Think Biosolution

Characterization of R-value vs O_2-saturation

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Introduction

Blood oxygen saturation is an important biometric measure that is representative of both generic and specific health conditions. It is a measure of the ratio of oxygen-saturated hemoglobin to the total hemoglobin content in the blood.

Measurement of blood oxygen saturation is used to determine if oxygen supply to body tissue is operating at optimal levels. Typical oxygen saturation level in healthy subjects is in the 95-100 per cent range, with levels below 90% considered to suggest hypoxemia (low blood oxygen), resulting in hypoxia (insufficient oxygen in body tissue).

Current Techniques

Current approaches at measurement of blood oxygenation (SO_2) are primarily either of two premises.

1. Arterial oxygen saturation (SaO_2) – consisting of arterial blood gas analysis
2. Peripheral oxygen saturation (SpO_2) – consisting of pulse oximetry, a non-invasive estimation of blood oxygenation through measurement of the optical response of blood-rich tissue

Although SaO_2 is considered more accurate, given its non-invasive nature, as well as reasonable degree of accuracy, SpO_2 is the preferred technique of measurement of blood oxygenation in most non-emergency scenarios like home and clinic use.

We have integrated an optical Photoplethysmographic sensor into our remote patient monitoring device, QuasaR™, which measures and reports the R-value at the chest (Figure 2) and reports blood oxygen saturation(SpO_2) based on these readings. The QuasaR™ devices use a color sensor, coupled to an illumination system in contact with the skin, that consists of red and infrared monochromatic LEDs and a proprietary light dissipation module.

Method

Pulse Oximetry

Pulse Oximetry is based on the principle that blood absorbance of light is wavelength dependent, hence light of 2 wavelengths (Red - 660nm and Infrared - 870nm) are incident alternately on the tissue and the reflected light is measures over time.

The received signal has 2 components

1. AC – pulsatile component
2. DC – baseline component

R-value

For each incident wavelength, the AC and DC components are measured. From the received signal, the R-value is calculated as

$$R_{SpO2} = \frac{AC_{Red}}{DC_{Red}} \Big/ \frac{AC_{IR}}{DC_{IR}}$$

Setup

The R-value acquired from QuasaR™ is compared to the SpO2 value as acquired by the NoninConnect Elite 3240, an FDA-approved pulse oximeter.

Figure 1. SpO2 measurement using NoninConnect 3290 Pulse Oximeter

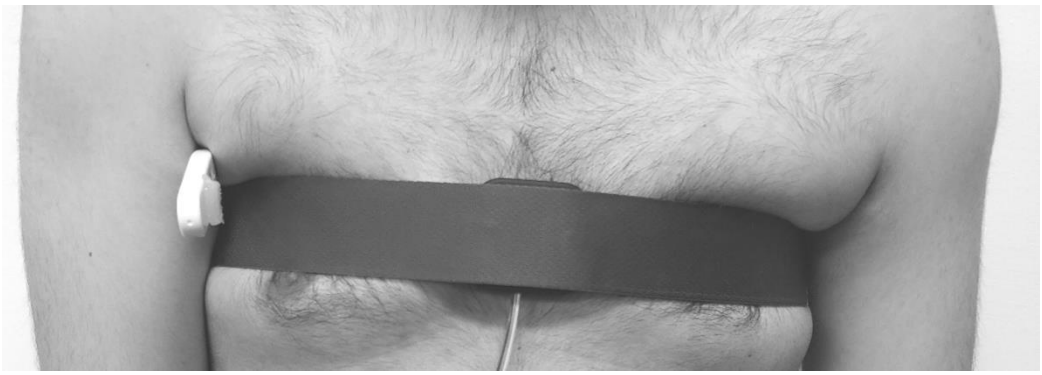

Figure 2. Setup for R-value capture using QuasaR™

Results

We saw minimal variation between multiple trials with similar R-Values for similar SpO_2 readings.

