

PROBLEMS OF PHOTONICS IN MEDICAL DIAGNOSTICS

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Biophotonic devices and technologies in problems of medical diagnostics

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The standard diagnostic procedures preceding the start of treatment, aimed to identify the disease as well as to understand its aetiology and pathophysiological features in a particular patient, include blood tests, X-ray imaging, etc. As a rule, a significant part of these investigations is performed using optical methods. Since soft biological tissues are light-scattering media that transmit light inside themselves, optical methods also make it possible to examine tissues inside the body without violating its integrity (noninvasively, *in vivo*, *in situ*). Basically, these technologies presently refer to the technologies of optical biomedical diagnostics, or diagnostic biophotonics [1]; however, traditional optical technologies (microscopy, spectrophotometry, luminescence analysis, etc.) still clearly prevail in laboratory diagnostics. Nevertheless, noninvasive optical methods are already well known today. First, these are laser tomographic methods [2], such as optical coherence tomography (OCT), optical-acoustic tomography, etc., aimed at obtaining images of the internal structure of tissues. In particular, OCT methods are already standard for ophthalmology when examining the eye retina and its vascular pathologies. Another important area is noninvasive medical spectrophotometry (NMS) [3, 4]. It is based on the use of photometric and optical spectroscopic methods (absorption, Doppler, Raman, fluorescence and other kinds of spectroscopy) for assessing the biochemical composition of tissues and its dynamics over time, including microhaemodynamics. Recently, NMS is often referred to as molecular diagnostics, emphasising thereby that it is used to determine the content of biological molecules in the examination area [4]. Technologies are also being developed that combine tomographic and NMS methods [5]. Unfortunately, a significant part of the listed methods and devices are still at the stage of experimental development and implementation. The road to the market for them is long and difficult [6]. If instruments are used to measure any parameters, they must also have appropriate metrological support, must be certified as a measuring instrument [7]. One of the problems here is the creation of computational algorithms for such systems, the overwhelming majority of which work according to the principle of solving inverse problems of the optics of light-scattering media [8, 9]. However, algorithms for solving such problems are not standardised, and their methodological errors are poorly studied.

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As a result, the diagnostic results are often poorly reproducible, methodological and instrument-dependent. A serious problem is the proof of the efficiency of using these systems and the development of algorithms for their use in clinical practice. For a technology to be recognised in medicine, an evidence base is needed based on the participation in research not of 20–25 patients, as is often the case in scientific publications, but at least 1000 (better 10 000) subjects. Moreover, a set of groups of patients is required, taking into account gender, age, possible combinations of diseases in each of them, and for devices for early detection of diseases, traceability of the results of diagnostics of these groups within three to five years is also necessary. All this is a very long and expensive process. However, if all studies are not performed properly at the development stage, the specificity and sensitivity of the method may not be sufficient for practical application, especially against the background of other diseases. This happened at one time with the technology of laser Doppler flowmetry.

Quantum Electronics periodically publishes topical collections on the use of lasers in medicine. However, a significant proportion of the papers presented in them concern methods of treatment or fundamental research of the optical properties of biological tissues. This collection is devoted to a number of current trends in the development of devices for diagnostic biophotonics. The papers are presented by scientific groups from the leading institutions of the country (Institute of Applied Physics of RAS, General Physics Institute of RAS, Federal Research Centre 'Crystallography and Photonics' of RAS, etc.), the purpose of which is to create instrumental and methodological support for diagnostics. Of course, the papers published here do not cover the entire scope of work in our country in this area, but reflect some advanced approaches, ideas and technologies that may be of interest to a wide range of readers.

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