

Portable Health Monitoring – Bridging Long Distances Between Patient and Specialist

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Abstract— The percentage of elderly is steadily increasing in the European population. This demographic trend puts a high strain on the limited resources of the healthcare, resulting in a need for complementary work procedures. A portable health monitoring equipment, for distance and home healthcare, that measure physiological parameters was developed. The measured parameters are stored in a central database and can be viewed and evaluated immediately by a doctor at the hospital. It is a mobile concept for the healthcare personnel that bridges the long distances between the specialist and the patient. Standard medical measurement devices, which are familiar to the healthcare staff, are combined with wireless and mobile communication in a medical briefcase. Measurable parameters are blood pressure, ECG, glucose, hemoglobin, medication, blood oxygen saturation, pulse, spirometry, warfarin, and weight. The patients that are well enough can do the measurements by themselves, which gives the doctor a reliable history of frequent measurements as a basis for follow up of treatments. The equipment is in use in healthcare centers and home healthcare. The concept of combining off the shelf devices allows for easy addition of more parameters, thus widening the coverage of monitored diseases and treatment.

I. INTRODUCTION

The percentage of elderly is steadily increasing in the European population. In 1975, 12.7% of the population was over 65 years of age, in the year 2000 it had risen to 15.7%, and estimations show that in the year 2025 it will be close to 23%. This demographic trend puts a high strain on the limited resources of the healthcare, resulting in a need for complementary work procedures. Today, as much as 70 % of the healthcare costs originate from this part of the population. Home healthcare and electronic venues are prioritized areas both in Sweden as well as within the European Union. [1]

Checkup is a portable health monitoring equipment that measure valuable physiological parameters that can be viewed and evaluated immediately by a doctor at the hospital. It is a mobile concept for health care personnel in the distance and home health care that bridge the long distances between specialist and patient so that unnecessary travel is reduced. Some patients are well enough to do the measurements by themselves during a period of time which will give the doctor a reliable history of frequent measurements as a basis for decision.

Checkup was developed by Explizit AB which is a company located in Skellefteå, in the north of Sweden. Explizit's vision with Checkup is to reduce unnecessary hospital visits for the patient and to reduce the cost for the healthcare. Since the start of the development of Checkup, Explizit has been incorporated into Argentum Group.

II. SYSTEM DESIGN

Checkup consists of a briefcase with medical measurement devices for measuring physiological parameters, a database in which the parameters are stored, and a website where healthcare staff can view and evaluate the parameters (Fig. 1).

The briefcase is a standard briefcase of carry on size, which can hold a number of medical measurement devices. A Linux based, wireless access point, is incorporated in the briefcase. The wireless access point is the core of the system and handles the communication with the measuring devices, connects a measurement with an anonymous serial number read from a patient card, and takes care of transporting the measurement to the central database storage. A power adaptor is connected to a wall socket and within a minute the system is ready to be used.

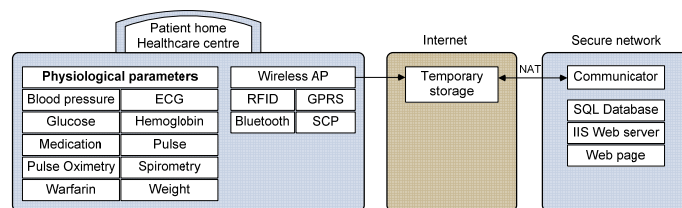


Figure 1. Checkup system overview.

To conform to laws regulating how patient specific data can be handled and transported the measurements can not be associated with patient information at this stage in the system. Therefore, each patient has a card for identification. This card is a RFID card which is placed in a pocket on the outside of the briefcase. When the wireless access point receives a measurement from a measuring device, the anonymous serial number on the RFID card is read and connected with the measurement. Only when the measurement reaches the database in the central storage, inside the firewalls of the

organization, is the measurement connected to a specific patient. This provides for full patient secrecy.

The medical measurement devices are off the shelf devices, well known to the healthcare staff. Some are natively equipped with a Bluetooth interface and devices without Bluetooth interface are modified to enable wireless communication with the access point. Today the measurable parameters are blood pressure, ECG, glucose, hemoglobin, medication, blood oxygen saturation, pulse, spirometry, warfarin, and weight. By using off the shelf devices, with embedded Bluetooth communication or modifying those without, we make it easy to add more parameters and thus widening the coverage of monitored diseases and treatment.

