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User-Friendly Environment for Tele-cardiology in Rural Areas

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The aim of this paper is to present in brief the attempts to develop a user-friendly environment for tele-cardiology consultations in a rural area as part of pilot project 7- BUL/03/001 co-funded by Bulgaria and International Telecommunication Union (ITU), Switzerland. The project is in its first half.

The emphasis on telecardiology (monitoring and transmission of ECG, blood pressure and heart rate data) is due to the fact that cardiovascular diseases are leading cause of death in the country. The examination of vital cardiovascular parameters is the first and that's why the most often used tool providing clues to cardiovascular problems. Precise monitoring of these parameters is a good method to reveal first symptoms of coming myocardial infarct or other cardiovascular complications. Groups that will benefit from telecardiology application are patients suffering from cardiovascular diseases; patients on medications, which may affect the heart and elderly.

Introduction

Telecardiology is the practice of cardiology, which utilizes state-of-the-art information and communication technologies [1]. It aims to provide patients with access to specialized healthcare services as well as to increase the quality of their life by reducing the cost of their treatment, reducing the inconvenience of traveling and periods of stay away from home and working environment.

Telecardiology originates almost 35 years ago as a result of the necessity to monitor cardiovascular parameters of first group of patients with implanted pacemakers. This led to the development of first single lead trans-telephonic electrocardiograms. At present, individuals with pacemakers are the largest group receiving telecardiology consultations and continuous monitoring. Further development of all aspects of telecardiology and its worldwide dissemination is on the pipe-line. This is because main target of telecardiology are patients with cardiovascular diseases (CVD) although it is applicable in cases of kidney diseases, pulmonary diseases, abnormal pregnancy, etc. CVD afflict over 60 million people in our continent and are killer number 1 in Europe. Development of all aspects of telecardiology and its wide dissemination is a necessity because CVD diseases are not only the most common chronic diseases in Europe but they are also the most expensive diseases for healthcare providers. Today, it is impossible to list even the most outstanding publications in the area of telecardiology. They are thousands.

The aim of this paper is to present in brief the progress of one specific aspect of ongoing project 7- BUL/03/001 that sought to promote access to basic telecommunications, broadcasting and Internet as tools of development of rural areas. Project partners are Bulgarian Ministry of Transport and Communication, Bulgarian Telecommunication Company, Bulgarian Association of Telecenters, Telemedicine group at Bulgarian Academy of Sciences represented by Solar-Terrestrial Influences Laboratory and ITU. Project objectives are two folded:

(1) In the area of telecommunications - to develop, test and evaluate the effectiveness of a local, packet-based wireless access infrastructure in semi-mountainous rural. These tasks do not concern present paper. As a consequence of fulfillment of telecommunication tasks

(2) A platform for the wide introduction and application of multimedia services such as telemedicine, teleeducation, etc. has to be available. Tele-cardiology is one of project's multimedia applications.

Development of tele-cardiology is essential for our country as cardiovascular diseases were and still are leading cause of dead for all age groups 40 and above. The main challenges are to develop:

1. A user-friendly telecardiology environment (or system) for
2. General practitioners (GPs).

User-friendly system is a system that is easy to learn and easy to use. Certain parameters can be used to judge whether this is the case, i.e.:

- Adequacy – put in another words - only necessary input should be required;
- Easy to learn - manuals and written instructions should be as clear as possible and
- Robustness, i.e. impact of error should be inversely proportional to probability of error.

The decision to concentrate efforts on GPs was based on study of ecology of medical care. Put in another words, on an analyses where do people look for medical help. Despite of the predictions and expectations for seeking care at tertiary level facilities at first place, the dominant numbers revealed that at first place are the visits of primary care levels (GPs). What is more, regardless of some variations, there is a clear overall stability of this trend in Europe and USA, which is almost unchanged for over 40 years [2-4]. Or, if we want to affect outcomes, as we really want to, our strategies should be concerned with where most people are served by the health care system, where there is the greatest potential for contributing to alleviating the burden of disease and human suffering. Understanding and taking into account the ecology of healthcare, pre-defined the choice of primary care level, i.e. GP.

