application. It is assumed that the patient always applies to state hospitals with this given key. At the main central system where HCRN is given, the corresponding demographic information will be kept in a table with indexed format. Health care transaction sequences are as follows:

(a) The identification and status information is transferred from the regional server to the hospital to which the patient applies, Fig. 4. If the patient applies to the hospital in that region for the first time, the patient demographic information is transferred from the main server to the hospital being applied. Then, she/he is sent to the relevant clinic. Thus, the treatment process is started. Transaction data is stored in the database of the hospital where the transaction took place.

(b) Since the dispatching is done over the clinical code tables defined for the hospital, patient application will be processed as a work order in the place where polyclinics accept the patients. Due to this feature of the model, the patient will not be able to get any treatment unless her/his application is entered into the system at the registration desk.
(c) Before the physician starts medical treatment, she/he sees the list of the patients sent to him in the workstation in her/his room. The identity information of the patient received from the central system can also be seen on the screen. When the physician needs the past medical information of the patient, firstly he can access the information in the local database. If this information is insufficient, then the hospitals that have records about the patient are found on the table received from the central system.

(d) Connections are made to remote hospitals in different geographical regions over TCP/IP WAN, so that the detailed information of the patient in treatment can be obtained. In the detailed information, all medical records such as the treatments undergone, medicines, analyses and radiology images are to be obtained. The information in the remote hospitals is read-only to the outside. No remote changes are allowed to be made to the records of the accessed hospital.

A model has been put into practice as a pilot application in laboratory environment with the structure given in Fig. 5 and the following basic transactions are realized successfully:

After the registration of the patient is done “Acceptance” folder is selected and the transaction of sending the patient to the relevant polyclinic is done on the screen, shown in Fig. 6a. On the same window, the other state hospitals where the patient has medical records are also shown. In the “Treatment” module, which is selected from main menu, all the polyclinics of the hospital can be seen as a “Selection List”. Thus, the physician is able to see the list of the patients and start the treatment by selecting the patients from the list shown in Fig. 6b. This list can be restricted by authorization codes given to the personnel.

The treatment applied and the medicine prescribed by the physician can be written as a free text into the text field in the “Treatment” screen. The information stored in this field can be filtered by
Fig. 6. (a) Acceptance of the patient for the requested clinic, called A004. The patient also has a number of medical records on other state hospitals, shown on the right corner of the window. (b) Treatment folder. Patients registered for the clinic A003. The doctor selects a patient from the list for treatment. (c) Searching a key word on the hospital database. There are four different cases with the same key word. Two of them belong to the same person with HCRN 3.
entering a key word or word group to be searched in the “Search” folder shown in Fig. 6c. The medicine prescribed to each HCRN, treatment method and physician interpretations can be utilized in decision process.

In the same way, when an analysis information is needed by the physician an order can be given to the laboratory from “Laboratory” folder on the patient information window. Using the “Laboratory Diagnosis” module in the main menu, all the orders given by each polyclinic become visible on laboratory workstation and the results of the inspections are entered into the system by the laboratory technician.

When the patient who is finished with the laboratory transactions goes back to her/his physician, the physician will be able to go on with the treatment seeing the results of the inspections. If the physician requests an investigation from radiology unit, the transactions are carried out in the same way, but the results are entered into the “Radiology” folder.

**4. Results and discussion**

In patient registration-acceptance and diagnosis-treatment transactions, instead of writing the same information to different registration books, the usage of the model program results in the following:

(a) Work request between the polyclinics is done by dispatching the patient to the relevant unit by authorized personnel. Sending the patient from one unit to another and the request to the radiology department or laboratory are made directly by the physician, on the screen. Therefore, there is
no need to store the standard data over and over again, for the patient who travels among the
clinicals.
(b) With the method, some positive values such as reduction in work load, data consistency,
displaying standard data everywhere, storing the correct data in database, increased security level of
the accessed data and consistency of statistical data, are gained.
(c) Useful statistical data, such as a common disease distribution according to regions and social
level of community, death rate of diseases and health care service expenses of the country are
obtained easily compared to the conventional paper work.
(d) Defining the table contents dynamically according to the need of the organizations makes it
easier to share the data generated in the hospital.
(e) With the application minimizing data entry transactions and preventing the operator from
switching between the windows, data input speed was increased and the data integrity was established
by reducing the error rate.
(f) Building up queries that will construct decision support functions from the archived data for
future use is provided. Patients are prevented from carrying papers, documents or files between and
within the hospitals.
(g) The most important point in health systems is to provide better medical diagnostic and treat-
sment services for the patient as soon as possible. Since the transactions are carried out completely in
computer environment, the information recorded in the system is accessible very quickly whenever
needed.
(h) The integration of hardware and software is a very big problem in an institution when some
of the user requirements are to be embedded into the system after the database is established having
a specific hardware and software. For the future needs of the organization, the proposed model
minimizes such kind of system dependencies, preserving both the existing investment and time loss
for transferring old data to new system.

When the patient makes an application to state hospitals in different regions of the country,
demographic information of the patient is accessed from the central system and then moved to the
database of the calling hospital. The aim of this information transfer is to prevent the data retrieval
from the central system repeatedly, when the patient applies to different services in the hospital. Some of her/his demographic information may need to be updated. When the patient departs from
the hospital where he gets medical treatment, all updated demographic information is transferred to
the table in the central server.

Another point of special attention in the application is to keep the network traffic in the minimum
level by accessing the diagnosis and treatment information at those points where the patient makes
applications only when needed. Since the databases are in distributed structure, complete loss of any
information is prevented. When the patient does not need to change her/his health care center, there
will be no need to transfer the medical information over the network.

System will prevent some misusages such as unauthorized service delivery or off the record
material usage during the diagnosis and treatment process, because transactions are made on the
data already stored in the tables.

It is not yet a common implementation to give a medical service to the people by using unique
HCRN keys in Turkey. Patient records are carried out by using the information like name and
surname. In the near future, if such a method is put into practice, it would be possible to keep track
of the patient around the country (Fig. 2).
5. Conclusion

In this paper, a modular, easy to operate and cost-effective model has been introduced for the Health Care system in Turkey. Although some national systems providing the same services have been evolving around the world for 30 years, for example the US Veterans Affair DHCP, this model will be the first sample for Turkey when it is implemented. This model enables users to share a variety of diagnostic, treatment and laboratory data according to the need to know the principle in a hospital’s inner cycle and query the system databases to obtain similar occurrences of a specific case which provides information that helps decision making process of medical personnel in hospitals.

This model also provides accurate decision making support for all integrated hospitals by maintaining medical records dynamically, including medical personnel’s experiences, with full participation of the end-users, in multi-vendor equipped environment over TCP/IP network.

References


İnan Güler graduated from Erciyes University in 1981. He took his M.S. degree from Middle East Technical University in 1985, and his Ph.D. degree from Technical University of Istanbul in 1990, all in Electronic Engineering. Between 1988 and 1989 he worked in the Department of Medical Physics and Clinical Engineering at Leicester Royal Infirmary, where he studied the experimental part of his Ph.D. He is a Professor at Gazi University where he leads the Biomedical Engineering Group and is the Head of the Department. His area of interest are biomedical systems, biomedical signal processing, biomedical instrumentation, and electronic circuit design. He has written more than 60 articles on biomedical engineering.

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