Determination of ideal PtcO$_2$ measurement time in evaluation of hypoxic wound patients.

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Shah JB, Ram DM, Fredrick E, Otto GH, Sheffield PJ. Determination of ideal PtcO$_2$ measurement time in evaluation of hypoxic wound patients. Undersea Hyperb Med 2008; 35(1):41-51. **Objective:** Evaluation of ideal time for baseline PtcO$_2$ readings in air, elevation test, and oxygen challenge during evaluation of hypoxic wound patients. **Design:** Retrospective analysis. **IRB APPROVAL:** Western IRB deemed this study exempt from requiring IRB approval. **Patients:** 202 patients with lower extremity wounds. **Method:** Patients had PtcO$_2$ measurements using 6 electrodes positioned in 3 paired locations along the limb (above the knee: AK; below the knee: BK; and foot). Measurements were made from each electrode at 7 different time-event occasions: position of limb (supine or elevated), type of breathing gas (sea level air or oxygen), and time of measurement. A total of 8,484 measurements were analyzed by first examining each electrode’s data, and then pooling the data for each location pair. **Main Results:** PtcO$_2$ readings for air (10 minutes) were less than air at 20 minutes. Maximal readings were close to the 20-minute mark for AK and BK measurements, and closer to 30 minutes for the foot. Elevation test at 3 versus 5 minutes showed a continuing decline in PtcO$_2$ values. Oxygen challenge readings at 5 and 10 minutes were significantly different: the latter always larger than the former. **Conclusion:** Ideal times for baseline readings, leg elevation test, and oxygen challenge test are at least 20, 5, and 10 minutes, respectively.

**INTRODUCTION**

Transcutaneous oximetry (PtcO$_2$) is a commonly used, noninvasive assessment tool to measure the local tissue oxygen tension in tissue fluids below the skin, and is derived from local capillary (nutritive) blood perfusion (1-3). Originally, the technique was developed for use in neonatology (4), but is now commonly used in pediatric intensive care units (5), plastic surgery (6), vascular surgery (7), anesthesiology (8), orthopedics (9), and hyperbaric medicine (10). Tissue oxygenation and perfusion data are collected to identify the presence of tissue hypoxia, responders to hyperoxia, and adequacy of perfusion (1, 11). However, in order to obtain reproducible results, it is important to standardize the data collection technique.

Data collection requires a skilled technologist using a rigorous, consistent protocol that employs a standardized measurement site, sensor position, equipment, electrode, electrolyte solution, and temperature (1). After reviewing different protocols used by different wound centers, several differences were noted in the time intervals used for recording baseline values, the leg elevation test, and oxygen challenge testing. Moreover, following a review of the literature we did not find a study that determined the ideal time intervals at which to perform a standardized PtcO$_2$ measurement.

Shorter baseline times would equate
to a more cost-effective PtcO₂ evaluation. However, inherent in this approach is the risk of missing the true baseline and interpreting a low PtcO₂ reading as hypoxia and need for further intervention—a “false positive.” Similarly, it is also important to determine the minimum time interval needed for the elevation test, which can help interpret any drop in PtcO₂ readings that might be correlated clinically with patients’ peripheral vascular disease and the oxygen challenge test. While shorter intervals (5 minutes) could miss some patients who are responders to hypoxia, longer intervals mean a much longer hyperbaric and more expensive evaluation.

As a result, we decided to perform a time optimization study, to examine the optimal time for baseline PtcO₂ readings in air, the leg elevation test, and oxygen challenge. In addition, we also assessed whether the oxygen response is predictable from PtcO₂ values taken using respired air.

**METHODS**

**Patients**

Transcutaneous oxygen (PtcO₂) records of 202 patients with lower extremity wounds that were referred to the Wound Care and Hyperbaric Medicine Department, Southwest General Hospital, San Antonio, TX during 2002-2003 were reviewed. At the Southwest General Hospital Wound-Care Center, we routinely use pulse oximetry to determine the level of central oxygenation (12-19). In addition, the pulse oximeter is widely used in various settings, such as the Pediatric ICU (19), Medical and Surgical ICU (13,16) and Anesthesiology (12,14,18,19) as a marker of central oxygenation (41,43,44). In our center, pulse oximetry readings of 92% are required before a patient can undergo a PtcO₂ study. In patients with compromised peripheral perfusion because of significant vascular disease in the upper extremity, the pulse oximeter is attached to the ear lobe to ensure that a patient’s level of central oxygenation is not going to affect transcutaneous readings in the lower extremity (12).

