Chronic Respiratory Disease

Chronic Respiratory Disease
Volume 19: 1–8

DOI: 10.1177/14799731211070844
journals.sagepub.com/home/crd
SAGE

Comparison of forehead and finger oximetry sensors during the six minute walk test

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Abstract

Background: Measurement of oxygen saturation (S_pO_2) during the 6 minute walk test (6MWT) could be impacted by the measurement site.

Aims: To compare S_pO_2 and heart rate (HR) between forehead and finger sensors during the 6MWT. Sensor readings were also to be compared for signal quality and with capillary blood gas (CBG) pre and post 6MWT.

Method: 80 subjects with pulmonary vascular disease (PVD) and/or interstitial lung disease (ILD) performed the 6MWT. Pulse oximetry was recorded at 30 s intervals. CBG was taken pre and post 6MWT to determine capillary oxygen saturation (S_CO_2).

Results: The forehead sensor recorded higher values for S_pO_2 ($p < 0.001$) and HR ($p < 0.01$) compared with the finger sensor during the 6MWT. For both sensors, the demonstrated bias compared to CBG post 6MWT was higher and more variable in subjects who desaturated. During the 6MWT there was a higher occurrence ($p < 0.001$) of poor signal quality in the finger sensor compared with the forehead sensor.

Conclusion: This study suggests that the sensor site can impact pulse oximetry readings. The variance in bias suggests pulse oximetry may not accurately reflect S_CO_2 measurements particularly in subjects who desaturate during 6MWT.

Keywords

Pulse oximetry, 6 minute walk test, oxygen desaturation, pulmonary vascular disease, interstitial lung disease

Date received: 13 July 2021; accepted: 6 December 2021

Introduction

There are two types of pulse oximetry: transmission and reflectance oximetry. Transmission pulse oximetry is most widely utilised, particularly the finger sensor. Transmission pulse oximetry can be less effective in poor peripheral circulation as it can be more prone to the effects of vasoconstriction and this can decrease accuracy of readings due to reduced photoplethysmography signal .[1] Reflectance pulse oximetry, as used in the forehead sensor, is less vulnerable to vasoconstriction .[2] Additionally, it can be more securely attached which could make it less prone to motion artefact and therefore more reliable during exercise testing.

The 6 minute walk test (6MWT) is clinically used to monitor a range of cardiorespiratory disorders including commonly pulmonary vascular disease (PVD) and interstitial lung disease (ILD). Guidelines for the 6MWT recommend pulse oximetry for detection of exercise-induced oxygen desaturation .[3,4] The 6MWT has advantages such as increased

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sensitivity in detecting exercise-induced oxygen desaturation compared with maximal exercise testing.[5] Detection of significant exercise-induced oxygen desaturation from the 6MWT may aid decisions in prescribing ambulatory oxygen and additionally exercise-induced oxygen desaturation has shown to be prognostically significant in both PVD and ILD.[6–8]

A few investigations have demonstrated significantly higher S_pO_2 values recorded using the forehead sensor compared to the finger sensor with exercise.[9,10] However, only one study investigated this during the 6MWT; this was in a scleroderma population where only pre and post S_pO_2 values were compared between sensors and accuracy of values were not compared to a blood gas standard.[10]

The primary aim of this investigation was therefore to compare the differences in S_pO_2 values between the forehead and finger sensors recorded throughout the duration of the 6MWT in subjects with PVD and ILD

Secondary aims included comparing the agreement of sensor readings to a reference of arterialized capillary oxygen saturation (S_CO_2) pre and post 6MWT and assessing sensors signal quality during the 6MWT in subjects with PVD and ILD. Arterialized capillary blood sampling was selected as the technique to obtain reference of arterial oxygen saturation as it has advantages of being minimally invasive and low risk compared with arterial sampling.

Methods

Study design

This was a single centre study taking place in the Department of Respiratory Physiology at Royal Papworth Hospital, Cambridge. Ethical approval for the study (210,827) was given by the research committee and Health Research Authority. Written informed consent was obtained from all subjects.