The wireless access point has a mobile network modem and utilizes GPRS for communication of the measurements. When a GPRS connection is established a Ssh tunnel is created to a server in the public domain where the measurements are temporarily stored. Each measurement is transferred with SCP as soon as it is completed. If for some reason a GRPS connection could not be established the measurement is stored locally on the wireless access point until a connection is established.

A server, behind the organization firewall, connects to the server on the public domain to transfer the measurements to the central storage. At this point, inside the firewall, the measurement is connected to a specific patient. The database server is SQL Server 2005.

A web page (Fig. 2) presents the patients and their measurements to healthcare staff for follow up. Measured values are presented in graphs which simplifies identification of trends and determination of the effects of subscribed medication. Limits for specific parameters can be set for each patient and the system will issue a warning when the limits are exceeded.

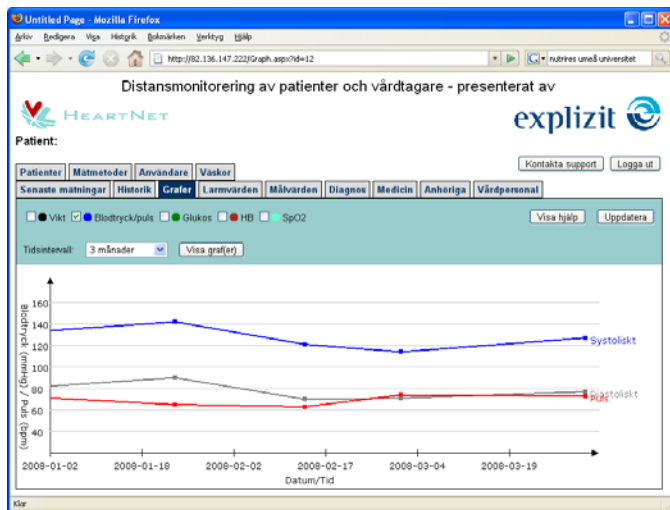


Figure 2. Web page displaying monitored parameters in a graph. (Patient id and name has been removed in the picture)

A. Evaluation

Checkup is in use and is being evaluated in a number of healthcare centers, elderly centers and patient homes.

When used in patient homes the briefcase is stationed in the patient home for a short period of time, often two to three weeks, for follow up of treatment. In elderly centers the nursing staff performs the measurements on the patients.

In one healthcare centre in Skellefteå, Sweden, the patients perform measurements of blood pressure and pulse by themselves. At arrival the patients check out their personal RFID card from the reception and proceed to a room where the briefcase is located to take their own blood pressure and pulse. The patients are educated in how to perform the measurements in the best way.

III. DISCUSSION AND CONCLUSION

Checkup is a well working system for portable health monitoring. The system allows for monitoring of valuable physiological parameters which can immediately be viewed and evaluated by a doctor at the hospital.

The size and weight of the briefcase has been one aspect of the system that users have commented on. The briefcase is of carry on size and has wheels so that it can be rolled. This might work out well in situations where the location of the briefcase is not changed on a day to day basis, for example a healthcare center. However, for healthcare teams which visits several patients in their homes during a day this might be an issue. It is not unlikely that the team already has a lot of medical equipment to carry along making the introduction of another system harder. Development of a backpack in an effort to make the Checkup system more portable is in progress. The backpack will be lighter than the briefcase and hopefully this will be a vital improvement in the portability factor.

In the future a Checkup Light is a vision we work with. Today more and more people are willing to buy their own measurement devices to keep track of the health status. Almost everybody also owns an own mobile cell phone. With a software package to download from the internet and install on the phone, you have everything needed for a system which works exactly the same as Checkup.

B. Conclusion

We believe that Checkup is a system that can be highly valuable for the healthcare. This is achieved with reduction of used resources, time, and money and improvement of the quality of the healthcare due to an increased number of measurements over time. Travel for patients can be reduced if measurements can be performed at home. Healthcare staff can be relieved of a heavy workload when the patients can perform the measurements themselves.

REFERENCES

- [1] European Commission (2005), Green Paper – Confronting demographic change: a new solidarity between the generations. COM(2005) 94. Brussels