**General Measurement Technique**

Each transcutaneous measurement followed a standard protocol. Standard radiometer calibration procedures were followed to first establish the zero point and then measure atmospheric air pressure (1). Each measurement involved the use of 6 electrodes placed in standardized locations: 2 electrodes on the foot at the transmetatarsal area (one on the lateral foot and the other on the medial foot); 2 electrodes at the below knee amputation (BK) level (one on the medial and the other on the lateral side); and 2 electrodes at the above knee amputation (AK) level (one on the medial and the other on the lateral side of the affected extremity). The ideal sites were located over a homogenous capillary bed without large veins, skin defects, hair, or bone. A Radiometer TCM 3 unit was employed using the standardized heating temperature of 44°C. After performing basic skin preparation by cleaning the area, the fixation ring was adhered to the skin and the electrode secured into the fixation ring.

Leg elevation test was accomplished by keeping the leg elevated at 30°. The oxygen challenge was administered at normobaric pressure by using a standard wall outlet, which provides oxygen to an oral mask with a reservoir bag. The mask was carefully placed and secured into position with oxygen delivery set to high flow (12-14 L/min).

**Data Collection and Analysis**

The following definitions and grouping were employed: A10 is the baseline supine air value at 10 minutes; A20 is the baseline
supine air value at 20 minutes; EL3 and EL5 are the values for the elevated patient at 3 and 5 minutes, respectively, determined during leg elevation; A30 is the post-elevation air value at 30 minutes prior to oxygen challenge; and O5 and O10 are the oxygen challenge values determined during 100% oxygen at 5 and 10 minutes, respectively. The elapsed time for the sequence of these $PtcO_2$ measurements that would normally be recorded is 10, 20, 23, 25, 30, 35, and 40 minutes, respectively.

A total of 202 $PtcO_2$ studies were recorded on an excel spreadsheet and then compiled into a database for statistical analysis by SPSS (SPSS v8.0, SPSS, Inc., Chicago, IL). The data for each electrode were analyzed separately, resulting in the discovery of 15 missing observations that reduced the number of pairs in some of the comparisons to 200 or 199. Outlier values between 3 and 4 standard deviations from the mean in some of the paired comparisons were investigated. Their deletion made no difference in the results, since the database was so large. An additional 8 obvious data entry errors were identified and corrected (e.g. transposition of 28 to 82).

The initial evaluations examined each electrode separately using paired t-tests to compare selected time-event conditions, augmented by scatter plots and polynomial regression. Later studies pooled the electrode data at the same general location to shift the focus from electrode detail to the behavior of the 3 locations across the time-event schedule of measurements.

RESULTS

There were 199-202 observations for each electrode. A paired comparisons test of the electrode pairs at each time-event combination showed that one electrode measured consistently higher than the other one at the AK location. The degree of difference was less at the BK location and was nearly zero at the foot. Due to the large sample sizes, the paired mean difference between the electrodes that exceeded 1.6 mm Hg measured in air was significant, but as electrode measurements are rounded to the nearest integer, this is not a medically significant difference. The difference in the oxygen challenge group needed for statistical significance was 8 mm Hg.

The mean and standard deviation for each type of $PtcO_2$ measurement for each electrode in the time-event sequence of measurement is shown in Table 1. The majority of differences between means at each location are within 2 mm Hg.

$PtcO_2$ values steadily decreased from the upper leg down to the foot, with measurements at the foot about half the above-the-knee measurements. Since each pair of electrodes at the same location provided similar results, the data were pooled so they represented the equivalent of 1 composite electrode with 404 measurement sets, rather than 2 separate electrodes with 202 measurement sets each. All subsequent results report pooled data by location, unless otherwise stated.

