# The Pulse Oximeter in the Dental Surgery

**H. Lopert**
Royal Canberra Hospital,
Canberra, Australia

Pain is one of the major factors that brings patients to the dental surgery, but fear and anxiety are common reasons why patients fail to seek dental care. The control of pain and anxiety is therefore a very important part of dental practice.

The use of sedative techniques is increasing, due mainly to patient demand and also the realization by the dental surgeons that the work they can do on a patient is much improved if the patient is relaxed and cooperative and does not shrink away. But with the increasing use of sedative techniques has come an increasing incidence of problems resulting in patient morbidity and mortality. As the majority of dental patients are ambulatory and in good health, this is totally unacceptable.

Reliable figures for mortality and morbidity in the dental chair are difficult to come by, but reports in dental literature[1] and of litigation[2] suggest that problems are more common than is generally realized.

Minimal standards of training of personnel and of the equipment essential for procedures have been promulgated, but debate as to the correct monitoring equipment continues. I would like to put forward the concept of the use of the pulse oximeter as the *most* useful and the *only* piece of mechanical monitoring equipment needed in the dental surgery.

The purpose of monitoring is twofold. It serves to control depth and response to the sedation given, ie, the degree of physiological trespass, and to warn of impending disasters, most of which occur infrequently and are therefore unexpected. The monitoring techniques most frequently used in anesthesia—that is, electrocardiography and noninvasive blood pressure monitoring—are primarily of value in the control of the depth of sedation and are of little value for the early detection of potentially disastrous situations.

In any critical incident, time elapses between the detection of the problem, the identification of the cause, and its correction, during which damage to the patient may occur. Delay in any of these phases increases the likelihood of injury. Thus, both early detection and a prompt response are important if any disaster is to be averted.

The big killer and the big damager is hypoxia, the lack of availability of oxygen ($O_2$) to the tissues. For adequate availability of $O_2$ to the tissues a number of criteria must be satisfied:

1. An adequate concentration of oxygen in gases inhaled by the patient.
2. Controlling the amount of oxygen actually entering the lungs: adequate ventilation by the patient.
3. Adequate pulmonary gas exchange.
4. Adequate blood flow to the tissues.
5. Adequate oxygen-carrying capacity.

The early detection of even small levels of hypoxia gives warning of impending disaster before major damage is done to the patient. Even in the healthy patient there is a very small margin of safety which gives little time for remedial measures before irreparable damage occurs.

Human senses cannot detect hypoxia or the adequacy of ventilation with sufficient sensitivity or reliability. Therefore, the use of monitors that can detect such factors extends the vigilance of the operator.

The pulse oximeter is an instrument that detects hypoxia. Tissue hypoxia is the major cause of morbidity and ultimately the cause of death in most humans. Pulse oximeters are usually accurate to within 2% in the range of 70 to 100% hemoglobin saturation when the sensors are receiving a satisfactory signal.

The principle by which pulse oximeters work is the use of two narrow wave-band light-emitting diodes and stabilizing circuits to ensure consistent light output. Each LED switches on and off at about 700 Hz, and a single broad band photo diode detects the transmitted light and compares this with the background light. A microprocessor determines the amounts of background red and infrared light reaching the sensor in both systole and diastole. A microprocessor considers only the pulse-added signal produced by each pulse under the sensor and the differential absorption at the two light wavelengths. From these it calculates the percentage $O_2$ saturation of the arterial blood. Saturation values are assayed over seconds and are usually displayed both digitally and audibly. The pulse signal is generated as a by-product of

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Address correspondence to Dr. H. Lopert, Royal Canberra Hospital, Canberra, Australia.


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the saturation measurement and is displayed both digitally and (usually) graphically.

In the most recent generation of pulse oximeters the sensors are noninvasive. Routine calibration is not required, as the pulse oximeter monitors are programmed to check their internal calibration and sensor function when switched on and intermittently during use. Alarms are activated by switching on the monitor. Most pulse oximeters give a continuous audible indication of each pulse with the tone being modulated by the degree of saturation. Most provide a graph or a wave-form display of the pulse plethysmogram, and some have additional signal strength indicators that help to verify good signal acquisition and to provide an index of the reliability of the displayed saturation values. As no skin heating is used for measurement, they are capable of continuous and safe operation.

Interference from skin pigmentation and jaundice is not a problem, but there are some limitations on their use. An adequate pulse is needed: gross hypothermia, vasoconstriction, or low blood pressure will result in a loss of signal. Movement artifact caused by patient shivering or movement of the sensor may obscure pulse signal. If you are using a finger sensor, synthetic fingernails may interfere with light transmission and saturation readings. It is said that nail varnish does not interfere with these signals, but, in my experience, it does. The sensor must be kept clean and free of adhesive material.

Hemoglobin must be the dominant color species; therefore, gross anemia and abnormal hemoglobins like methemoglobin or carboxyhemoglobin are not distinguished from oxyhemoglobin—but one assumes that patients with these conditions would not be suitable for this type of work in the dental surgery. If you are using very high intensity light you need to screen the sensor effectively, or the oximeter may display inappropriately high pulse and saturation values.

The pulse oximeter presents an opportunity for a great increase in patient safety. It may be used to advantage as a continuous, noninvasive, rapid-response monitor of oxygenation in all patients who are at risk. Poor patient access or difficulty in observing the patient's color—for instance, when a rubber dam has been placed in the mouth—would be particular indications for pulse oximetry. Patients at special risk from hypoxia such as the pregnant, the grossly obese, those with deeply pigmented skin, and those with lung disease are good candidates for the use of pulse oximetry. But an argument can be made for the use of pulse oximetry in every patient in whom normal reflexes are depressed due to sedation. Pulse oximeters are reliable and suffer from no major disadvantages. They provide an indication on a beat-to-beat basis of heart rate, pulse rhythm and volume, and the saturation of the hemoglobin in arterial blood. If the patient is having inhalational sedation, that is, with nitrous oxide and oxygen, then pulse oximeters do not replace the use of an oxygen analyzer on the inspirationary limb of the patient circuit which monitors machine and circuit function.

Pulse oximeters represent the greatest advance in patient monitoring to date, for they noninvasively and safely provide a continuous indication of adequate circulatory and respiratory function.

## REFERENCES

1. Goodson, Moore. JADA, 1983.
2. MDU, 1982.
3. Griffiths, Isley, Runciman. Anesthesia and Intensive Care 1988;16:1.