Subjects

Royal Papworth Hospital is a specialist centre for referral of patients diagnosed with PVD and ILD. Many of these patients as part of their clinical evaluation at this hospital complete a 6MWT. Subjects were therefore recruited to the study that had a planned clinical 6MWT. In total, 80 patients were recruited with inclusion criteria of a diagnosis of PVD and/or ILD and aged between 18 and 80 years old. Individuals who used walking aids, ambulatory oxygen or currently smoked were excluded.

Six-minute walk test

The oximeter used was the Masimo Rad-5® with settings of an averaging time rate of 8 s and normal sensitivity setting. Two Rad-5 devices were attached to the patient simultaneously with the forehead sensor attached to one device and the finger sensor to the other device. A reusable forehead reflectance sensor (LNCS TF-1) was placed above the subject's left eyebrow and secured with a headband. The reusable finger sensor (LNCS DC-I) was attached to the subject's right index finger. No skin preparation was performed other than removal of nail varnish (if present) on the subject's right index finger. The 6 minute walk test (6MWT) was performed according to the department protocol based on ATS guidelines [3] and with further guidance, particularly regarding criteria for termination of the test, determined by referring clinical teams. In ILD subjects, the 6MWT test was terminated early if S_pO_2 dropped to 75% or below using the forehead sensor or had significant symptoms as described in ATS guidance. In PVD subjects, the 6MWT test was only terminated early if the patient presented unwell with symptoms of anginal chest pain, extreme light headiness or unsteadiness not with a significant drop in S_pO_2 values in isolation. None of the subjects in the study had their 6MWT terminated early due to significant drop in S_pO_2 values or presence of significant symptoms. The subject performed their normal clinical 6MWT along a 10-m corridor with both devices and sensors attached. Both devices displayed measurements of S_pO_2 and heart rate (HR) continuously during the 6MWT and values were recorded from both devices at the same time by the investigator at 30 s intervals during the 6MWT. During the 6MWT the signal quality was continuously monitored on the Masimo Rad-5 device from the signal IQ bar displayed which provided a visual indicator of the signal quality. A high signal IQ bar indicated that the signal quality was good and when the IQ bar dropped to two bars or less and turned red this was poor signal quality and S_pO_2 values recorded at this point of the 6MWT was noted as an occurrence of poor signal.

Capillary blood gas

Capillary blood gas (CBG) samples were obtained at rest and post walk from the earlobes which were arterialised using Deep Heat (Mentholatum Corporation). Resting CBG was obtained from the subject seated and rested in normal ambient conditions. Post CBG was obtained from the subject immediately post walk test in a seated position in the walk corridor. Readings were recorded from the oximeter devices when half of the CBG capillary tube had been filled with blood.

Statistical analyses

Data analysis was performed using Statistical Package for Social Sciences (SPSS) version 25. The level of statistical significance was set at $p < 0.05$. A two-way repeated measure analysis of variance (ANOVA) was performed to investigate differences and interactions in S_pO_2 and HR readings between the sensors during the 6MWT. Within-subject factors entered in the ANOVA model were sensor

and time. All readings recorded at 30 s intervals of the 6MWT were entered into the analysis. To compare the occurrences of poor signal between sensors during the 6MWT, the Wilcoxon Rank Sum test was performed. Agreement between the S_pO_2 and S_CO_2 was assessed using the Bland Altman (BA) method which calculated the bias (S_pO_2-S_CO_2) for both sensors [11]. As per BA method 95% limits of agreement was calculated and confidence intervals for the 95% limits of agreement. Linear regression was used to test for any change in the bias in the Bland Altman analysis with change in oxygen saturation range.

Results

Population characteristics

Mean demographics of the population were age was 59 ± 13 (range 28–80), male (n=40) female (n=40) and mean resting S_CO_2 was 94 ± 4.6% (range 74–99%).