<table>
<thead>
<tr>
<th>Electrode</th>
<th>A10 (mm Hg)</th>
<th>A20 (mm Hg)</th>
<th>EL3 (mm Hg)</th>
<th>EL5 (mm Hg)</th>
<th>A30 (mm Hg)</th>
<th>O5 (mm Hg)</th>
<th>O10 (mm Hg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-AKA</td>
<td>48.8 (16.3)</td>
<td>51.5 (15.8)</td>
<td>50.5 (16.3)</td>
<td>50.3 (16.7)</td>
<td>52.0 (15.6)</td>
<td>163.2 (85.3)</td>
<td>195.9 (97.8)</td>
</tr>
<tr>
<td>2-AKA</td>
<td>50.4 (15.8)</td>
<td>52.8 (15.4)</td>
<td>52.1 (15.9)</td>
<td>51.7 (16.3)</td>
<td>53.4 (15.5)</td>
<td>173.7 (87.0)</td>
<td>209.6 (97.2)</td>
</tr>
<tr>
<td>3-BKA</td>
<td>38.6 (18.8)</td>
<td>42.2 (19.0)</td>
<td>39.5 (19.5)</td>
<td>39.2 (19.9)</td>
<td>43.1 (19.3)</td>
<td>127.4 (83.2)</td>
<td>153.8 (99.2)</td>
</tr>
<tr>
<td>4-BKA</td>
<td>39.1 (18.8)</td>
<td>41.7 (19.3)</td>
<td>38.5 (20.0)</td>
<td>38.6 (20.1)</td>
<td>42.7 (19.9)</td>
<td>126.9 (81.4)</td>
<td>153.9 (96.9)</td>
</tr>
<tr>
<td>5-Foot</td>
<td>25.8 (15.8)</td>
<td>27.5 (20.2)</td>
<td>22.3 (19.6)</td>
<td>21.8 (19.8)</td>
<td>27.1 (21.0)</td>
<td>90.4 (91.1)</td>
<td>105.2 (108.1)</td>
</tr>
<tr>
<td>6-Foot</td>
<td>24.5 (19.2)</td>
<td>27.5 (21.0)</td>
<td>22.6 (20.5)</td>
<td>21.9 (20.3)</td>
<td>27.1 (22.0)</td>
<td>96.4 (97.1)</td>
<td>111.2 (112.9)</td>
</tr>
<tr>
<td>Average</td>
<td>37.9 (40.4)</td>
<td>37.6 (37.2)</td>
<td>37.2 (40.9)</td>
<td>37.2 (40.9)</td>
<td>37.2 (37.2)</td>
<td>129.7 (154.9)</td>
<td></td>
</tr>
</tbody>
</table>
PtcO\textsubscript{2} in Air

The relationships between measurements made at sea-level air are shown in Figure 1.

Fig. 1. PtcO\textsubscript{2} sea level air measurements for the 3 electrode positions, before, during, and just after elevation (A10, A20, EL3, EL5, and A30) at 10, 20, 23, 25, and 30 minutes after the start of the study.

The average measurement for each electrode is plotted. The quadratic regression curves fitted to the 3 leg supine time-events using the pooled data at each location are shown in Figure 2. The assumption is made that measurements performed at the 30-minute time (5 minutes after leg elevation) are a continuation of the same stabilization curve measured at 10 and 20 minutes. The curves in Figure 2 show that maximum PtcO\textsubscript{2} occurs between 25 and 30 minutes after placement of the electrodes. The difference between 20 and 30 minutes is negligible for both leg positions (AKA and BKA), but noticeable for the foot position. In addition, the pattern of measurement outcome also shows a decrease in PtcO\textsubscript{2} with regard to electrode position from above the knee to the foot.

The regression models are shown in Table 2. Five minutes after leg elevation, the supine AK and BK readings have exceeded the 20-minute pre-elevation level, but the foot has not (Figure 2). None of the differences were significant at the 10% level in paired t-tests, and the differences were all less than 0.6 mm Hg. Thus, baseline readings taken between 20 and 30 minutes in air are not different. However, foot readings at 30 minutes were lower than at 20 minutes.

Table 2. Regression model results for a plot of baseline PtcO\textsubscript{2} values at 10 and 20 minutes (Air 10, Air 20) for the 3 different electrode positions.

<table>
<thead>
<tr>
<th>Model</th>
<th>Equation</th>
<th>(R^2)</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above Knee</td>
<td>(A20 = 6.633 + 0.918 \times A10)</td>
<td>0.894</td>
<td>± 10.2 mm Hg</td>
</tr>
<tr>
<td>Below Knee</td>
<td>(A20 = 4.586 + 0.961 \times A10)</td>
<td>0.890</td>
<td>± 12.7 mm Hg</td>
</tr>
<tr>
<td>Foot</td>
<td>(A20 = 2.101 + 1.019 \times A10)</td>
<td>0.874</td>
<td>± 14.6 mm Hg</td>
</tr>
</tbody>
</table>

Elevated Leg Readings

Leg elevation reduced the PtcO\textsubscript{2} measurements at each position measured. The magnitude of the drop also increased as the electrode position on the limb changed from above the knee to the foot.

