

Upgrading the Cardiac Patient Record in the Coronary Care Unit into the New Millennium

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Abstract

Since the early 1980s an automatic patient discharge letter program exists in our coronary care unit (CCU) ward. This program was terminal-oriented and used by the attending cardiologists. Although several revisions were made since 1983, a need existed to renew this terminal-based application and therefore we upgraded the software into the MS-Windows era. We decided to maintain the existing CCU database, which was written in the MUMPS language, and to develop a Windows-based front-end. The new application was developed in Delphi and a special gateway was made between Delphi and the MUMPS database.

The software has replaced the previous one successfully in the beginning of 2000 and the reactions of the users are positive. The combination of coded information and automatic generation, which proved to powerful 20 years ago, still turned out to be a modern and powerful tool in this new millennium.

1. Introduction

Already more than 30 years ago our center saw the need for systematic record keeping in a central computer system. In research oriented units it is essential to be able to recover information from the records in order to answer questions such as the number of patients admitted with a given diagnosis, the treatment given to various patient groups and the outcome of disease. Therefore, the multi-user Thoraxcenter Utility System (TUS) was developed in the 1970s [1,2]. In 1979 a new form was introduced in our Coronary Care Unit (CCU) which extended the traditional written patient records with coded information [3]. However, physician's compliance deteriorated mainly caused by the lack of feedback to the CCU physicians. In order to overcome these problems an extension to the CCU module was developed in 1983 [4]. This application was developed in such way that first coded information was entered and then an automatic patient letter was generated to be sent to the general practitioner. The CCU module was fully embedded in TUS, which, on its part, has extensive online links with the central Hospital Information System (HIS).

The coded information was entered on an optical mark sense card and the continuous data and free text was entered using a VT100 terminal. In this way, information

such as name and address of the patient and his general practitioner was easily retrieved from HIS and imported in the patient discharge letter. Although some revisions were made since then, the CCU module has been used continuously for almost 20 years.

However, in the recent years the need existed to renew this terminal-based application and upgrade it into the MS-Windows era. We decided to maintain the existing TUS database infrastructure. TUS is developed in the MUMPS programming environment using a network of PC's. Because this MUMPS environment uses its own operating system, special communication programs were needed. The new application was developed in Delphi and a special gateway was made between Delphi and the MUMPS database.

2. Thoraxcenter Utility System (TUS)

The MUMPS-based TUS system was designed and developed in 1974 and contains most of the (ASCII) patient data of our cardiology department. Coded information is entered and discharge letters are generated in all the departments such as Cathlab, CCU, Medium Care, Thoracic surgery clinic and the outpatient clinic. Other clinical applications consist of waiting lists for thoracic surgery, coronary angioplasty and heart transplantation as well as the weekly operation schedules. Furthermore, clinical data are entered at the holter, echo and stress echo department and at the nuclear scan department. TUS is available 24-hours a day, 7 days a week. A journal-based back-up system is running online. In case of a fatal (disk) error, the back up can be in the production within minutes without loss of data.

The current TUS configuration consists of a network of PC's (Figure 1). Two systems are used to handle the CPU of the end-users. The configuration includes two identical database systems (a production and a back-up system) and is used for storage of all data. Furthermore, the TUS configuration includes one system for research applications. Another 2 systems are used for the communication with Windows.

3. Gateway

In order to communicate between MUMPS and Delphi a special gateway was developed. The goal of this gateway was to send data in both directions. For

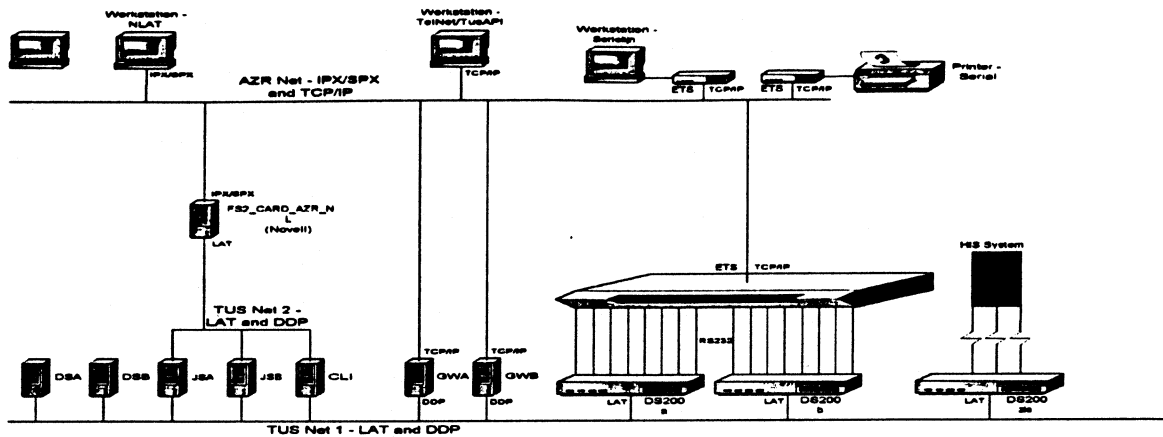


Figure 1. TUS configuration

reasons of central storage it was decided that the data dictionary and the database should be located in the same directory. For the structure of the database we have chosen for our locally used CLINT data management system, which is especially used for research applications [5]. CLINT has extensive query and statistical tools as well as import- and export facilities to the statistical packages.