Materials and Methods

Place

The project takes place in Septemvri – a community with total area 349 km^2 and ~30 000 inhabitants, 2 towns and 12 villages most of them with 1000 – 2500 residents. Septemvri community is an ideal representative of rural area with scarcity of public facilities and technical personal, difficult topographical and climatic conditions that make critical demands on equipment plus low level of economic activity based mainly on agriculture, high percentage of

unemployment (>33%), and high calling rates per ordinary telephone line.

Another reason to choose Septemvri is that there is no licensed cardiologist in this region. Cardiologist is visiting the region once a week for 4 hours. Thus, in order to receive an expert opinion, patients have either (a) to wait (sometimes weeks) or (b) to travel minimum 60 or even 100 kilometres to another region. At first glance the second option may be preferable, but let's not forget that most of patient with cardiovascular problems are chronically ill, unemployed or relatively old and for them such travel is enormous obstacle. In addition, the region is semi-mountainous, which makes travels during autumn, winter and spring rather difficult.

Equipment

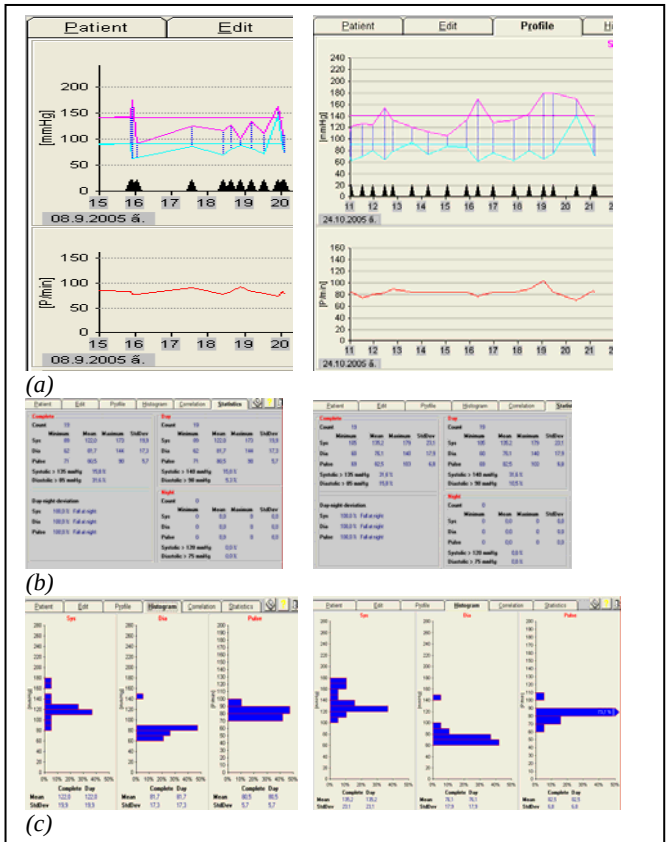
A newly build telecommunication network connects the regional Medical Center and regional Emergency Care Center in town Septemvri with telecenters, GP offices and police stations of two towns and 7 villages. The network is also connected to a specialized tele-server at STIL-BAS, Bulgarian Academy of Sciences, Sofia.

To offer telecardiology service, GPs are supplied with portable blood pressure meters (holters) and portable 4 channel electrocardiographs (ECG holters). The examination of pulse, blood pressure and electrocardiogram are the first and that's why the most often used tools providing clues to cardiovascular problems. Physician can easily detect many heart conditions before symptoms become apparent by measuring pulse, blood pressure and by using an electrocardiogram. That is why the precise monitoring of these parameters is essential for treatment of CVD patients as well as for revealing first symptoms of coming myocardial infarct or other cardiovascular complications.

Blood pressure holters are BOSO TM-2430 PC (fig. 1). They are fully automatic, have measurements range 60 - 290 mmHg for the systolic; and 30 - 195 mmHg for diastolic blood pressure; pulse frequency range - from 20 up to 240 beats per minute; measurement intervals - 1 to 30 per hour and memory capacity - over 200 readings. The devices are battery operated. Their weight, batteries included, is 250 g. The software allows saving patients' data and visualizing and/or printing results both in tabular or graphical format. Only a click is necessary to change the format of data presentation (fig. 2).