The average PtcO\textsubscript{2} measurements for the 2 elevated leg readings (EL2, EL3) and the 2 readings in air before and after elevation (A20, A30) are shown in Table 3. Noteworthy is that the PtcO\textsubscript{2} measurements are noticeably smaller after 5 minutes of leg elevation. There are also strong relationships between PtcO\textsubscript{2} values at 20 minutes (A20) and the elevated leg measurement after 5 minutes (EL5).
Figure 3 shows the relationship for the PtcO₂ measurements in air at 20 min (A20) and elevated leg at 5 min (EL5) for the electrodes positioned at the foot. In this case, the best-fit regression equation is curvilinear: EL5 = -0.1491 + 0.5674 x A20 + 0.0054 x (A20)^2. The correlation coefficient is 0.875 with a 95% CI of ± 7.0 mm Hg. Initial PtcO₂ values below 40 mm Hg tended to be more depressed during leg elevation than those with higher initial values.

The PtcO₂ measurements at 5 minutes after leg elevation (EL5) closely parallel the leg supine measurements at 20 minutes (A20) for electrodes positioned below the knee as shown by the comparison of a perfect regression line with the fitted linear regression line (Figure 4). There is also a much less pronounced drop-off for PtcO₂ measurements below 30 mm Hg compared to those seen with the foot data in Figure 3. The fitted regression line has a correlation coefficient of 0.916 and a 95% confidence interval of ± 11.6 mm Hg.

The graph for above the knee data (not shown) shows comparable results to Figure 4.

Table 3. Mean (SD) PtcO₂ values for the 2 elevated leg measurements (EL3, EL5) and the 2 measurements in air, before and after elevation (A20, A30) for the 3 electrode positions (AK = above the knee; BK = below the knee).

<table>
<thead>
<tr>
<th>Electrode Position</th>
<th>A20 (mm Hg)</th>
<th>EL3 (mm Hg)</th>
<th>EL5 (mm Hg)</th>
<th>A30 (mm Hg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AK</td>
<td>52.1 (15.6)</td>
<td>51.3 (16.1)</td>
<td>50.9 (16.5)</td>
<td>52.7 (15.6)</td>
</tr>
<tr>
<td>BK</td>
<td>41.9 (19.1)</td>
<td>39.0 (19.7)</td>
<td>38.9 (19.9)</td>
<td>42.9 (19.5)</td>
</tr>
<tr>
<td>Foot</td>
<td>27.5 (20.6)</td>
<td>22.4 (20.0)</td>
<td>21.9 (20.0)</td>
<td>27.1 (21.5)</td>
</tr>
</tbody>
</table>

Breathing Oxygen at Sea Level

PtcO₂ measurements were taken at 5-minute and 10-minutes, and a summary of the data is shown in Table 4 (see page 46). The largest differences are above the knee.

Oxygen values cannot be accurately predicted from the values taken in air, as shown in Figures 5 and 6 in which the PtcO₂ values for oxygen at 10 minutes (O10) are plotted against air at 20 min (A20) for 2 electrode locations: below the knee (Figure 5) and the foot (Figure 6). The results for the above knee case (not shown) are similar.
The regression equations used to calculate best fit and corresponding correlation coefficients for the data shown in Figs. 5 and 6 are:

\[ O_{10} = 4.337 \times A_{20} - 0.0341 \times (A_{20})^2 + 0.0004 \times (A_{20})^3 \ (0.465; \text{Figure 5}) \]

\[ O_{10} = 3.4335 \times A_{20} + 0.0106 \times (A_{20})^2 \ (0.553; \text{Figure 6}). \]

Some patients experienced a decrease in PtcO₂ values with the administration of oxygen (Table 5), although almost all the cases of negative or zero response were for the electrodes located on the foot. These 73 electrodes had a significant correlation with the decrease in oxygen during 5 minutes of leg elevation (correlation coefficient = 0.414, \( P < 0.001 \)); the remaining 329 measurements with positive oxygen response were uncorrelated with the leg elevation oxygen drop (correlation coefficient: 0.0).

The issue of whether the leg supine and elevated conditions have the same response when oxygen challenge produced a zero or negative PtcO₂ change is shown in Table 6. The data show that the transcutaneous oximetry values for the elevated leg position at 5 minutes
are generally lower compared to baseline values at 20 minutes in air.

**Table 6.** Numbers of individual electrode readings obtained by categorizing PtcO₂ values for baseline supine position in air (A20) and when the leg is elevated for 5 minutes (EL5) for patients in which the oxygen challenge produced a zero or negative response. Figures in parentheses are percentages obtained by dividing number of readings for patients in which a zero or negative response to oxygen challenge was obtained by the total number of readings in each PtcO₂ category.