In total, 80 subjects were enrolled into the study. Fifty three subjects had PVD and 24 subjects with ILD. Three subjects were diagnosed with both PVD and ILD. The disease and clinical characteristics of the population are presented in Supplementa1 Table 1

SpO_2 and HR response during the 6MWT

To investigate for differences and interactions in S_pO_2 and HR values in the different cohorts between the sensors during the 6MWT, a two-way repeated measure ANOVA was performed. Within-subject factors entered in the ANOVA model were sensor and time. Results are presented in Table 1. Mean differences in S_pO_2 and HR values recorded between forehead and finger sensors are reported in Supplemental Table 2.

For all cohorts, time was a significant factor, as expected, with S_pO_2 decreasing and HR increasing during the course of the 6MWT ($p < 0.001$) (see Table 1). Sensor was a significant factor for both S_pO_2 and HR values in the whole cohort and when cohorts were tested separately was significant in both PVD and ILD cohorts. The S_pO_2 recorded using the forehead sensor significantly higher compared with readings using the finger sensor ($p < 0.001$), although the average difference in S_pO_2 values at each time point of the 6MWT was clinically small ranging from 1 to 3% (See Figure 1(a)). The HR values were also significantly higher using the forehead sensor compared with readings using the finger sensor ($p < 0.01$). The average difference in HR values at each time point of the 6MWT ranged from 0 to 9 bpm as presented in Figure 1(b).

The interaction of the factors sensor and time was only significant for HR ($p < 0.05$) and when cohorts were tested separately was only found in the PVD cohort ($p < 0.05$). This suggests that for the PVD cohort the change of HR response over the timespan for the 6MWT was significantly different between the 2 sensors.

Table 1. ANOVA results comparing differences and interaction of S_pO_2 and HR values between sensors during the 6MWT.

	Whole population		
—	Sensor	Time	Sensor/Time
S_pO_2	$p < 0.001$	$p < 0.001$	NS
HR	$p < 0.01$	$p < 0.001$	$p < 0.05$
—	PVD population		
—	Sensor	Time	Sensor/Time
S_pO_2	$p < 0.001$	$p < 0.001$	NS
HR	$p < 0.001$	$p < 0.001$	$p < 0.05$
—	ILD population		
—	Sensor	Time	Sensor/Time
S_pO_2	$p < 0.01$	$p < 0.001$	NS
HR	$p < 0.01$	$p < 0.001$	NS

Within-Subject Factors.
Sensor – to determine if SpO_2 and HR values were significantly different between sensors.
Time – to determine if S_pO_2 and HR values significantly changed over time of the 6MWT for both sensors.
Sensor/Time – to determine if any changes in SpO2 and HR over time of the 6MWT were significantly different between sensors.
ANOVA= Analysis of variance, p value of significance, NS= not significant, SpO2 = oxygen saturation, HR= heart rate, PVD= pulmonary vascular disease, ILD= interstitial lung disease.

Comparison of signal quality between sensors

The occurrence of poor signal during the 6MWT was compared between the sensors and these results are presented in Table 2. There was a higher occurrence ($p < 0.001$) of poor signal using the finger sensor (189/1040) compared with the forehead sensor (34/1040) during the 6MWT as shown by the Wilcoxon Rank Sum test in the whole population and additionally for the PVD cohort when tested separately

Agreement of sensor readings to capillary blood gas

Capillary blood collection. Average time to CBG collection was 86 ± 49 s. Resting CBG was obtained successfully in 65/80 patients and post walk in 60/80 patients. Samples were not obtained successfully in all subjects due to insufficient CBG collected for analysis due to subjects bleeding insufficiently. This was most frequently observed in subjects with poor circulation. Four patients presenting with exercise desaturation during 6MWT had resaturated to normal by time of CBG collection post walk due to fast recovery.

Comparisons of forehead and finger sensor readings of S_pO_2 with CBG S_CO_2 are presented for the different cohorts in Table 3 and in Figures 2 and 3 and also Supplemental Figures 1–4. The bias is presented, calculated using Bland Altman analysis which compares agreement between S_pO_2 and S_CO_2.