The ECG holter is product of SIGNACOR Ltd, Bulgaria (Fig. 3 a). It is also fully automatic, has 4 MB flash memory, where up to 27 hours ECG records of 4 independent channels may be saved. The holter has a sampling rate 200 s/sec, 50 Hz reject digital filter and weights less than 250 g with batteries and patient cable. Unavoidable self-diagnostic tests for batteries' power and electrodes' impedance are additional bonuses and part of standard monitoring procedure. The software is in Bulgarian, which is an extra benefit and helps GPs partially to overcome the psychological barrier of using new, non-standard equipment. The software allows continuous real-time analyzes of rhythm and morphological changes in all available independent ECG leads; ST measurements; 12 Standard ECG leads reconstruction; automatic marking each time when the ECG differs from the patient's typical ECG; computing every minute averaged heart rate, RR-irregularity, QRS-width and ST deviations; automatic storage of all computed data; statistics of abnormal QRS complexes; measurements of heart rate variability; on-line monitoring on the screen at any time during the recording session; built-in editor to enter remarks and final conclusions; possibility to mark certain ECG episodes and save them as a compressed file; possibility to display and print any ECG episode; generation of summary reports, histograms, tables that may be printed (Fig. 3 b).

Fig. 1 BOSO TM-2430 PC



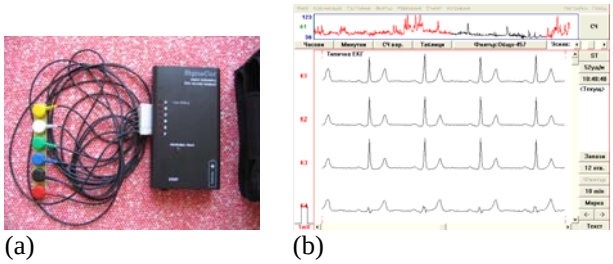
(a)

(b)

(c)

Fig. 2 Blood pressure monitoring: (a) graphical presentations of 4 and 10 hours records; (b) tabular and (c) histograms of the same data

Using available devices, GPs may monitor and analyze cardiovascular data and control the prescribed medication. When the GP is not skilled enough or feels necessity to consult cardiologist, he/she has the chance to do this via his



(a) (b)

Fig. 3 ECG holter (a) and record (b)

own computer or via local telecenter and to transfer abnormal parts of ECG to Septemvri Medical Centre. The feedback helps proper and fast treatment and follow-up of patients. The inclusion of this center in the net is significant achievement as this is the place where once a week the cardiologist delivers consultations. Thus local medical personnel, licensed cardiologist and patients are included in the process of tele-consultations, tele-diagnostics and tele-treatment. If and when necessary, available information may be transferred to local Emergency Medical Center, too. One additional benefit of the ECG holter software is the fact the ECG may be saved as a picture file and transfer for consultations to cardiologist who do not have the software.

It is a decision of local medical staff to whom from all patients to offer the possibility for long term monitoring and further tele-consultations.

Results

The telecommunication network is ready. Local telecenters and GPs offices have been equipped. GPs lacking computer skills were trained in basic computer abilities. At present they undergo training for using electronic mails, IP telephones and video connections.

After revealing the low level of computer skills of local GPs we gave up the idea to organize group training courses for the proper usage of blood pressure and ECG holter and start individual training of both GPs and nurses, if there are any in some of the villages. Individual trainings were combined with practical demonstrations.

Realistic in our expectations, we were prepared to face significant problems during the realization of tele-cardiology applications. Some of the problems so far are:

- Personal negative attitude or at least suspicion towards telemedicine /e-health applications and especially to distant consultations / treatment as compared to face-to-face service. This has nothing to do with GPs age, irrespective of our preliminary expectations that those GPs that are 45 yrs old and above will be more rigid in accepting new technology.
- Lack of technical experience of both medical staff and patients causes serious problems both in usage of devices and data collection, analyzes and transfer of records for consultations. Despite of the fact that most of GPs have experience with standard electrocardiographs the use of PC connected devices turned out to be a serious problem. Starting the holters, filling up patients' personal data and medical history and especially downloading results is a serious emotional obstacle for many GPs. This is one serious challenge to be overcome within next months.
- Ethical and financial problems.
- In addition, during virtual consultations people lack the nonverbal communication channel to which they are so accustomed in face-to-face communication. This is partially overcome by application of IP telephones and video connections. Thus in the process of teleconsultations, if and when necessary, colleagues communicate via IP telephones or video channels.