R-values acquired from QuasaR show a strong correlation to the SpO2 as acquired from the FDA approved pulse oximeter across multiple trials. The results are discussed in Table 1 and Figure 3.

Table 1. Comparison of R-vs-SpO2

	Trial 1		Trial 2		Trial 3	
Timestamp	SpO2	R-value	SpO2	R-value	SpO2	R-value
t	99	0.884445	98	2.086467	98	1.009616
t+1	99	0.529647	98	1.304967	98	0.764156
t+2	99	0.629405	98	5.022526	98	1.062085
t+3	99	0.589744	99	0.685923	98	0.588466
t+4	99	0.713123	98	1.363158	97	1.742257
t+5	98	1.227753	98	1.583965	94	1.988042
t+6	98	1.387107	97	1.455899	96	1.604827
t+7	98	1.436019	98	0.846769	95	1.887991
t+8	98	1.481833	99	3.063759	97	1.310097
t+9	98	2.234277	98	1.763752	99	0.434667

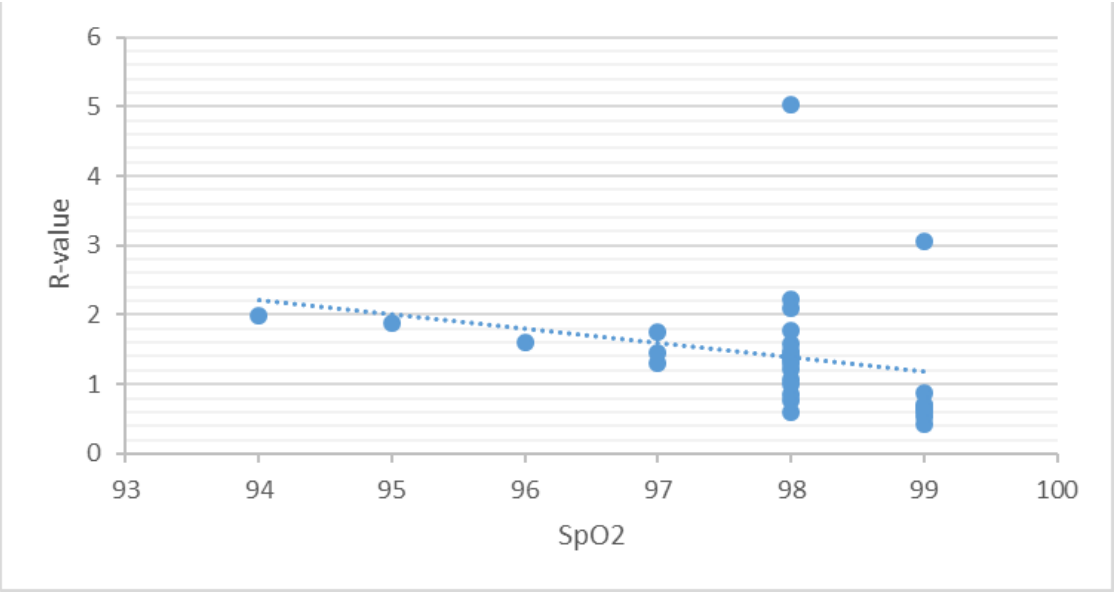

Figure 3. Comparison of R-value from QuasaR with SpO_2 from pulse oximeter

Conclusion

In these trials, we see a clear relationship between R-value as measured by QuasaR at the chest with SpO_2 as measured at the fingertip by an FDA-approved pulse oximeter. This establishes that SpO_2 is determinable at the chest using the QuasaR™ device.

References

1. Nuhr, M., et al. "Forehead SpO2 monitoring compared to finger SpO2 recording in emergency transport." *Anaesthesia* 59.4 (2004): 390-393.
2. https://www.accessdata.fda.gov/cdrh_docs/pdf9/K092620.pdf
3. Tremper, Kevin K. "Pulse oximetry." *Chest* 95.4 (1989): 713-715.

