Effect of recording site on pulse oximetry readings

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Abstract

An audit found clinically significant differences between ear and finger pulse oximetry readings during ambulatory oxygen assessments.

Keywords: Pulse oximetry/Ambulatory oxygen therapy/Oxygen saturation

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The purpose of ambulatory oxygen therapy is to improve patients’ quality of life and maintain independence by enabling them to perform normal activities of daily living, by improving or correcting exercise-induced hypoxaemia.

Ambulatory oxygen therapy refers to the provision of oxygen to patients who demonstrate oxygen desaturation during exercise and activities of daily living (British Thoracic Society, 2006). It has been shown to be effective in increasing exercise capacity and reducing breathlessness in those with exercise arterial oxygen desaturation, which is defined as a fall in oxygen saturation of 4% to a value of <90% (Eaton et al, 2002; Leach et al, 1992).

A formal ambulatory oxygen assessment is necessary to calculate the oxygen flow rate needed to correct the exercise desaturation (BTS, 2006). It also gives an opportunity to introduce patients to their oxygen equipment and educate them in the most effective way to use the therapy.

Patients’ ambulatory oxygen needs are routinely assessed and titrated using portable finger pulse oximetry. The ambulatory assessment protocol at Wythenshawe Hospital is based on the BTS (2006) guidelines. In practice, when we used finger oximetry we found movement artefact from hand movement or reduced circulation could adversely affect the measurement. To try to resolve this, an ear oximeter was used alongside finger oximetry on all ambulatory oxygen assessment patients.

It soon became apparent that there was a marked discrepancy in the readings, even when finger oximetry readings were maintained throughout the assessment.

A preliminary audit of the data suggested ear oximetry readings were higher. We believed these differences could be significant enough to affect the prescription of ambulatory oxygen so we decided that both ear and finger oximetry recordings should be audited over an 18-month period.

Aim

The audit investigated whether there was a significant difference between finger and ear oximetry readings during ambulatory oxygen assessments and to determine whether any differences could change clinical outcome.

Method

The 18-month audit looked at 304 patients who were referred for ambulatory oxygen assessment or review. The breakdown of primary diagnoses was: 100 people with chronic obstructive pulmonary disease (COPD); 158 with...
5 key points

1 Patients’ ambulatory oxygen needs should be routinely assessed and titrated using portable finger pulse oximetry

2 This audit found clinically significant differences between ear and finger oximetry readings, which led to a change in practice

3 To carry out pulse oximetry

Using the ear, it must be suitably vasodilated – the ear lobe should look red.

If assessment is prolonged, it may be necessary to revasodilate the ear if the signal becomes weak.

Oxygen saturation should be monitored even after exercise – many patients, especially those with pulmonary fibrosis, continue to desaturate post exercise.

Finger pulse oximetry is used to assess patients’ ambulatory oxygen needs.

Patients were told to walk at a comfortable pace for up to six minutes. Pre- and post-pulse oximetry saturation and pulse rate were recorded from the finger and ear oximeters simultaneously.

Results

Bland-Altman plots were used to show limits of agreement; the accepted equipment accuracy was ±2% (for oxygen saturations of 70-100%). This is what most oximeters quote as their accuracy range, including the Minolta.

There was a statistically significant difference between ear and finger pulse oximetry measurements both before and after exercise (p<0.001 for both).

Bland-Altman analysis demonstrates the variation around the mean, and was used to investigate whether there was a clinically significant difference between the ear and finger oximetry readings.

The mean difference before exercise was 1.9%, which is within the accepted accuracy of the equipment of ±2% for oxygen saturations of 70-100%. However, the mean difference after exercise was 2.8%, which falls outside the equipment accuracy limit.

The accuracy of oximeters is limited below saturation readings of 70%. Analysis of the raw data showed that only five of the patients audited had post-exercise saturations that fell below 70% and, in all these cases, the two oximeters recorded saturations within 2% of each other. This suggests the saturation differences are not a result of the equipment’s limitations.

Eighty-two (27%) of the 304 patients audited would have had a different outcome from their treatment if only one oximeter had been used during their assessment. A different outcome was defined as the patient either meeting the criteria to start ambulatory oxygen or needing an increase in their oxygen flow rate according to just one of the oximeter recordings.

The other 222 patients had the same outcome regardless of which oximeter was analysed.

Of the 82 patients who had a different outcome, 77 would have been started on ambulatory oxygen or had their flow rate increased if finger oximetry alone had been used. This is one quarter (25%) of the total 304 patients audited. The remaining five required an increase in flow rate.

The results therefore suggest that, before exercise, the two methods can be used interchangeably but, after exercise, the mean difference is clinically significant (±2%) so the two methods cannot be used interchangeably.

Discussion

There are limitations to our audit and its findings. Only one make of oximeter is routinely used at Wythenshawe Hospital during ambulatory oxygen assessments so this was used in this audit.

The differences in the recordings after exercise are most likely due to a combination of both movement artefact and poor peripheral blood flow in the finger, both of which are minimised in a suitably vasodilated ear lobe.

The findings of this audit have resulted in a change of practice at Wythenshawe Hospital. All patients referred for any exercise study are now assessed using ear oximetry only.

Financially, the NHS benefits, because fewer patients met the criteria for ambulatory oxygen so do not require oxygen therapy reviews. Also, as fewer patients met the criteria for commencing ambulatory oxygen, they did not need costly portable oxygen cylinders; those who did not need their flow rate increased did not need additional cylinders.

The principles of these findings can be applied to non-exercise clinical uses of portable oximeters. While movement artefact may not be a significant issue for ward patients, poor circulation could affect readings.

Conclusion

The audit found statistically and, more importantly, clinically significant differences between ear and finger oximetry measurements recorded after exercise.

More than a quarter (27%) of the 304 patients audited would have had a different outcome from their treatment if only one oximeter had been used during assessment; one quarter (25%) of the total audited would have been started on ambulatory oxygen or had their flow rate increased if finger oximetry alone had been used.

It is clear that this difference in outcomes is potentially significant, not only to patients emotionally and in terms of the impact on quality of life, but also to the national ambulatory oxygen budget.