<table>
<thead>
<tr>
<th>PtcO₂ Category</th>
<th>A20</th>
<th>EL5</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 1 mm Hg</td>
<td>16 (62)</td>
<td>21 (47)</td>
</tr>
<tr>
<td>2 mm Hg</td>
<td>11 (55)</td>
<td>15 (48)</td>
</tr>
<tr>
<td>3 mm Hg</td>
<td>9 (50)</td>
<td>10 (37)</td>
</tr>
<tr>
<td>4 mm Hg</td>
<td>8 (44)</td>
<td>9 (43)</td>
</tr>
<tr>
<td>5-6 mm Hg</td>
<td>9 (50)</td>
<td>8 (38)</td>
</tr>
<tr>
<td>7-10 mm Hg</td>
<td>7 (37)</td>
<td>5 (17)</td>
</tr>
<tr>
<td>11-30 mm Hg</td>
<td>12 (11)</td>
<td>4 (4)</td>
</tr>
<tr>
<td>&gt; 30 mm Hg</td>
<td>1 (0.6)</td>
<td>1 (0.7)</td>
</tr>
<tr>
<td>Total</td>
<td>73 (18)</td>
<td>73 (18)</td>
</tr>
</tbody>
</table>

**DISCUSSION**

Transcutaneous oximetry is a noninvasive and a widely used assessment tool employed in wound-care centers for the evaluation of hypoxic wounds (1,2,10,20-22), level of amputation (9,23), limb salvage (7,24) and response to hyperbaric oxygen therapy (1-3,10,20,21,25). However, no controlled studies have been performed to determine the best times to measure the individual PtcO₂ test components that comprise the overall transcutaneous oximetry evaluation (1). Since it takes approximately 45-50 minutes to complete a PtcO₂ study, with the current emphasis on cost savings in the managed care setting, there have been recent attempts to decrease the time taken to perform a PtcO₂ study by decreasing the baseline measurement time to 10-15 minutes, followed by an oxygen challenge of 10 minutes. A standardized protocol with standard time intervals, which can be followed across all settings, would be ideal to improve the quality of the test as well as verifying whether cost savings can be achieved through shorter test periods. This study attempted to determine amount of time required for each element of test during PtcO₂ evaluation by examining retrospective data of 202 transcutaneous oximetry studies.

**Baseline Air**

In the first part of the PtcO₂ testing we studied baseline air values, which help determine the degree of hypoxia at baseline. This study confirmed the supposition that it takes at least 20 minutes to achieve a satisfactory baseline value in the supine patient. As the sensor heats the skin, equilibration of the electrode occurs within 10-15 minutes for subjects with normal circulation, but requires about 15-20 minutes for patients with compromised circulation (1,2).

In 1979, Sheffield and Dunn reported that PwO₂ measurements obtained by the use of invasive electrodes required a 90-minute precalibration equilibration period in a water-bath tonometer (26). Moreover the inserted electrode was allowed to equilibrate for a further 20 minutes to establish adequate baseline responses. In later work, Workman and Sheffield (27) studied continuous transcutaneous oxygen monitoring in smokers under normobaric and hyperbaric conditions and found that approximately 15 minutes was required to stabilize the electrode in all subjects, while Takagi-Smith allowed 10-15 minutes for equilibration before attempting to measure baseline values (28). In a later report, Sheffield proposed a 20-minute equilibration period for transcutaneous oximeters (1).

An assumption is made that the
measurement at the 30-minute mark (5 minutes after leg elevation) is a continuation of same stabilization curve measured at 10 and 20 minutes. This assumption is based on transcutaneous oximetry studies in which it was found that electrodes drift with time and a 5-minute return to the supine position breathing air after the leg elevation test should help readings re-achieve baseline values (1, 26). However our measurements at the foot suggest incomplete recovery from the leg elevation test, since the average readings at 30 minutes were slightly lower than at 20 minutes, although the difference between 20 and 30 minutes is negligible for BKA and AKA locations. Furthermore, the curves in Figure 2 show that maximum PtcO2 occurs between 25 and 30 minutes after placement of the electrodes. This data indicates that 30 minutes is probably required to obtain the best baseline measurements.

Measurement in air at 10, 20, 30 and 40 minutes before leg elevation would undoubtedly have been a better design but as this was a retrospective study, we could not look at baseline air values at higher time interval. Therefore further outcome studies are necessary to validate these findings.

