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Telemedicine devices in internal medicine and neurology

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Abstract

Introduction

Monitoring of patients systems remotely with feedback send to physician and patient could be applied in many fields of medicine. Telemedicine could presumably lead to improvement of patients care and treatment both in chronic conditions and in emergency, lowering demands on costs and time resources.

Material and methods

Articles in the EBSCO database have been analyzed using keywords: Telemedicine devices, telemedicine devices, neurology, cardiology. The available literature is subjectively selected. Then, the newest version of every paper was searched for.

Results

The most important and popular types of devices used in telemedicine in internal medicine and neurology were presented.

Conclusions

The development of devices in telemedicine results in an increase in effectiveness in the diagnosis and treatment of patients. In addition, remote access to the results of measurements made by these devices affects the quality of treatment.

Key words: telemedicine devices, cardiology, neurology, telemedicine

Introduction

Monitoring devices have different designs and functions and, depending on their purpose, they can monitor various clinical parameters. The device communicates wirelessly with other devices using various communication protocols depending on energy demand, range or interoperability. In practice, solutions such as Bluetooth, ZigBee and Wibree are used. The clinical status of patients can be monitored remotely based on the parameters recorded by external and internal sensors. The data recorded by external sensors include [1, 2]:

- heart rate measurement (ECG)
- breathing frequency
- blood pressure
- body temperature
- spirometry
- blood glucose levels
- body weight
- saturation of blood with oxygen
- number of steps (pedometer)
- remote monitoring of drug intake is also possible (drug dispenser)

Internal (implantable) devices include [1,2]:

- cardiostimulators (pacemakers),
- cardiovertery-defiblators (cardiac resynchronization therapy)

The transmission of information in telemedicine systems takes place in two phases, which is related to the overall structure of these systems. In the first phase, information is transmitted in the patient's environment. This is a short distance transmission of information. It concerns the transmission of information received directly from the patient's body using appropriate sensors or transducers, as well as information generated by the patient in the form of additional messages or parametric data. This information is transmitted to the data integrator module, which is carried by the patient. The data integrator module initially processes the information and then sends it wirelessly directly or indirectly through an additional communicator module (smartphone, computer) to a long distance transmission system (e.g. Internet).

The second phase of information transmission in telemedicine systems involves the transmission of information over long distances to the monitoring and supervision center or the doctor treating the patient. Information used for medical supervision and diagnosis is sent from the patient to the doctor, and in the opposite direction - the doctor's directions and recommendations or additional doctor's queries aimed at increasing the effectiveness of supervision and medical care.

Telemedicine devices in internal medicine

Blood glucose measurement – glucometers

There are many different types of glucometers on the market. However, only some are adapted for use in remote monitoring systems. Only hydrometers equipped with appropriate interfaces for wireless sending of measurement results to the monitoring center are suitable for this purpose. The transmission of results is usually carried out using a computer intermediary device, which can be e.g. a smart phone or computer.

A glucometer is a device used for quick and accurate measurement and current reading of blood sugar levels, using special test strips with embedded electrodes or a chemical reagent. A drop of blood (obtained from the earlobe, finger or forearm puncture) is applied to a small test strip, which is then inserted into the meter. The meter calculates and displays your blood glucose. Glucometers are commonly used by diabetics to self-control blood sugar levels during treatment [1, 3].

Roche Accu-Chek Instant from Roche Diagnostics are widespread. They used an amperometric method of measuring glucose. The disadvantage of commonly used glucometers is the invasive method of taking the measurement, because the droplet of blood that is placed on the test strip is obtained by puncture. Non-invasive glucometers do not have this inconvenience, which, however, do not guarantee such high measurement accuracy as invasive glucometers. Non-invasive glucometers are particularly suitable for long-term monitoring of blood sugar levels in remote monitoring and medical supervision systems [1, 3].

Fig. 1. Accu-Chek Instant glucometer from Roche Diagnostics [3]

Advantages and functionality of the Accu-Chek Instant meter [3]:

- Measurement result in less than 4 seconds
- Easy navigation with one button
- Measurement precision in accordance with EN ISO 15197: 2015
- Connect to a smartphone with an installed application via Bluetooth
- Computer connectivity via USB cable
- Color marking of the result on a 9-point scale
- Backlit LCD display - easy to read result
- Memory capacity - at least 720 glucose results and at least 30 control measurements
- Wide strip capillary - easy absorption of even a small blood sample
- Without coding
- Average values: from the last 7, 30 and 90 days

Telemonitoring of pulmonary disorders

With the help of modern telemedicine tools, we can also monitor sleep breathing disorders, which are a risk factor for cardiovascular diseases. A night interrupted by apneas and / or shortness of breath may cause many adverse effects. The most serious of these include arrhythmias, hypertension, pulmonary hypertension, endothelial dysfunction, metabolic disorders, as well as chronic fatigue and problems with cognitive functions. Portable apparatus for testing for respiratory disorders record, among others movements of the chest and abdomen during breathing, airflow through the airways, dermal oximetry, night motor activity assessment, ECG and sleep monitoring. Some devices allows on performing tests at the patient's home, as well as remote monitoring of recorded parameters and treatment effects. An example of such a solution could be the ResMed Air Solutions integrated healthcare platform [4].