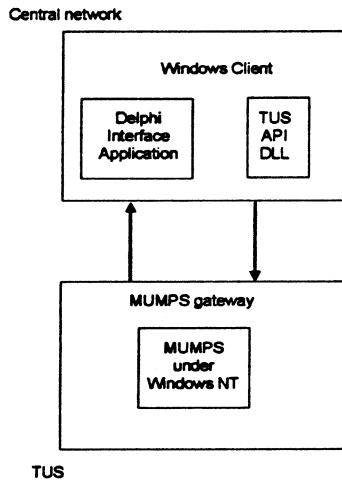


Figure 2. Gateway

The gateway consists of 2 parts: the MUMPS server/client program TCPTUS and a Windows DLL TUS-API. TCPTUS consists of a server part and a client part (Figure 2). The server part is responsible for the initial connection with Windows by making a connection with the server and starting a TCPTUS client. This last program handles the further connection with Windows. This TCPTUS client program includes the processing of the commands given by the user and call of the programs. DLL TUS-API is a collection of functions, which handles

the communication at the Windows part. This program is written in MS visual C++.

The ultimate goal of the gateway was to establish such a dynamic general Delphi-MUMPS interface that it would be completely table-driven and thus, useful for other applications. To accomplish this, a protocol was needed which included all necessary steps and it was needed that all kind of data should be send and/or retrieved to and from Delphi and MUMPS. The following types of data should be retrieved from the MUMPS machine and send to Delphi: the name and address of the patient and his general practitioner. Furthermore, previous written letters must be send to the Delphi machine. From the Delphi machine the following tools must be available: sending new and retrieving previous entered coded data, and sending instructions to generate the preliminary letter and to let a MUMPS program to print the edited final version of the letter. Most interface routines are named in the Table.

Table. Interface routines

GETDIC	get dictionary
GETDATA	get coded data
GETPAT	get patient's name & address
GETGP	get general practitioner's name & address
GETLAB	get laboratory data
GETDATE	get date(s) of existing letter(s)
GETLETTER	get existing discharge letter
GETHOSP	get name and address of referring hospital
GETCLIN	get name of the attending cardiologist

SENDDATA send coded data
 SENDLETTER send discharge letter

GENLETTER give instruction to MUMPS to generate the preliminary discharge letter
 PRNTLETTER give instruction to MUMPS to print letter

GET= getting data from the MUMPS database to Delphi
 SEND= send data from Delphi to the MUMPS database

4. Data entry

The data entry programs were developed in Delphi. After entering the patient's hospital number or (part) of the name and birth date of the patient, a connection is made with TUS and all relevant data including previous admissions are displayed on the screen. Then, a new data entry session can be started for a new admission, or already existing data can be displayed or modified. An example of part of the data entry screen is displayed in Figure 3.

The data dictionary is fully based on the CLINT rules. Distinction is made between several types of data, such as categorical, continuous, alphanumeric, date, clock time and boolean. The new dictionary did not differ significantly from the previous dictionary and most of it could be left unchanged. Only a small set of only the most essential data was collected. In total, about 30 variables were collected including patient history, risk factors, diagnosis and treatment. If necessary, the lab data could automatically be retrieved from HIS and imported in the discharge letter.

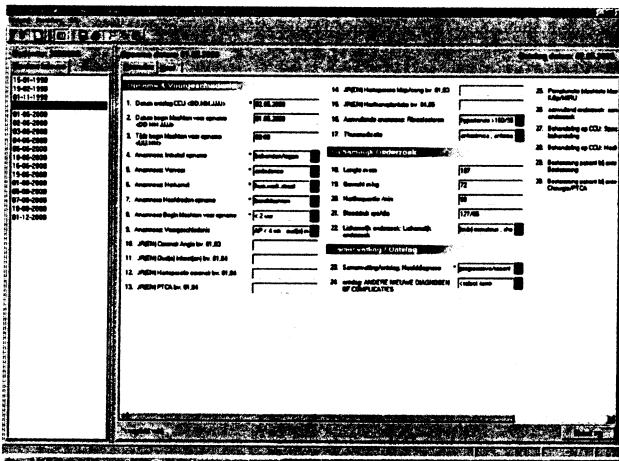







Figure 3. Part of the data entry screen

5. Discharge letter

In the previous version all activities started only just before patient's discharge. With the new release the attending physician already starts to enter data directly after patient's admission. When all coded data are entered, a preliminary discharge letter is automatically generated. The envelope window contains the name and address of the general practitioner. The first sentence consists of the name of the patient, the dates of admission and discharge plus the diagnosis. If a previous letter exists the history paragraph of that letter is automatically copied and paste in the new letter. Such history paragraph can be very extensive and a lot of time can be saved. Furthermore, the physical examination paragraph containing length, weight, blood pressure and heart rate is

