DEVELOPMENT OF AN INTEGRATED HOME TELEMEDICINE SYSTEM

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Abstract- **We developed an integrated home telemedicine system equipped with automatic diagnosis and consultation function for patients with chronic disease such as cardiac disease, respiratory disease, diabetes and hypertension. The system measures standard 12ch ECG, respiratory function, blood glucose level and non-invasive blood pressure (NIBP). The measured data were stored on the system and transmitted to the central server everyday through the internet. The system performed automatic diagnosis at every measurement and offered medical consultation to the patient. If there was any abnormality in the diagnostic result, the system gave a real-time alarm to the healthcare center for adequate teleconsultation or medical service. We have installed the developed system on an apartment for the performance evaluation and confirmed the possibility of the system as an effective tool for the telemedicine.**

Keywords –**Telemedicine, e-healthcare, ECG, spirometer, blood glucose, blood pressure**

I. INTRODUCTION

Telemedicine has received continued attention because it is recognized as a way for the higher quality of life and the reduction of medical expenditure. In previous research, most of intelligent works were centralized at healthcare center and the function of telemedicine terminal device was mainly focused on the acquisition and transmission of physiological data[1-3]. In this case, patient measures one's physiological data and transmits the data to the healthcare center using the telemedicine terminal device. Then, the central server analyzes the data and diagnoses the current state of the patient. And the healthcare center provides an appropriate teleconsultation or medical service if it is needed. But, increasing number of users can cause an overload on network or processing of central server. In this study, an intelligent telemedicine terminal device was developed to reduce the load of central server. The system provides real time analysis of measured data and automated medical consultation to the patient.

II. MATERIALS AND METHODS

A. Design of the system

The system was designed for patients with chronic disease such as cardiac disease, respiratory disease, diabetes and hypertension. It is composed of standard 12ch ECG, spirometry, blood glucose meter and NIBP. Patients can access the system through 320*240 graphic LCD and touch screen. The system was connected to the central server through the internet [fig.1].

B. Measurement and diagnosis

The system offers a convenient way for the measurement by providing graphical instruction at every stage on 320*240 graphic LCD with touch screen. Measured data are analyzed in real time and the diagnostic result is shown on LCD with medical consultation.

ECG

ECG measurement is required for the analysis of cardiac function of patient with chronic heart disease. ECG measurement module of the system was designed to meet the safety specification of IEC 60601-1, IEC 60601-2-25 and performance specification of KS P 1202-7. It acquires standard 12ch ECG data for 10 sec and estimates parameters such as heart rate, PR interval, QRS duration, QT/QTc and P-R-T axes. Then it executes automatic diagnosis for heart disease over 200 cases related to rhythm, hypertrophy, QRS axis, conduction abnormality, myocardial infarction and ST-T abnormality.

Spirometry

Spirometry is required for the analysis of respiratory function of patient with chronic respiratory disease. Spirometry module of the system was designed to meet the safety specification of IEC601-1 and performance specification of KS P 1222. It can examine FVC(forced vital capacity), SVC(slow vital capacity) and MVV(maximum voluntary ventilation) with specified respiration protocol. At every measurement it estimates about 20 parameters related to volume and flow. Then it provides diagnostic results of the respiratory function of patient.

Blood glucose level

Continued measurement of blood glucose level is required for patient with diabetes. Blood glucose meter module of the system was designed to meet the safety specification of IEC601-1 and the measurement error to be within 6.5%. It uses 5μl of capillary blood collected from finger. Measured blood glucose level is shown with the history data in a chart form. The system diagnoses the current state of patient considering patient's history on diabetes and postprandial time.

NIBP

Continued measurement of NIBP is required for patient with hypertension. NIBP measuring module of the system was designed to meet the safety specification of IEC601-1 and performance specification of EN1060, KS P 6012 and

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IEC 601-2-30. And it meets the specification of SP10 recommended by Association for the Advancement of Medical Instrumentation (AAMI). Patient can measure one's blood pressure by wrapping the cuff on left arm. The system measures systolic pressure, diastolic pressure and heart rate. Measured blood pressure is shown with the history data in a chart form. The system diagnoses the current state of patient considering patient's history on blood pressure.

C. Transmission of Collected Data to a Central Server

The measured data were stored on the system and was transmitted to the central server with the diagnostic result everyday. The data size of transmission was 96 kbyte per full measurement of ECG, spirometry, blood glucose level and NIBP.

D. Performance Evaluation

The developed system was installed in an apartment and connected to the central server through the internet. The central server was located at the Medical Electronics Laboratory of Seoul National University Hospital which was 1 km apart from the apartment. Whenever any resident member used the measuring module, the original waveform with diagnostic results were stored on the system and transmitted to the central server everyday. Then medical service team reviewed the transmitted data and offered teleconsultation if needed.

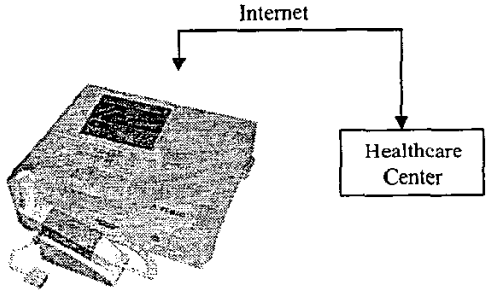

Fig. 1. Developed telemedicine system composed of standard 12ch ECG, spirometry, blood glucose meter and NIBP. It is connected to the central server through the internet.

III. RESULTS

Fig. 2 shows the typical PC monitor display of central server. Data were transmitted without corruption and there existed no problem with the diagnosis of data at the center. The diagnostic result at the center agreed with that of system at the apartment. But, there existed a problem caused by false measurement of ECG due to wrong placement of electrodes. This problem was solved by repeated education to the patient. Patients who have used this system showed the response that they felt the sense of security with the real time diagnostic result and medical consultation function of the system.

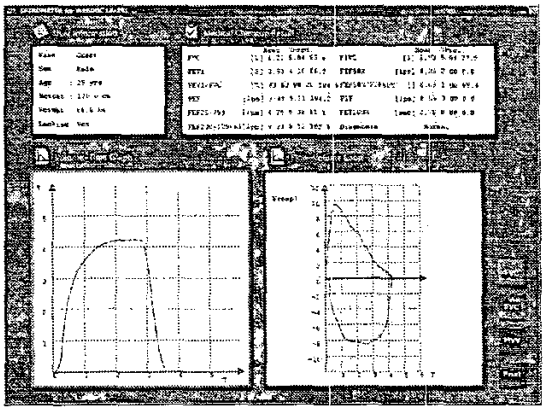

Fig. 2. A typical PC monitor display of central server. It shows the measurement result of spirometry.

IV. CONCLUSION

We developed an integrated home telemedicine system for patients with chronic disease and evaluated its performance. It showed the possibility as an effective tool for telemedicine. We expect this system will contribute to the higher quality of life and reduction of medical expenditure.

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