Development of a Multi-parameter Probe for Monitoring of Neonates

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Arterial oxygen saturation is one of the key parameters routinely monitored using pulse oximetry (SpO_2) in neonatal intensive care units. However, available SpO_2 probes for neonates are based on so-called transmission photoplethysmography (PPG) technique, limiting its use to body locations such as the limbs. To overcome this limitation, a novel multichannel reflective probe was developed, integrating ECG electrodes and respiration monitoring. After Swissmedic approval, the probe is currently being validated on neonatal patients at the University Hospital Zurich (UZH).

For preterm infants and severely ill newborns undergoing intensive or intermediate care, it is crucial to monitor their vital signs, in particular their cardiorespiratory function. Heart and respiratory rate are routinely monitored by electrocardiography (ECG) and impedance plethysmography (IPG) to assess correct breathing and cardiac activity.

Additionally for more than 40 years, pulse oximetry (SpO_2) has been used to monitor the amount of oxygen in blood and is even referred to as the fifth vital sign. However, most current SpO_2 probes for neonates are based on transmission photoplethysmography (PPG) (Figure 1), which requires an additional sensor and limits the placement of it to the arms and legs of the neonate. Unfortunately, such a sensor position has several limitations. Firstly, newborns continuously move their limbs leading to movement artefacts and thus false alarms. And secondly, hands, forearms, feet and lower legs are preferred sites for insertion of peripheral and central catheters, thus complicating the work of the medical staff.

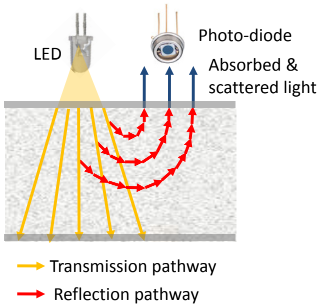

Figure 1: Transmission vs reflection photoplethysmography

To overcome the limitation of currently-used SpO_2 probes, CSEM has developed an innovative SpO_2 probe (Figure 2) based on reflective PPG. The new design is composed of two sensors allowing the monitoring of the following vital signs:

Physiological parameter	Technology
Heart rate	ECG
Respiratory rate	IPG
SpO_2	Reflective PPG

The use of transmission PPG theoretically enables the positioning of the sensor anywhere on the body. In addition to the potential new locations, the integration of ECG and respiration monitoring to the SpO_2 probe, leads to a highly integrated miniaturized multi-parameter probe thuse freeing space on the neonate body and reducing considerably the number of connected cables.

Particular attention was taken about the materials in contact with the neonate: in order to avoid skin irritations sensor probes were encased in medical grade silicon. Even more, low adhesion non-sensitizing silicone gel was used to attach the probe to the skin, and stainless steel was used as as electro-conductive surface.

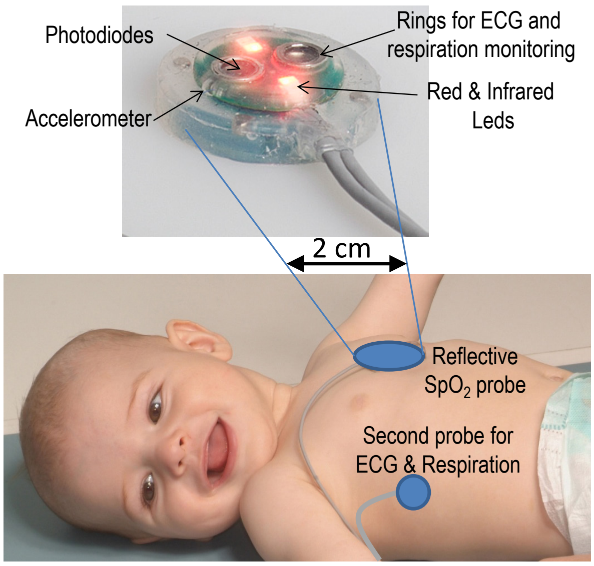

Figure 2: Multiparameter probe for neonate monitoring

The novel probes were initially validated on healthy adults undergoing normobaric hypoxia (Figure 3). After successful validation and approval from the ethics committee and Swissmedic, a second validation is currently being performed on neonatal patients at the University Hospital Zurich (UZH).

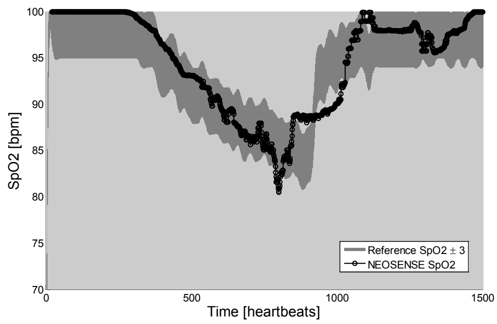

Figure 3: Example of a validation result on healthy adults

This developed neonatal probe is expected to improve the quality of neonatal vital-sign monitoring, and to decrease the workload of NICU care givers. Last but not least, by reducing the amount of cabling to the baby and the occurrence of false alarms, is expected a greatly reduced parental anxiety.

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