Software for Acquisition of Exercise Test Database

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Abstract

The purpose of this project was to design and implement software that will provide the ability to collate all exercise ECG test patient information to a database. Software was meant to reduce the workload of nurses and doctors and decrease amount of errors in information. In addition to which the software was meant to replace the manually written paper form with a printed version from the application. The automation and calculation components will speed up the work of nurses and doctors and also helps doctors when making diagnoses of the patients. The development process was done in close collaboration with the personnel of Tampere University Hospital. This guarantied that the implementation of the software to hospital environment was easy to complete. Software has been in use since October 2000 and there has been approximately 1000 patients tested with the software.

1. Introduction

The goal of the project, where this application was developed, was to gather all exercise ECG measurements (approximately 3000 patients) made in the Tampere University Hospital (TUH) clinical physiology unit during years 2001-2002 with all the background information from patients to a single database for research purposes. ECG signals will be saved in raw format, so different kind of signal processing algorithms can be researched with these subjects. ST/HR hysteresis has been one main area of the research projects in Ragnar Granit Institute (RGI) and has produced several articles. One main research area in RGI exercise ECG leads [1] and ECG parameters in detection of CAD[2]. One of the main goals was to validate method for adjustment of ST segment to heart rate (HR), ST/HR hysteresis, in different population and for this there had to be extensive amount of patient data available for research purposes. With the aid of the database it will also be possible to analyse patients' characteristics and also use it in statistical purposes. Components of this project are shown in figure 1. This article describes the software that was developed for gathering all exercise test patient information to the database

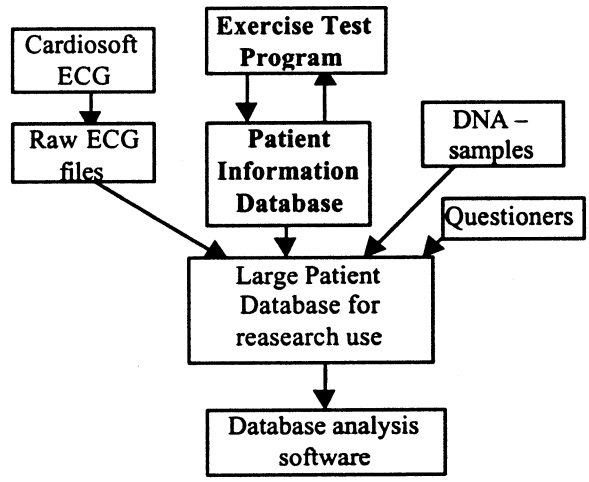

Figure 1. The components of the research project. The software for gathering exercise test information is shown in bold letters.

The gathering of the database containing patient information was launched in the beginning of October 2000. On September 2001 there has been added approximately 1000 patients to database. The gathering of raw ECG measurements started on January 2001. On the August there has been gathered 12-lead ECG signals from approximately 800 patients.

End of the year 2001 there also will be 14-lead ECG data gathered. There will also be DNA samples added to the database and questioners filled by the patients. Questioners involve information about the patients' manner for living. With this database it is possible to perform research and development on ECG analysis. The database enables also easy and fast comparison of ECG parameters and other stored diagnostic variables.

2. Program description

The program was constructed with Visual Basic 6.0 and database format is Microsoft Access. The developed program runs in Windows (95, 98, NT) operating system.

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Computers in Cardiology 2001;28:565-568.

There are two different language versions made from the program one in Finnish and other in English.

The design and development work was carried out in close co-operation with nurses, doctors and other hospital personnel. There were several occasions where nurses or doctors put forward requirements that the application was meant to satisfy. The program had to work in conjunction with, but without any influence or interference to the GE Marquette-Hellige ECG measurement software used by TUH.