At rest in the whole cohort the forehead sensor exhibited an average bias of 2.77 ± 2.13 whilst the finger sensor had

an average bias of 0.68 ± 2.37 indicating closer agreement of finger sensor S_pO_2 with S_CO_2 than the forehead sensor as demonstrated by Figure 2. However, there was no systematic change in bias with change in oxygen saturation scale for both forehead sensor (r = 0.15, $p > 0.05$) and finger sensor (r = 0.06 $p > 0.05$). This indicates that at rest the level of agreement between both sensor readings to CBG was similar across the oxygen saturation scale range (85–100%).

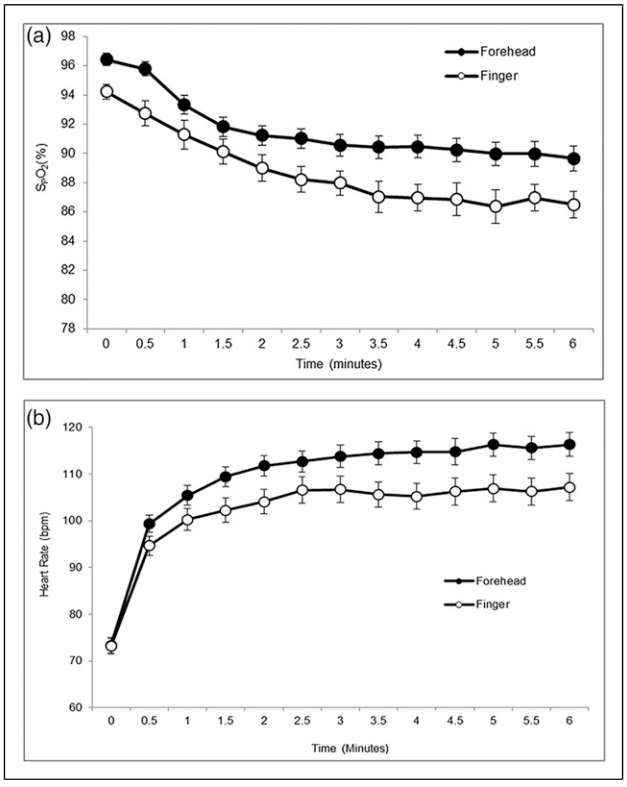

Figure 1. Comparison of SpO_2 response (A) and HR response (B) between forehead and finger sensors during the 6MWT for the whole population group (presented as mean and standard error).

Post 6MWT in the whole cohort the forehead sensor demonstrated an average bias of 2.98 ± 3.16 compared to an average bias of 0.85 ± 4.87 for the finger sensor again indicating closer agreement of finger sensor S_pO_2 with S_CO_2 than the forehead sensor as demonstrated by Figure 3 Bland Altman. There was however significant systematic change in bias with change in oxygen saturation scale for both forehead sensor (r = 0.33, $p < 0.001$) and finger sensor (r = 0.12 $p < 0.01$). This demonstrates that the level of agreement between sensor readings to CBG was different across the oxygen saturation scale range (65–100%). There was a higher bias in the lower oxygen saturation range indicating a lower level of agreement between sensor readings to CBG. Although the bias was lower for the finger sensor it was variable for both sensors, particularly for the finger sensor due to its wider limits of agreement.

Bland Altman analyses were additionally performed in PVD and ILD to compare agreement between S_pO_2 and S_CO_2 between the different sensors and these are presented in Supplemental Figures 1–4. The presented bias values were commonly higher and more variable in the PVD cohort compared to the ILD cohort where sensor values presented with more negative bias and mostly had closer agreement to S_CO_2.

Discussion

Pulse oximetry plays an important role in monitoring a range of patients with cardiorespiratory disorders during the 6MWT and may play a significant role in aiding clinical decisions in prescribing ambulatory oxygen. In this study, we investigated how different oximetry sensors influence the values recorded and compared these to a capillary blood gas standard. This study, we believe, is unique in comparing simultaneous measurements of S_pO_2 between forehead and finger sensors throughout the 6MWT.

Our findings demonstrated that the measurement site of pulse oximetry significantly impacted values recorded with significantly higher S_pO_2 using the forehead sensor compared with the finger sensor throughout the 6MWT in both our PVD and ILD cohorts. Average differences between

Table 2. Occurrence of poor signal quality measurements during 6 MWT.

