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The implantable sensors

Various transducers of non-electrical values to electrical firmly have taken their place in many areas of human knowledge and, more over, in medicine. It is hard to imagine a modern doctor who would not use a huge number of achievements of radio-electronics, microelectronics, metrology and diagnostics.

The sensor is a measurement tool used for signal transformation in a convenient form for transmission, further transformation, processing and (or) keeping, but this form can't be directly perceived. Sensors are widely used in scientific research, testing, quality control, telemetry, automated control systems and in other areas and systems, where it is required to obtain measurement information. [1] Although they are one of the most slowly developing fields of medical electronics and all electronics generally, the overwhelming majority of diagnostic and therapeutic devices and systems contain many different transducers and electrodes, without which the work of the system is unthinkable.

Sensors implantable into the body have become a popular development in bioengineering. Electronics can serve the medicine in different ways. Being attached to the skin external devices monitor temperature, pulse, blood pressure and circulation. This information is very useful during training the athletes, and when integrated under the skin of ordinary people sensors can follow the minimal changes in the patient's body and send a message to the doctor, if something goes wrong.

Nowadays medical chips, which are small sensors implanted under the skin, are already used in the world. The sensor has a protective shell, under which the microcircuits are located. This medical chipis sewn under the skin, using a special

syringe. Also, it can be injected into the muscle of the forearm, right hand or the right hand between the fingers. Supporters of chipping suppose one of the main advantages of this technology is the possibility of fast medical aid to sick people. [2] For example, you can ask any diabetic if he like to pierce a finger daily to measure blood glucose levels, and you will know this is quite unpleasant. Sothe task of creating a painless glucometer an instrument for measuring the glucose level is one of the most important questions in the case of diabetes treatment.

American bioengineering is doing big steps in the fight against diabetes. Recently they have presented a prototype of a wireless glucometer-implant, which may test the level of sugar in the blood of the patient during the year without replacement. If federal public health agencies in the US approve thisinnovation and allow mass production, people with diabetes will have an excellent alternative to the existing glucometer.

The principle of an implant operation is simple. The sensor is implanted under the skin and makes measurements, data is transmitted to an external source (such as a mobile phone or PDA), information processing is carried out and the result is given. Wireless blood glucose meter is compact, has a diameter of 38 mm at a thickness of 16 mm. It aims to change the principle of analysis by eliminating any piercing and pain. Now there are special needle-like glucose sensors that analyze blood on a regular basis. However, these devices still require replacement every 3-7 days.

Scientists have confirmed that the continuous monitoring of glucose levels allows to avoid complications, such as chronic kidney disease, eye and cardiovascular system disorders. The author of the research, bioengineer David Gowe, University of California, San Diego, had already carried out tests on animals and received positive results. Wireless glucose sensor consists of two parts. The first part has a catalyst glucose and oxidase enzyme, and causes the chemical reaction depending on the amount of oxygen that sugar absorbs and the content of the oxygen in the interstitial

fluid under the skin. The second sensor measures the oxygen level on the basis of data from the first sensor and compares with the standard value, thus determining actual content of glucose in blood at a given time. David Gowe announced that he is going to start clinical testing of the implant on humans in the coming months. In case of success this innovation will appear in the free market and will be able to help millions of people with diabetes. [3]

The team of engineers from the Massachusetts Institute of Technology is working on the creation of built-in sensor made of carbon nanotubes. The miniature device can be input under the skin with the injection where it will constantly have monitored the patient's health throughout the whole year. After this period the sensor will have to be replaced. Such devices can perform functions of the whole laboratory: they will constantly measure the blood sugar level, warn of inflammation, of increasing pressure and temperature, and send a signal if concentration of harmful substances such as air pollution, dangerous gases or toxins is increased in the environment.

Sensors of the nanotubes were invented by a chemical engineer at MIT Nicole Iverson. Together with her team she implanted the prototype into the body of the mouse and the published results of the test in the article in the Nature Nanotechnology journal.

Iverson and her colleagues are currently working on a sensor that could be implanted under the skin of diabetic patients to monitor the level of sugar or insulin levels. This eliminates the necessity of taking blood samples for analysis.

Nanotubes, being one of allotropic modifications of carbon can be widely used in medicine because of small size and high sensitivity. This is an ideal material for manufacturing sensors, as they can be made to glow under the infrared light upon contact with certain chemicals. Made of carbon nanotubes sensors also can be applied

to detect other molecules including glucose.

For manufacturing her devices Iverson wrapped carbon nanotubes in the DNA, which susceptible to nitric oxide (NO), that is used by many cells for transmitting signals to each other. Based on this design scientists have created two types of sensors: the first sensor implanted with from the injection is designed for a short-term monitoring of the patient's health (for example, during rehabilitation after surgery), and surgically implanted second sensor is for a long-time monitoring of patients, suffering from cancer, diabetes and immune reactions after implantation of artificial joints. Iverson’s team attached a layer of the polymer to short-time monitoring sensors, that does not allow the nanotubes to stick together with each other, so that the device can easily circulate through the blood stream, and pass through the lungs and the heart, without causing any harm to the body. [4]

To sum up, it should be noted that the sensors are universal devices widely used in medicine, especially for automatic diagnostics. With implantable miniature sensors it is possible to avoid unpleasant daily taking of blood samples in case of diabetics and in addition it may be used for continuous monitoring of patients after surgery or in the case of oncology. Andthis sensors are harmless to the body that is an absolute advantage.

References:

1)https://ru.m.wikipedia.org/wiki/Датчик
2)http://apocalypse.orthodoxy.ru/review/2011_1.htm
3)http://diabetdieta.ru/sovsem-skoro-postoyannyjj-kontr..
4)http://www.vesti.ru/doc.html?id=1150890