This program can be described as an intelligent graphical interface for the database. The 'intelligence' stems from the calculation components included in the program, and the ability of the program to automatically respond to user actions. The program had to be very easy to use, reliable in all situations, and it should make the nurses' and doctors' work easier to complete. The goal was also to replace the manually written paper form used by the personnel with the designed program and the printed form for use of hospital procedures.

Use of the application was closely matched to the procedure used in the exercise test. Application design involved participation into several exercise tests. This helped to understood the requirements for the application.

The application operates on top of measurement software and, thus gives users the ability to enter information easily during the test. Because the program can be used in different environments, it's not dependent of any software.

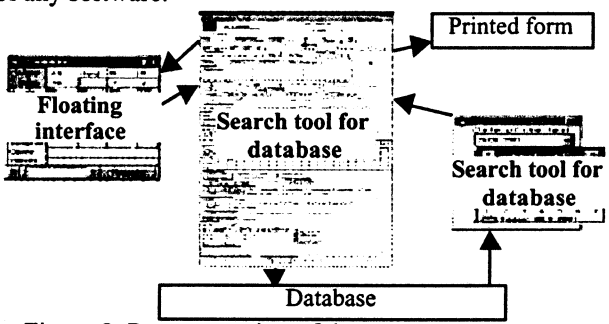

Figure 2. Representation of the program structure.

The program includes following components; main interface, floating interface (on top of the measuring software), database, and search tool for database (figure 2). Arrows in Figure 2 shows how the information is transferred between these components.

All the information is written in main interface or in floating interface. Floating interface is used when there are ECG signals shown on the ECG recording software and doctor has to monitor those.

All the information can be printed out in a paper form. Same time the patient information is saved to database. User can afterwards display saved patient information with search tool.

3. Application in standard procedure

The nurse will start the application (figure 3), before the exercise test begins. The nurse enters all the proper information about the patient to correct fields. The program helps the procedure by automatically entering the time and the date of the exercise test, calculating patient's age, value for body mass index (BMI), waist and hip relation and defines the patient's gender. Application calculates estimations for maximum heart rate, peak expiratory flow (PEF) [2], mean workload attained during the last four minutes ($W_{last4'}$) [3] and hypothetical maximal workload sustainable for six minutes ($W_{max6'}$)[3]. Calculations are made based on patient's identity number, weight, height and circumference of the hip and waist inputted by user.

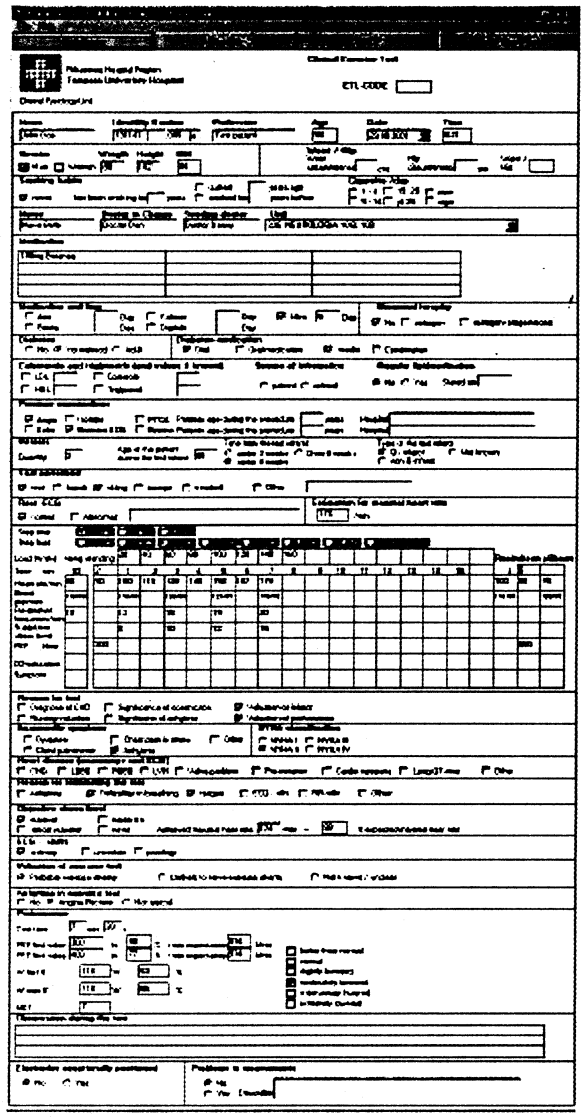

Figure 3. The main interface of software.