	Occurrence of poor signal in total measurements		Z value	Significance (p value)
Whole population	Forehead	34/1040	−4.6	$p< 0.001$
	Finger	189/1040		
PVD population	Forehead	33/728	−4.6	$p <0.001$
	Finger	176/728		
ILD population	Forehead	1/351	−1.8	$p= 0.07$ (NS)
	Finger	30/351		

The occurrence of poor signal is reported as the number of poor signal readings recorded out of the total number of recorded readings during the 6MWT; Abbreviations – PVD= pulmonary vascular disease, ILD= interstitial lung disease, Z value from Wilcoxon Rank Sum test, NS= not significant.

sensor S_pO_2 readings, however, were clinically small at 1–3% and within the quoted accuracy error of the oximeter .[12] It is important to highlight though that in many subjects substantial clinical differences in sensor S_pO_2 readings during the 6MWT were observed and therefore not within the quoted accuracy of oximetry. Although we did not investigate the difference in sensor readings in a range of respiratory conditions we believe our oximetry findings are likely to be reflected in other respiratory conditions. Indeed, other investigations [9,10] have similarly reported significantly higher S_pO_2 values using the forehead sensor compared to the finger sensor with exercise in other cohorts such as COPD and scleroderma respectively. Our finding that the forehead sensor recorded higher S_pO_2 than the finger sensor will likely have several clinical implications. In particular, the type of sensor used during the 6MWT could impact the result obtained in terms of extent of exercise desaturation which may influence clinical decision making. Pulse oximetry is used during ambulatory oxygen assessment to help decide eligibility for supplemental oxygen therapy and the use of the forehead sensor may result in fewer patients, for example meeting these criteria. Possible reasons for differences in sensor readings could be due to several factors. The differences in S_pO_2 values could be due to differences in perfusion in the forehead compared with the finger. The finger sensor can be less effective in poor perfusion states. This is because the peripheral circulation is under control of the autonomic nervous system and in either low temperature or low cardiac output conditions these vessels can vasoconstrict in order to maintain central blood flow. Vasoconstriction can reduce the photoplethysmography signal thereby impacting the readings from this sensor .[1] In the forehead sensor, however, the light source and photodetector are positioned next to each other on the surface of the skin which is a likely advantage in conditions with poor peripheral circulation as this is less vulnerable to vasoconstriction. Peripheral vasoconstriction has demonstrated to impact measured S_pO_2 values in a number of clinical investigations .[13-15] Differences in perfusion between the forehead and finger could have been a factor in differences in S_pO_2 values in our investigation due to a proportion of our cohort presenting with characteristics of poor peripheral circulation such as scleroderma, Raynaud's and peripheral cyanosis. Additionally, differences in sensor readings may have been partly impacted by the different methodologies used to record pulse oximetry, that is reflectance and transmission. Transmission oximetry calculates S_pO_2 by the light emitting diode transmitting light through the vascular bed. In reflectance oximetry, the transmitted light will be reflected back to the photodetector on the same side of the vascular bed .[1] It is probable that the two measurement techniques may use different algorithms to calculate S_pO_2. Further investigation is needed to explore the causes of these differences in sensor readings.

Our findings also demonstrated higher recorded HR values in the forehead sensor compared with the finger sensor. The results from the ANOVA additionally demonstrated that the interaction of the factor sensor with time for HR readings was significant in the whole cohort and when cohorts were tested separately was significant for the PVD cohort. This indicates that in the PVD cohort the change in HR response over the timespan of the 6MWT was significantly different between the two sensors. A likely explanation of this finding is that a proportion of subjects with PVD were found to have a decrease in measured HR values from mid-point to the end of the 6MWT with the finger sensor which was not observed with the forehead sensor. This reduced HR response may have reflected occurrence of peripheral vasoconstriction in these subjects as peripheral vasoconstriction has been shown to reduce measured HR using the finger sensor .[13] This was a likely response to a reduction of cardiac output in these patients which can be commonly reduced in PVD .[16] The decrease in HR response in the finger sensor during progression of the walk was not observed in the ILD cohort. Some other investigators have examined the impact of different sensors on HR readings with exercise. Yamayha et al. found using the forehead sensor a better bias and precision for recording HR during exercise compared with the finger sensor and that the finger sensor significantly underestimated the HR when compared to electrocardiogram .[17] Conversely, Wilson et al.[9] found no difference in HR between sensors during exercise .

