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Non-Invasive Lung Oxygen Monitoring in Term Infants: A Pilot Trial

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Abstract: Employing non-invasive GASMAS based system, lung oxygen measurements were performed on 25 healthy term infants on various chest positions. Oxygen and water vapor absorption signal was detected on most occasions.

1. Introduction

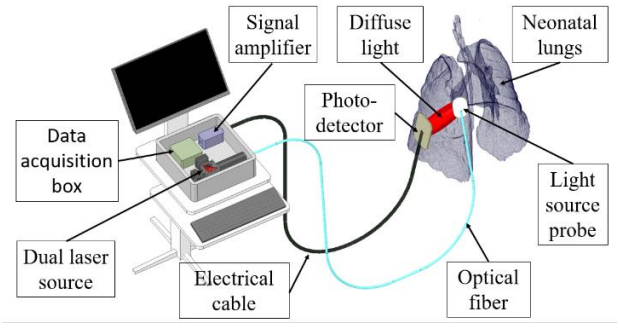
Respiratory morbidities are the most common reason for the admission to the neonatal unit [1]. More than 80% of infants born before 28 weeks require respiratory support [2]. Reasons include transient tachypnoea of the newborn, meconium aspiration syndrome for term-born infants and respiratory distress syndrome related to surfactant deficiency for premature neonates [3, 4]. These respiratory conditions reduce the gas volume inside the lungs, compromise oxygen absorption, resulting in decreased blood oxygen levels. Currently used methods to monitor neonatal respiratory status cannot measure oxygen concentration or lung volume directly. Optical oxygen concentration measurements present an advantage allowing fast and non-invasive detection of oxygen concentrations within the lungs. Gas in scattering media absorption spectroscopy (GASMAS) has been recently employed as a *novel* optical technology to monitor neonatal lung oxygen content and the feasibility of this technique has been documented in previous studies [5-8]. Since GASMAS was used in neonates for the first time in 2012, the lung analyzing system has been improved and requires more testing performed to demonstrate measurement repeatability and validation.

2. Methods

2.1. Spectroscopic Technique

The GASMAS system (GPX Medical AB, Sweden) incorporates two low power, near-infrared diode lasers at 764nm wavelength for oxygen absorption and 935nm - for water vapor absorption. Assuming that relative humidity is 100% in the lungs and tissue temperature is 37°C, the instrument calculates the absorption path length for water vapor. Subsequently, assuming pathlength is same for both gasses, the oxygen concentration in the probed volume is calculated by means of Beer–Lambert law [8].

Figure 1. Schematic drawing of the lung analyzer system



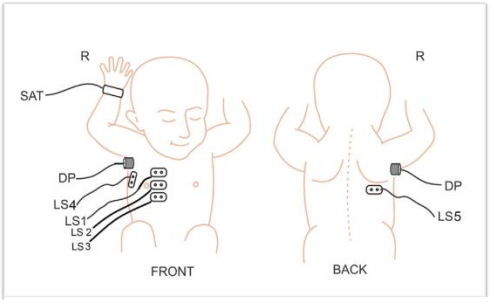
2.1. Subjects

25 full term (>37 weeks gestational age), healthy infants were recruited to the clinical study after parental consent was obtained (Table 1.). Lung oxygen measurements performed using GASMAS integrated into research lung analyzer between 1 and 5 days of age. Daily measurement sessions were performed when feasible, prior to hospital discharge. Probes were placed in 10 anatomically determined positions on the chest (Figure 2).

Table 1. Characteristics of study population

N = 25	Mean (± SD) / %
Gestational age (weeks)	39 (1.3)
Birth weight (kg)	3.64 (0.72)
Male	40
Vaginal delivery	40
Apgar score at 1 min	8.9 (0.2)
Apgar score at 5 mins	9.6 (0.4)

Figure 2. Location of probe placement

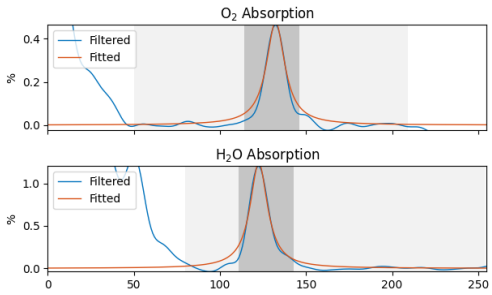


Photodetector probe (DP) below the armpit and light source probe (LS) in midclavicular line the 2nd intercostal space (LS1), the level of nipple (LS2), the 4th intercostal space (LS3), below the detector (LS4) and below the scapular angle on the back (LS5).

3. Preliminary Results

A total of 40 measurement sessions performed: 10 infants had 1 session, 15 infants – 2 sessions, representing a total of 351 measurements in different locations over the chest, obtaining overall 3511 measured values. Oxygen absorption signal was detected in 56% of measurements. Typical measured absorption spectra of water vapor and oxygen gas is shown in Figure 3. The recruitment to the clinical study is ongoing and more results are to follow in regards of oxygen concentration variations, repeatability, and optimal positions for measurements.

Figure 3. Gas absorption signals



Oxygen and water vapor absorption signals obtained from the infant No.25 with measurement performed on the left side of the chest with DP in the armpit and LS in a 3rd position (LS3)

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