Apnea Link Air is a compact and handy device for home sleep control, integrated with Air View software (this software streamlines the treatment process, enables data sharing on demand one hour after the end of a given therapy session), allowing effective supervision of every stage of the diagnostic process and sharing obtained data with authorized groups of recipients, e.g. doctors.

Fig. 2. Apnea Link Air sleep apnea monitoring system [4]

Telemonitoring of body temperature

An example of Body Temperature Telemonitoring is the TempTraq transducer developed by Blue Spark Technologies Inc. from Cleveland, USA, designed to measure body temperature mainly in children. The TempTraq patch transducer sticks under the child's armpit. The patch is a non-allergenic elastic material in which a temperature sensor with a power supply battery and a Bluetooth wireless transmission system are embedded. The capacity of the power supply battery allows the patch to work for about 24 hours. As a result of temperature measurement, they can be sent wirelessly, e.g. to a smart phone, laptop, and then to physician [5].

Fig. 3. TempTraq patch thermometer [5]

Advantages of the TempTraq plaster thermometer [5]:

- a thin and flexible patch is comfortable to wear and easy to remove
- constant monitoring of the child's body temperature
- lack of adverse effects
- the software can monitor several slices at the same time
- easy data transfer to receiver (physician, caregiver)
- high accuracy of measurements

Disadvantages of the TempTraq plaster thermometer [5]:

- high price compared to traditional thermometers,
- short battery life.

Telemedicine devices in neurology

Remote medical surveillance systems are mainly used to monitor the vital functions of patients at high risk. One of these groups is the group of patients with disorders of the neurological system. EEG devices are one of the groups of devices for monitoring patients with disorders of the neurological system.

An example of such a device is the Mobita 32-Channel Wireless EEG System from Biopac.

This device records high-quality patient EEG data in 32 channels using water electrodes. The system includes [6]:

• Mobita device with a built-in 3D accelerator and a drain channel

• ConfiCap configured to 32-channel EEG

• cap with 32 rings for water-based electrodes

• water-based electrodes

• AcqKnowledge software

The Mobita device is suitable for recording wireless EEG in various branches of medicine, such as psychology and neurology. Mobita can record many different types of signals.

The system can wirelessly send data back to a computer running the AcqKnowledge program for real-time display and signal analysis, or record in local mode for later verification [6].

Fig. 4. Mobita 32-Channel Wireless EEG System from Biopac [6]

Another example of a telemedicine device used in neurology can be the eTNS Monarch device. eTNS Monarch contains a device the size of a mobile phone that sends a low level electrical impulse through a cord to a small patch stuck to the patient's forehead. Therapeutic impulses stimulate the branches of the trigeminal nerve, which activates the nerve pathway to other parts of the brain that are thought to be involved in Attention Deficit Hyperactivity Disorder. Neuroimaging studies have shown that eTNS increases activity in areas of the brain that are known to be important in regulating attention, emotions, and behavior [7].

This device also allows you to collect collected data during your work, and then allows you to send them wirelessly to your computer or directly to the physician.

Fig. 5. eTNS Monarch device [7]

The NS-EEG-D1-W portable hand-held monitor is a telemedicine device that is used at home. This device is suitable for all standard applications of routine EEG testing and long-term EEG monitoring. It registers and then displays the EEG waveform in real time over Wi-Fi and simultaneously saves the measurement results on the memory card [8].

The most important features of the device include [8]:

- portable design
- low energy consumption - it is able to monitor the patient's condition for up to 72 hours using four AA batteries
- supports recording and displaying the EEG waveform in real time via Wi-Fi
- dynamic recording using a Flash memory card
- ability to quickly transfer data - data saved on a Flash memory card can be quickly transferred to a computer via a USB 2.0 / USB 1.1 interface

• optional video system - Record, edit and display video synchronously with EEG signals

Fig. 6. Portable device NS-EEG-D1-W by Neurostyle [8]

Software supporting NS-EEG-D1-W device allows [8]:

• EEG mapping

• EEG trend analysis

• EEG spectral analysis

• brain waves - fast playback and fast positioning function

• automatic recognition of peaks with adjustable peak wave parameters

• the user can view EEG waveforms with various combinations of parameters and filters

• automatically generating reports of various EEG cases

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