During the 6MWT, we observed a higher occurrence of poor signal using the finger sensor compared with the forehead sensor which was significant for the PVD but not for the ILD population. Lack of significance in ILD may be due to the smaller population size, as statistical significance was nearly achieved, although significantly the occurrence of poor signal was seen in certain ILD subjects such as those with scleroderma. The likely explanation in the PVD cohort, for poor signal to be more frequently observed using the finger sensor was likely due to peripheral vasoconstriction and would be expected to occur in subjects with poor circulation during walking. In poor circulatory conditions, there is a smaller amplitude signal which can be difficult to distinguish from background noise that may increase during walking due to motion thereby increasing chances of a poor signal with the finger sensor .[18] Clinically the finger sensor is the most widely used sensor for the 6MWT. Our findings significantly highlight that there is a higher probability of poor signal occurring in the finger sensor and therefore measurement error. Our findings suggest that the forehead sensor may be the preferred sensor choice especially in PVD

Table 3. Sensor SpO_2 compared with CBG ScO_2 at rest and post 6 MWT.

	Whole population group				PVD population group				ILD population group			
	Rest (*n*=65/80)		Post 6MWT (*n*=65/80)		Rest (*n*=41)		Post 6MWT (*n*=42)		Rest (*n*=19)		Post 6MWT (*n*=17)	
	Values (%)	Bias	Values (%)	Bias	Values	Bias	Values (%)	Bias	Values (%)	Bias	Values (%)	Bias
S_CO_2 %	95 (94–96)	n/a	93 (88–96)	n/a	95 (91–95)	n/a	90 (85–96)	n/a	96 (95–97)	n/a	94 (90–97)	n/a
Forehead (SpO_2)%	97 (96–99)	2.77 ± 2.13	95 (89–98)	2.98 ± 3.16	97 (94–97)	2.85 ± 2.29	93 (88–98)	3.56 ± 3.70	99 (98–100)	2.79 ± 1.51	97 (91–100)	2.35 ± 2.34
Finger (SpO_2)%	96 (93–97)	0.68 ± 2.37	93 (88–96)	0.85 ± 4.87	95 (92–97)	1.00 ± 2.42	92 (85–96)	1.85 ± 5.31	96 (99–97)	−0.10 ± 1.91	92 (88–97)	−0.88 ± 2.76

This table presents S_pO_2 readings from the different sensors and S_CO_2 obtained pre and post 6MWT.Abbreviations Values (%) for Rest and Post 6MWT presented as median, lower and upper interquartile range, n= number of patients in which CBG sample was obtained, n/a= not applicable, Bias (S_pO_2-ScO_2).