The above mentioned problems forced us to re-arrange the time scheme of the project, to extend the preliminary phase and prolong project duration. Nevertheless partners believe that final outcomes will compensate all difficulties as groups that will benefit from telecardiology application are not only chronic cardiovascular patients but also patients on medications, which may affect the heart, pregnant women, patients suffering from kidney diseases, pulmonary hypertension, anorexia nervosa, narcolepsy and elderly. The latter group is especially important as congestive heart failure, is the single most frequent cause of hospitalization for people aged 65 years or older and because the percentage of elderly in our population is rapidly increasing.

As mentioned earlier the network includes one more tele-server at STIL-BAS that has to be under the supervision of Telemedicine Group and have to serve as methodological supervisor to both local GPs and Septemvri Medical Centre staff in the process of development and deployment of all telemedicine activities, i.e. from correct use of tele-cardiology equipment to precise application of software and data storage and correct fill in of electronic patient databases. Telemedicine group has also the following tasks:

(1) To study and analyze medical effect of tele-cardiology service in terms of time of treatment, time for receiving consultations, etc;

(2) To try and estimate the financial effect of telecardiology applications compared to normal face-to-face visits;

(3) To assess the psychological effect of telecardiology, i.e. to rate the satisfaction of the medical staff applying tele-consultations, analyzing tele-healthcare acceptance from the point of view of patients and relatives, etc.

The above mentioned analyses will be made probably at the end of 2006 when big database will be collected.

Having in mind the problems faced so far and fears of local GPs, since fall 2005, one more service is introduced – Internet psychology counselling or tele-psychology consultations.

In Addition: Tele-psychology

The reasons to introduce tele-psychology are two folded:

- To offer support to local medical stuff as well as
- To consult local people when dealing with problems with education and upbringing such as behavioural problems, difficulties in education, communication problems parents – children, pupils – teachers, problems with cognitive, emotional and personal development, various kinds of communication problems, coping with stress at school and in the office, etc.

Especially important is the impact that tele-psychology counselling may have on treatment of CVD patients. Specific efforts are dedicated for distant treatment of depressive conditions in CVD patients as depression is common among these patients.

The reviews of research on the relationship of depression to CVD found that researchers consistently report major depression prevalence rates in the 15% - 23% range. Studies that report sub-syndromal symptoms of depression have also found higher rates. Thus the proportion of CVD patients suffering from serious symptoms of depression is in the range 20% - 50% [5 - 8]. While serious symptoms of depression are commonly found in CVD patients, depression is rarely diagnosed by either primary care physicians or cardiologists, and when it is diagnosed, it is apparently often left untreated. A significant first step in the treatment of patients with CVD

is increasing the ability and willingness of GPs and/or cardiologists to detect and treat depression. Finally, it is important to note that these symptoms do not refer to the transitory feelings of depression normally associated with chronic or potentially life-threatening illness. Rather, they are persisting cognitive and somatic conditions having a powerful impact upon cardiac prognosis.

Having in mind this, the inclusion of tele-psychology counseling specialized in treatment of depressions, may have an enormous impact on successful fulfillment of the project. In addition, the active inclusion of specialist in depression will be additional benefit and impact the creation of user-friendly tele-cardiology environment for GPs. What is more, randomised controlled trials of psychological interventions for depression in CVD patients are needed to investigate the impact of such interventions on depression, quality of life, behavioural CVD risk factors, cardiac morbidity, health economics and mortality, given the paucity of such trials in this area and the increasing prevalence of heart failure.

In conclusion

This project is the first attempt to apply telecardiology services in rural area. The expected outcomes are:

- Cheap tele-health service suitable to improve the quality of health care and health monitoring of patients due to faster diagnosis and treatment, reduced delay in giving medicines and performing scheduled actions, avoidance of inconvenience of travelling, highly qualified distant consultations, psychological comfort, etc;
- Development of advanced interactive environment for medical staff due to improved consultation and follow-up, more time available to devote to patients, reduction of waiting lists, travels and lost of time, reduction of stress and time pressure, etc;
- New knowledge concerning the acceptance of intelligent environment by patients and the influence of e-health service on life satisfaction and on satisfaction from virtual health supervision;
- Significant reduction of the part of health care budgets dedicated to home health visits.

Acknowledgement

The present study is conducted and will continue within next years in the context of the project 7- BUL/03/001 co-funded by Bulgaria and International Telecommunication Union (ITU), Switzerland and coordinated by Bulgarian Ministry of Transport and Communications.

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