Ruprecht-Karls-Universität Heidelberg
Medizinische Fakultät Mannheim
Dissertations-Kurzfassung

Development of a device for the assessment of kidney (liver) function by transcutaneous measurements of FITC-S (ICG) clearance

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The aim of the thesis is to present the development of a system for noninvasive fluorescent transcutaneous measurements of fluorescent markers (FITC-S, ICG), which is used for determination of renal and hepatic functions. The main task of the development was to establish a clinically usable measuring device. Preliminary experiments led to the conclusion that the most critical part of the device was the optical unit, especially the arrangement of the light source and the photodetector, and its position relative to the investigated skin surface. The quality of the measurements directly depends on the efficiency of the device to detect the fluorescent light in the presence of the excitation light as well as on the ability to keep the parameters of the optical unit stable during the whole measuring time. The tests and experiments suggested, that the efficiency of the detection of the fluorescent light can be increased by using optical filters for correction of the bandwidths of both, the selected light sources and the photodetectors. The most sensitive mechanical parameter of the optical unit is the distance between the photodetector and the measuring surface. First, it influences the magnitude of the measuring light. Second, its stability during the measurement reduces the artifacts from movements of the animal.

Carefully selected optical components, optical filters and their geometrical arrangement were the major aspects of the ability of the final prototype to produce high quality measurements of fluorescent markers with error less than 1 %. In order to perform the measurement on mice, the size of the device was miniaturized utilizing modern small-factor electronic components and double-layer printed circuit board with minimum object size of 0.5mm. To reduce the size of a battery the power consumption of the device was addressed during the development too.

The performance of the measuring system was confirmed by phantom studies and animal experiments, which confirms the achievement of all initial objectives of the development.