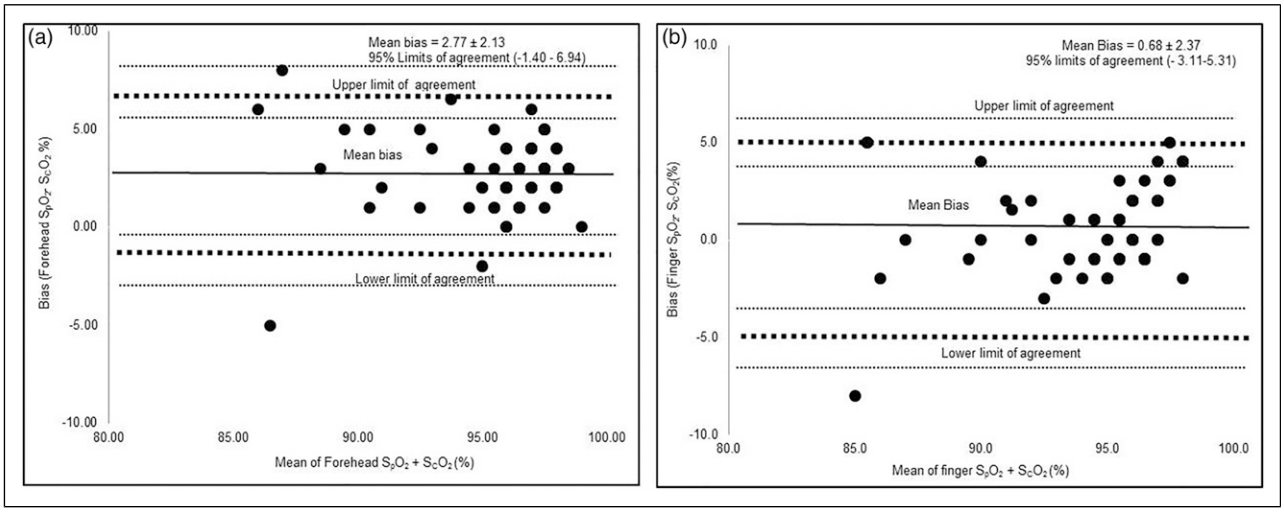

Figure 2. Bland Altman plots comparing forehead and finger sensor S_pO_2 readings to CBG ScO_2 at rest for the whole population (presented as mean bias, upper and lower limits of agreement calculated as ± 1.96 X SD of the bias and 95% confidence intervals). A: Comparing baseline forehead S_pO_2 to S_CO_2 in subjects at rest. B: Comparing finger S_pO_2 to S_CO_2 in subjects at rest.

and in ILD patients with poor circulation, for example those with scleroderma.

A few investigations have compared different sensors and how they agree to a blood gas standard with exercise [9,17,19] but we are the first to compare forehead and finger sensor readings pre and post 6MWT to a blood gas standard. The forehead sensor both at rest and post 6MWT presented with a predominantly positive bias which indicated that the forehead sensor was recording above the S_CO_2. A limitation with capillary blood is that it is likely to be less oxygenated compared to arterial blood, and this could have been a partial factor in the forehead sensor predominately recording above the S_CO_2. In comparison, at rest and post 6MWT, the finger sensor also demonstrated on average a smaller but still positive bias, but also had a greater amount of negative bias and overall more variable bias. At rest for both sensors there was no systematic change in bias with change in oxygen saturation scale which indicated the level of agreement for both sensors to CBG was similar across the oxygen saturation scale range. Post 6MWT, however, there was a significant systematic change in bias with change in oxygen saturation scale for both sensors. This indicates that the level of agreement between sensor readings to CBG was different across the oxygen saturation scale ranges as higher and more variable bias values were seen in the lower oxygen saturation range levels indicating a lower level of agreement between both sensor readings to CBG. This result highlights that the agreement of both sensor types to S_CO_2 post 6MWT was lower and more variable in subjects who desaturated and this suggests that pulse oximetry measured by both