automatically generated. In a special window the address of the referring hospital can be retrieved from a central database. Automatically, a copy of the letter is generated to be send to that hospital. After a preliminary letter is generated, it is displayed on the screen. An important condition was the use of MS-Office Word (Figure 4). However, another restriction was that all letters should be saved together with all other clinical letters in the central Mumps database. Furthermore, in the Thoraxcenter a standard layout is used for all patient letters. Especially, we did not want to risk that the letters are saved on local disks and printed locally and so lost for the central database. In order to achieve this, we decided that a MUMPS program should print the discharge letters in order to make it impossible to print the letter locally without saving to the central database. This approach allowed us to use the departmental standard layout with a standardized heading, including specific CCU information such as telephone number and fax number, and name of the head of the CCU. Furthermore, we were able to use our standard left margin, with all relevant names and telephone numbers of all subdepartments of our cardiology department. For all these reasons, we did not decide for MS-Word, because it would be an enormous task to eliminate most of the Word features. An elegant solution was the use of the Delphi editor. This Delphi editor works the other way around. It is a so-called WYSIWYG (What You see What You Get) editor. The source codes are hidden behind icons, which are by default not shown. We have made visible only the following icons:  generate preliminary discharge letter,  saving of the letter to the MUMPS database,  copy and cut,  copy and  paste, and an icon to give MUMPS instruction to print the letter.

6. Implementation

Because we dealt with a busy intensive care ward, the software has been extensively been tested before releasing. Especially, the gateway had our special concern and therefore, special simulation programs were developed to test this. The program was also running similar on different Windows machines to test its multi-user function. Only when the gateway was 100% free of bugs, the program was released in May 2000. No learning period was needed. We only draw the attention of one of resident's once that the new program was released and noticed him the location of the icon on the screen. That was the only introduction of the program. Furthermore, extensive HELP functions were embedded on every level of the program. The system turned out to be accepted without any problems and no gateway problems were reported.

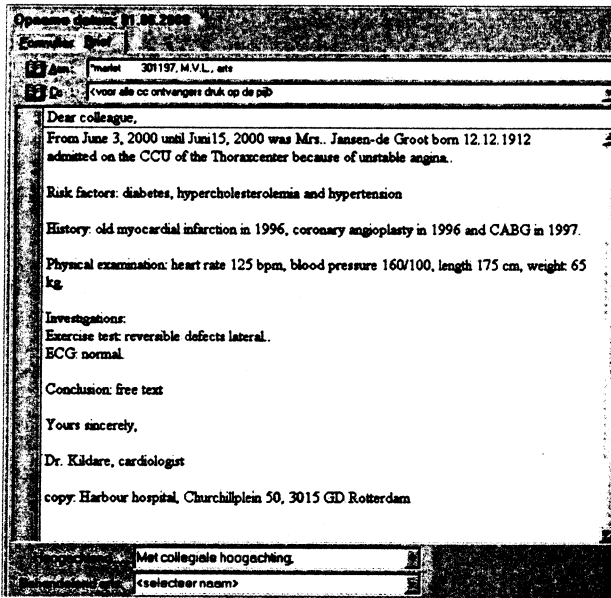


Figure 4. Example of a patient discharge letter

7. Results

The months previous to the moment that the new module has been operational (May 2000), the quality of the database deteriorated rapidly and we were glad that we were able to stop this negative process. In the year following, 950 patients were admitted to the eight-bed CCU. Discharge letters were generated in 97% of the patients. Most letters were generated within 10-15 minutes. Most of the time was needed for the free text conclusion remarks in the letter. To our knowledge no gateway problems occurred. The upgrading of the CCU application into the Windows world proved to be a great improvement over earlier VT-100 terminal based versions. We experienced that most of the clinicians, most cardiology or internal medicine residents, were already familiar with the Windows environment and did not need any introduction to the new CCU application. The most important administrative task left is that of checking that all patients are indeed entered into the computer system. Last but not least, we have assured the continuation of reliable data from the CCU to be retrieved by management, researchers and epidemiologists.

8. Conclusions

The software has replaced the previous one successfully in the beginning of 2000 and the reactions of the users are positive. The application has been developed in such way that it can, and is, easily been used for upgrading other applications. The combination of coded information and automatic generation, which proved to be powerful 20 years ago, still turned out to be a modern and powerful tool in this new millennium.

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