Oximetry in Preterm Infants Using A Multi-transducer Esophageal Catheter

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Introduction

Near-infrared spectroscopy (NIRS) provides a way of measuring oxygen (O_2) saturation levels in the blood. NIRS is currently used to measure cerebral and splanchnic O_2 saturation in term and preterm infants. According to new studies, commonly used O_2 saturation measurement methods are not accurate enough to measure saturation reliably [1]. Therefore, we propose to investigate the NIRS technology further. We want to use NIRS to measure O_2 saturation levels inside the esophagus. In this project I investigate the NIRS technology and develop an esophageal catheter prototype to acquire measurements.

Materials and Methods

We designed an evaluation board to explore the basics of NIRS. With this evaluation board we can measure NIRS and electrocardiogram (ECG) signals on the finger of a subject simultaneously. Using novel rapid-prototyping techniques we manufactured flexible electrical circuits on liquid crystal polymer (LCP) base. These circuits were built into an existing ECG catheter design, to produce a prototype which can measure NIRS and ECG.

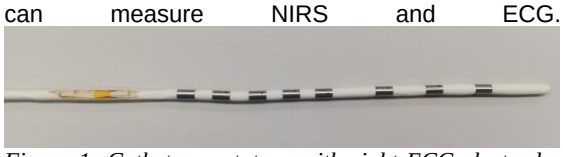

Figure 1: Catheter prototype with eight ECG electrodes and a NIRS sensor with two LEDs and a phototransistor.

This catheter prototype is tested in the esophagus of a living subject. We measure ECG and NIRS signals simultaneously.

Results

We tested functionality of the catheter. Additionally, we compared measurements at different depths in the esophagus. Results show different signal intensities depending on the depth. Also signals are strongly influenced by motion artifacts and breathing pattern.

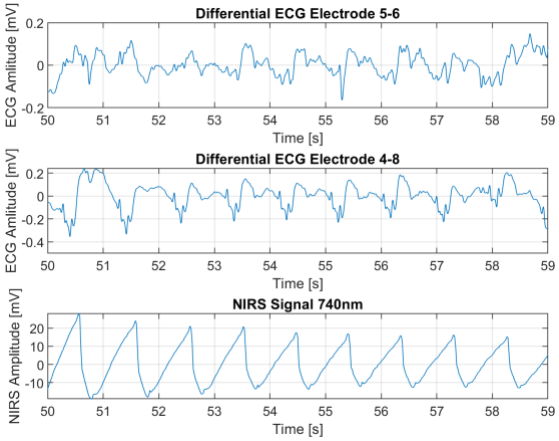

Figure 2: Filtered NIRS and ECG signals from in-vivo measurement.

Discussion

Measurement of NIRS signal inside the esophagus is possible. Depth measurement suggest optimal measurement site in the upper thoracic esophagus. This hypothesis has to be validated with further measurements. A more sophisticated catheter design can help to determine optimal measurement site. With hardware filtering and post-processing we were able to acquire a stable NIRS signal. The application of NIRS to measure O_2 saturation in the esophagus should be further investigated.

References

[1] D. Wackernagel, M. Blennow, and A. Hellström. *Accuracy of pulse oximetry in preterm and term infants is insufficient to determine arterial oxygen saturation and tension*. Acta Paediatrica, 109(11):2251–2257, 2020.

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