The role of pulse oximetry in the accident and emergency department

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SUMMARY

Prompt recognition and treatment of hypoxia is an important part of management in the accident and emergency (A & E) department. Until recently the only reliable method of detecting hypoxia was by estimation of the arterial blood gases (ABG). Continuous monitoring of the arterial oxygen saturation (SaO_2) is possible using an infra-red pulse oximeter. This study assessed the usefulness of this instrument in the A&E setting.

The SaO_2 was measured in 50 patients using a pulse oximeter. In 15 patients simultaneous ABG estimations were obtained. The SaO_2 correlated closely with calculated values for SaO_2 . The use of the oximeter identified 21 patients (42%) with clinically unsuspected hypoxia.

The pulse oximeter proved simple to use, accurate and a useful addition to our resuscitation equipment.

INTRODUCTION

The early detection and correction of hypoxia in acutely ill patients is an important part of management in the A&E department. Until recently this was only possible by analysis of arterial blood gases, which require the discomfort of arterial puncture and the risk of errors in sample handling, transport and analysis.

Experience in the operating theatre and intensive care units has shown that continuous, beat to beat monitoring of the arterial oxygen saturation (SaO_2) is possible with an infra-red pulse oximeter (Yelderman & New, 1983; Kim *et al.*, 1984; Taylor & Whitwam, 1986). Pulse oximetry accurately reflects oxygen delivery and provides continuous assessment of the partial pressure of oxygen.

To date little work has been published on the value of this technique in the A&E

setting (Jones *et al.*, 1988). This study attempted to determine the usefulness of pulse oximetry in this department.

PATIENTS

Fifty patients were entered into a prospective study from those seen in the Resuscitation Room of the A&E Department of Leeds General Infirmary between June and September 1988. There were 34 males and 16 females, median age 70 years (range 26–90). Initial diagnoses are shown in Table 1.

Table 1 Initial diagnoses of patients

Diagnosis	Number
Angina	13
Obstructive airways disease	6
Vasovagal collapse	6
Cerebral vascular accident	4
Pneumothorax	3
Asthma	2
Pneumonia	2
Pulmonary oedema	2
Septicaemia	2
Tachyarrhythmia	2
Pericarditis	1
Drug overdose	1
Acute pancreatitis	1
Facial injury	1
Total	50

METHODS

A microprocessor controlled pulse oximeter (Physio Control LIFESTAT 1600) was used to provide a continuous reading for SaO_2 and pulse rate. Pulse oximetry functions by placing a pulsating vascular bed, in this case a finger tip, between a 2-wavelength light source and a photodetector. The AC signal detected is due to pulsations of the vascular bed and is further processed using the known absorption coefficients of saturated and unsaturated haemoglobin to give the proportions of each, that is the SaO_2 . Pulse rate is derived from the pulsations of the vascular bed.

After routine assessments of the pulse and blood pressure the patient was connected to an ECG monitor and the peripheral sensor of the pulse oximeter attached, usually to the left index finger. The SaO_2 and pulse rate were recorded and any discrepancy between the ECG and oximeter values for the pulse rate noted. Arterial blood gases were performed at the discretion of the doctor involved.

The response to therapeutic manoeuvres, for example starting oxygen therapy, was also noted.

RESULTS

Satisfactory SaO_2 readings were obtained in all patients. Fifteen patients had arterial blood gas estimations at the same time as SaO_2 readings. These show good correlation with the values for SaO_2 calculated from the measured pH and PaO_2 (Fig. 1).

The SaO_2 correlated with PaO_2 over a wide range of pulse rate (50–140 beats/min) and systolic blood pressure (60–220 mmHg) irrespective of age, sex or diagnosis.

Use of the pulse oximeter prompted initiation of oxygen therapy in 17 (34%) patients with clinically unsuspected hypoxia and in a further four the inspired oxygen concentration was increased, when the SaO_2 was found to be lower than 94%. The availability of the SaO_2 value avoided arterial blood gas analysis in 22 patients and repeated arterial puncture in a further nine patients.

The only technical problem we encountered was that occasionally the peripheral sensor would become displaced but this was easily recognized and replaced.

Fig. 1 Comparison of SaO_2 from finger oximeter and calculated SaO_2 from measured arterial pH and PO_2 .

DISCUSSION

The early detection of hypoxia can be very difficult because the clinical signs are unreliable. Until recently estimation of arterial blood gases was the only reliable method. Measurement of PaO_2 using a transcutaneous electrode has overcome some of

the problems but these systems have varying response times and the position of the electrode must be changed to avoid tissue damage. In addition, the accuracy of the transcutaneous electrode is impaired in cases of reduced cutaneous blood flow, which does not occur with the pulse oximeter (Tremper & Shoemaker, 1981).

Pulse oximetry assumes only two forms of haemoglobin are present in the blood, reduced and oxygenated. This may lead to errors in the presence of other forms, for example carboxyhaemoglobin and methaemoglobin. However, the presence of foetal haemoglobin does not affect the accuracy (Fanconi *et al.*, 1985). The presence of carboxyhaemoglobin in cigarette smokers or after smoke inhalation may give falsely high values for the SaO_2 although the indicated saturation is an accurate reflection of the saturation of the haemoglobin available for oxygen delivery (Tweeddale & Douglas, 1985).

When interpreting the SaO_2 it is important to recognize that it is limited by the shape of the O_2 dissociation curve. Above 94% saturation large changes in oxygen tension produce small increases in saturation, while below this level there is a rapid fall in oxygen tension for a small fall in saturation. Assuming a normal dissociation curve, a saturation of 94% represents an O_2 tension of 10kPa and it is suggested the oximeter alarm should be set at this level, however in some patients the curve may be shifted to the left, for example after large blood transfusions, or to the right, for example sickle cell anaemia which will influence the interpretation of the saturation.

The early use of pulse oximetry allowed the rapid recognition of hypoxic patients, initiation of corrective measures and rapid assessment of the effectiveness of these measures. Failure to respond to simple measures may indicate the need for more aggressive therapy, for example intubation. We noted that certain procedures, for example tracheal suction and gastric lavage cause transient hypoxia. This underlines the need for adequate pre-oxygenation before these procedures. In addition to assessing the general oxygenation of a patient we found the pulse oximeter to be useful for determining local oxygen delivery in patients with limb trauma where reduced saturation was an early indicator of proximal arterial injury.

Forty-two per cent of our patients were receiving no oxygen or an adequate concentration of oxygen. This would have remained unrecognized until arterial blood gases were estimated. Failure to recognize hypoxia has been identified as one of the major avoidable causes of death in trauma patients (Anderson *et al.*, 1988). Early use of the pulse oximeter should identify patients at risk and would probably reduce the number of deaths in this group.

We have found the pulse oximeter to be a useful addition to our emergency room equipment. It provides rapid, continuous and accurate information, without the need for repeated arterial blood gas analysis, provided the limitations of the technique are recognized.

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