Leg Elevation
A 5-minute elevated limb challenge consists of elevating the leg to 30º to identify the presence of large or small vessel disease that might cause the PO2 to fall until the patient is returned to the normal supine position (1,2). Numerous studies have documented that PtcO2 values are usually reduced in peripheral vascular disease (29-35), and different sensitizing physiologic challenges have been tested to improve the diagnostic accuracy of PtcO2 testing (36,37). In addition, the effect of leg position has been described as a useful test to classify the severity of peripheral vascular disease (30). However, in our study, elevation for 3 minutes versus 5 minutes showed a continuous decline in PtcO2, suggesting that a minimum condition is not reached within 5 minutes of elevation. Thus, it is important to perform the elevation test for at least 5 minutes.

PtcO2 responses at the foot location in our study varied markedly between the supine and elevated positions: patients with low initial PtcO2 readings had a noticeable drop with the leg elevated, but as the initial PtcO2 increased, the drop-off decreased, suggesting the possibility of vascular disease in patients who have an initial low PtcO2. At high initial PtcO2 levels, the supine and elevated PtcO2 values tended to converge. Thus it is possible that if the elevation test is continued for a longer time we might continue to see a drop in PtcO2 values. From a practical viewpoint, however, it is not necessary to conduct leg elevation tests for durations greater than 5 minutes, because the presence of vascular disease is usually readily identified within the 5 min time domain.

Oxygen Challenge
The oxygen challenge identifies the wounded area’s response to oxygen. Oxygen inhalation also helps to unmask hidden oxygen reserves by increasing oxygen saturation in the arterial blood. Under normal conditions, following inhalation of 100% oxygen, PtcO2 values in the foot increase approximately by 230% (38), but this response is substantially reduced in patients with arterial disease (37,39). An oxygen challenge has also been reported to improve the diagnostic accuracy of the PtcO2 study in selecting amputation level (39,40), predicting skin flap survival (41), and assessing limb ischemia (42).

This study found that there were substantial differences between the oxygen challenge at 5 minutes and 10 minutes, with the PtcO2 value at 10 minutes always being higher than at 5 minutes. But one can infer from this study that it is important to perform
the oxygen challenge for at least 10 minutes. While it is possible that the oxygen response might have continued to change with a longer time interval, in patients with hypoxic wounds, the presence or absence of an oxygen response is usually identified within 10 minutes, so from a practical viewpoint, it would not be necessary to conduct an oxygen challenge beyond 10 minutes. Further outcome studies are necessary to determine which time interval for oxygen challenge would be better predictor for healing. In addition, it was also found that oxygen challenge response values could not be predicted from ideal PtcO₂ baseline values.

An interesting finding in our study was consistent with results reported by Fife et al (20), who showed that in 14.4% of cases, a decrease in PtcO₂ on oxygen challenge was observed. All patients who had a decrease in PtcO₂ upon oxygen challenge also had an initial baseline oxygen measurement of less than 15 mm Hg, which might suggest that this subset of patients has a critically ischemic limb and need immediate vascular referral (25). These findings also correlate with those of Froneck (29), who showed that a mild degree of arterial occlusive disease does not significantly influence the recorded PtcO₂ reading; only severe obstructions lead to a significant decrease. Further outcome studies will need to be accomplished to determine if those patients who have decrease in the PtcO₂ response during oxygen challenge, have a worse prognosis.

CONCLUSION

This retrospective study suggests that ideal baseline values when breathing air during the PtcO₂ test requires at least 20 minutes for baseline air readings, and if maximal baseline values are desired, the test should be extended to 30 minutes. In patients with altered perfusion ideal baseline may be higher than 30 minutes. The best results for physiological challenges were obtained when the leg elevation test was conducted for at least 5 minutes. However, leg elevation measurements appear to continue to decrease with time, so further studies will be needed to determine the time interval to observe the maximal decrease. For the oxygen challenge test, 10 minute oxygen challenge values were higher than 5 minute values. After each physiological challenge, the sensor should be allowed at least 5 minutes to re-equilibrate. Finally, our study suggests that the PtcO₂ response to the oxygen challenge cannot be accurately predicted from values taken in air. This study also found that 14.4% of cases had a decrease in PtcO₂ on oxygen challenge. Further outcome studies are necessary to determine ideal baseline values when breathing air, to determine which time interval for oxygen challenge would be better predictor for healing, to accurately determine amount of time required to re-equilibrate after each study and to determine prognosis in patients with negative oxygen challenge results.

REFERENCES

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