When the test has progressed into the stage where the first ECG recordings are made, the nurse will start the

program, which measures ECG. The main interface disappears and shows a small floating table (Figure 4).

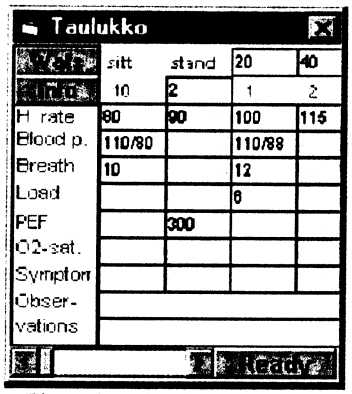

Figure 4. Floating interface.

The table will then remain on top, even if the user is operating in the ECG measuring program. This allows the user to input values, such as HR and blood pressure, and at the same time to monitor the ECG signal. Also it is convenient for the doctor to monitor the patient's behaviour when it is possible same time to see changes in inputted values.

Floating interface and the main interface are connected to each others, so when user adds values to first one it is showed also in second one.

After the exercise test doctor fills up the rest of the fields. Based on the values that were entered on the form, the application calculates characteristics that describe the performance of the patient. These values are the maximum heart rate percentage from the estimated maximum, values for PEF, $W_{last4'}$ and $W_{max6'}$ and their percentage from the estimation. Based on these values and the printed ECG signal, the doctor can give immediate feedback about the test to the patient.

When all the necessary entries have been made, the user can print the form. The application simultaneously saves all the information to the database.

Afterwards it is possible to search the patient information from the database. User can choose the date when the patient has been in the test and application shows all these patients. Stored patient information appears on the form after selection. User can't change these information afterwards.

4. Discussion

Exercise test database program was developed for the TUH. The program enables saving the information from the patient to digital database and also produces a printed form that can be used in normal filing system in Hospitals. Also the database can be sent to some other location in the hospital and doctor can use it easily when making the diagnostics about the patient.

The application was relatively easy to implement into use because the program development process was done in a close collaboration with the personnel of Tampere University hospital. This insured that the application works in the way the nurses and doctors had wanted.

Program doesn't work in any conjunction with other programs, so it can be used in any laboratory where Microsoft Windows (95, 98, NT) operating system is in use. Database, which is developed during the use of this application, can be effectively used in research and statistical purposes.

Application can, as happened in TUH, replace the standard manually written paper form. This will lead to more reliable information, since application checks some of the inputs and calculates automatically some of the characteristic values. The application helps also users work, by giving some information automatically. These automation components make the work for nurse and doctor faster to complete.

Users have been really appreciative of this program, since it assist their routine work and has been really easy to use. Since the program gives a lot of information automatically, program decreases the time spent in one patient. The program was implemented into standard procedure quite fluently. Main reason for this was that the users were able to tell their opinions and most important was that these opinions and requirements were satisfied during the development process.

The development of software for database analyses has already started. There will be possibilities to produce statistics about the exercise tests. These can be used for example in hospital own purposes for example to show how many tests have some doctor done in one month.

Also the analyses software will give researchers great number of ways to view and examine the information about the patients. This will lead to easier and faster ways to make scientific research.

5. Conclusion

The exercise test database program provides effortless way to gather patient information to the database and printout. The software was developed in close co-operation with TUH and it replaced the old manually filled paper form in the standard routine. The database that is gathered during the exercise tests can be used later for research and statistical purposes.

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