Biosignal interference and artifacts

During their transmission through a living system, biosignals are affected by obstacles, the distance between their input and output, etc. Depending on the origin of this distortion, we observe:

Disturbances are the measured values of biosignals that are undesirably affected by an interfering high-frequency signal that occurs during the operation of foreign technical sources in the vicinity of the measurement, such as electrical devices (mobile phones), other diagnostic and therapeutic devices, etc.

Artifacts (see below) are measurement inaccuracies caused, for example, by the presence of another (foreign) biosignal (eye movements in the ECG) or caused at the transfer point between the apparatus and the examined person (sweating under the electrodes, poor degreasing of the skin, a small amount of contact gel)

Distortion can occur when the signal passes through the examined person (it can therefore have great clinical and diagnostic significance - it shows us, for example, the degree of tissue transformation, etc.) or when it passes through the apparatus, which is a change caused, for example, by the use of filters.

The transmission of biosignals without attenuation and artifacts is therefore an ideal and only a very unlikely transmission. This phenomenon would occur when quantities are proportional to each other. But this phenomenon does not occur in a living organism. Signal interference occurs here, primarily passive attenuation and losses.

Artifacts

Artifacts occur to a greater or lesser extent depending on interference or imperfections during the signal conduction from the patient to the apparatus. These imperfections are quite common and can hardly be reduced in practice. Therefore, it is rather difficult to accurately estimate the ratio of artifacts to the real signal. It can only be our effort to perform the examination as carefully as possible and thus obtain results as close as possible to the real state of the examined person or specimen. A high level of staff training is required to minimize the occurrence of artifacts. Accurate reading of the measurement result and a current idea of what is happening in the examination room are also important. Mistaking an artifact for a biosignal or vice versa can be fatal. Likewise, overlooking an important symptom hidden in the noise can cause a big problem.

The most problematic area of the entire biosignal pathway is the boundary between the examined person and the apparatus. The biosignal often changes its character during the transition from the patient to the apparatus. Therefore, the signal in the input area is often very weak, not yet amplified. Due to the high susceptibility to artifacts, the largest amount of inaccuracies arises in this place. Imperfect knowledge of physical phenomena can therefore result in inaccurate readings of measured values. Artifacts are an undesirable phenomenon in this area of physics, and therefore we try to limit their occurrence to a minimum in this particular place. Degreasing the skin at the site of acquisition, using contact gel, etc. helps to limit the differences that arise in this way.

Furthermore, time constants and filters are used to suppress unwanted artifacts as an intentional distortion when using the calibration signal. The doctor must take into account the adjusted result in this way and then evaluate it soberly. In any case, the calibration signal will not suppress any artifacts, it is in its own way a certain, precisely defined, "artifact", by passing through the apparatus we can estimate the distortion caused by the given setting of filters and time constants.

Noise

Noise also plays a major role in conducting biosignals. In a simplified way, it can be compared to an audible noise when making a phone call from a booth. In this case, a lot of noise, crackling, disturbances and other signals are added to the signal transmitted over the network, which more or less devalues the resulting impression. This is exactly the case when the biosignal passes through a living system or apparatus. The signal/noise ratio can be used to determine the quality of the transmission system. As an example, I cite the creation of noise when making a phone call.

> If we talk to someone at a level of 50 dB in a noisy environment, also 50 dB, then the signal-to-noise ratio will be 0 dB, the signal will be lost in the noise, and the listeners will have difficulty understanding us. To increase the signal-to-noise ratio to at least 20 dB, we will need to raise our voice to 70 dB. The problem arises if others also want to be heard, and they also increase the intensity of their conversation: thus the noise intensity increases, the signal distance decreases, and the result is that people shout over each other and no one can understand anyone anyway.

A certain basic level of noise is a completely natural phenomenon and cannot be removed in any way, it is intrinsically related to the physical nature of the thing (e.g. inherent noise of used amplifiers, thermal noise, etc.). On a similar principle, noise arises when measuring biosignals.

Resources

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