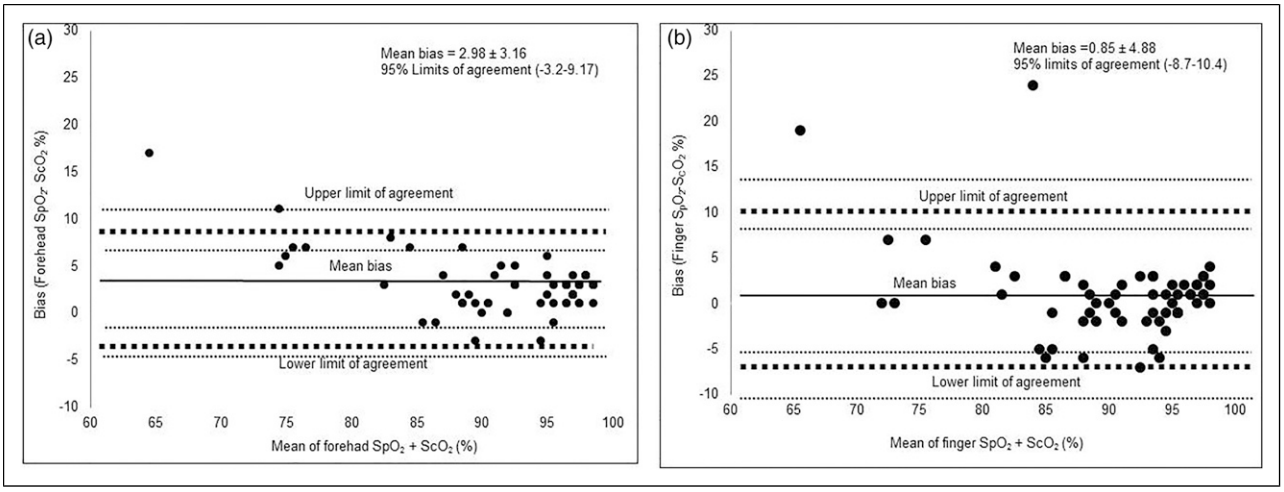

Figure 3. Bland Altman plots comparing forehead and finger sensor S_pO_2 readings to CBG S_CO2 post 6MWT for the whole population (presented as mean bias, upper and lower limits of agreement calculated as ± 1.96 X SD of the bias and 95% confidence intervals). A: Comparing baseline forehead S_pO_2 to S_CO_2 in subjects post 6MWT B: Comparing finger S_pO_2 to S_CO_2 in subjects post 6MWT.

forehead and finger sensor may not accurately reflect S_CO_2 in patients who desaturate during the 6MWT. This may be expected as pulse oximetry is less accurate in measuring S_pO_2 below 80% .[12] For both sensors, when looking at PVD and ILD cohorts separately the demonstrated bias values tended to be higher and more variable in the PVD cohort compared to the ILD cohort. This likely relates to characteristics of the PVD cohort with numerous subjects presenting with poor perfusion and additionally a number of subjects had congenital heart disease (CHD) where particularly high positive bias values were observed for both sensors and were least accurate with comparison to CBG readings. This may be expected as oximetry often overestimates in CHD due to low oxygen saturation and perfusion .[20]

Our findings importantly highlight the possible inaccuracy of pulse oximetry in reflecting the extent of exercise desaturation and we would suggest clinicians consider performing blood gas measurements alongside oximetry when making important clinical decisions such as when prescribing ambulatory oxygen. Despite the limitations of pulse oximetry, it is a clinically readily available tool to detect exercise-induced desaturation. Our findings showed that both sensors were able to detect exercise desaturation in all populations in accordance with the CBG. Blood gas collection techniques are technically difficult, and would unlikely be suitable to perform routinely with every 6MWT. As observed from our experience, CBG was not always obtained successfully especially in subjects with poor circulation or sufficiently quickly to reflect exercise desaturation in all our subjects due to fast recovery.

Limitations of study and future directions

The American Thoracic guidelines for 6MWT [3] state that the 6MWT should be performed on a 30 m corridor but due to insufficient corridor space the 6MWT was performed on a 10 m corridor. This a minor limitation as corridor length has demonstrated to affect walking distance and has shown not to impact S_pO_2 values during the 6MWT .[21]

The main limitation of this study was that the gold standard, arterial blood gas sampling by radial artery cannulation, was not performed. This was due to the risks posed with cannulation and therefore arterialized capillary blood was collected as a lower risk alternative. We also had technical limitations with CBG collection in a small number of subjects as already discussed. Further investigation is needed to explore the causes of differences in sensor readings and compare with arterial blood.

Conclusion

To conclude, the measurement site of pulse oximetry significantly impacts values recorded during the 6MWT with significantly higher S_pO_2 and HR values occurring in the forehead compared with the finger sensor in our PVD and ILD cohorts. In our cohorts, the forehead sensor was more reliable in signal quality for measurement of S_pO_2 values during the 6MWT, but predominantly recorded higher than S_CO_2, whereas the finger sensor demonstrated a lower bias but, more variable level of agreement to S_CO_2. Significantly our results showed that both sensors may not accurately reflect S_CO_2 especially in those who desaturate.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship and/or publication of this article.

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Supplemental Material

Supplemental material for this article is available online.

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