

Cardiovascular diseases are the most common cause of deaths in Poland. Such diseases are also the most common reason for the hospitalization. The direct cause of hospital mortality is usually sudden cardiac arrest (SCA). Despite CPR (cardiopulmonary resuscitation) standardization and improvement of vital functions monitoring, SCA in a hospitalized patient is still associated with a poor prognosis. For this reason there is a need to develop systems which are able to generate reports containing: evaluation of the general condition of the patient, suggestions of the most likely causes of the deterioration, suggested tests or urgent procedures.

A retrospective analysis of medical records shows that in many cases previous treatment was suboptimal. More accurate assessment of patients' general condition and optimization of treatment could potentially prevent many deaths. In order to make an objective assessment of the patient's general condition and minimize the risk of SCA, simple scores (such as, for example, Modified Early Warning Score) have been introduced. Such scores are based on the basic parameters of vital functions, such as pulse rate, respiratory rate, blood pressure, body temperature, etc. Introducing MEWS charts to patients records allows, despite its simplicity, to reduce the risk of SCA and hospital mortality.

In the era of artificial intelligence techniques, as well as the availability of ECG signal recorded by the medical monitors typically used in hospitals, it is advisable to work on solutions providing automated and advanced assessment of the patient's condition. The aim of this project was to develop a prototype device allowing such an assessment, and in particular detection of life-threatening situations associated with cardiovascular diseases. The discussed system may be especially important in places such as admission rooms and accident and emergency departments, where medical staff may be insufficient in relation to the number of patients.

An additional motivation to undertake this research was the fact that currently there are many computerized solutions to assess the patient's condition, but these solutions do not support real time operation based on online measurements of vital functions; instead these systems use patient data stored in the database, or require manual entry of such data. Therefore such mode of operation can be termed neither continuous, nor automatic monitoring.

In this project, a prototype device was constructed, based on modern microprocessor dedicated for mobile devices and equipped in a convenient graphical user interface with a touch screen. It is designed as an attachment, connected to a medical monitor (see illustration). This approach allows to reduce costs and simplify the construction (the medical monitor is responsible for data acquisition), while allowing to connect the device with monitors from different manufacturers (depending on the availability of the data format used by



*The prototype attached to a medical monitor*

the monitor). As the main element of data analysis in the designed system a Bayesian network was used. It is an artificial intelligence method that belongs to the, recently gaining popularity, solutions based on the probability theory. This network allows to combine multiple indicators (input values) to calculate the probability of occurrence of various diseases, particularly heart attack, which may lead to SCA. The network encodes data from the so-called evidence-based medicine (EBM) – long-term studies that allow to extract statistical, quantitative relationships between diseases and their symptoms. The developed solution was tested on data from hospitalized patients. Tests showed good ability to detect heart attacks and low level of false alarms.

The project impact on the discipline development should be considered primarily in the field of applications of artificial intelligence in medicine. The project showed that it is possible to construct a device analyzing in real-time the status of a patient with advanced artificial intelligence methods. This is important, among others, in the context of the current development of telemedicine. At present, there is an attempt to shift the burden of the data analysis from the telemedicine centers (where such an analysis is carried out by humans) to the mobile devices distributed among patients (where the analysis is performed by advanced algorithms).

The study is also important from the social point of view, because it is a part of the work aiming to improve the quality of medical care. Early detection of situations posing a threat to health and life allows to take timely remedial measures and therefore may constitute an important element of medical practice.