

Anaesthetic Monitoring - the Pulse Oximeter

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The finger on the pulse, the blood pressure (BP) cuff and the piece of string that ties the anaesthetist's trousers to the operating table are still the best monitoring devices in anaesthesia.

The piece of string makes him look at the patient to observe movement of the chest, colour etc., and also at the anaesthetic machine to see if cylinders have run out (if the old Boyles machines are still being used). It also makes him look at the reservoir bag to see if it is still moving with respiration.

There will never be a substitute for taking the BP with a manually inflated cuff and a finger on the pulse. However, electronic monitoring may also be useful.

The ECG display monitor does not give much additional information over and above that gained from feeling the pulse, and setting the monitor up may even distract the anaesthetist from his patient. You can see and diagnose arrhythmias on the ECG monitor but most Malawians do not get arrhythmias under anaesthesia.

A machine that told one about oxygenation would be more useful. Most of the avoidable deaths or near misses on the table that have occurred have been preceded by a period of hypoxia lasting several minutes. These regrettable events are, in my opinion, much more common in Malawi than many people realise or care to investigate. They unfortunately often affect otherwise healthy patients, resulting in brain damage or death.

Hypoxia is a lack of oxygen. A lack of oxygen kills. In the tissues this is invisible but fortunately for us, the pigment in blood, haemoglobin (Hb), has a different colour when it is de-oxygenated compared to when it is oxygenated. We are familiar with the darker colour of de-oxyhaemoglobin and when we see it under the skin we call that sign cyanosis.

The human eye cannot, however, detect any but the most advanced states of cyanosis, even if it is looking in the right direction! In dark skinned

people cyanosis is even harder to see. When there is severe anaemia, cyanosis cannot be seen at all, even when the patient is grossly hypoxic.

The different colour between oxy- and de-oxyhaemoglobin is caused by different wavelengths of light being reflected by the blood pigment in these different states. An electronic photocell can detect this difference.

The pulse oximeter is such a device. It consists of a small photocell probe, resembling a clothes peg, which is conveniently clipped to the thumb or finger and connected to a compact battery and mains operated display unit. The finger probe is set to detect the two different wavelengths of reflected light in capillary blood and the display shows the amount of oxy-Hb compared with the sum of the oxy- and de-oxy-Hb present, expressed as a % saturation. "100% sat" means you are as fully oxygenated as you can be.

Provided the capillary bed is perfused and only these two types of haemoglobin present in the blood (i.e. there is no carboxyhaemoglobin or methaemoglobin present), the pulse oximeter will give the observer a beat by beat display of the oxygen saturation of the blood in the finger and therefore, by inference, of the tissues generally.

There are several applications for this state-of-the-art technology. However it must be remembered that the first step in using this machine is to place it on a firm surface and ensure the wires leading to it will be stepped over, and not stepped on. A machine at Queen Elizabeth Central Hospital was pulled to the floor a short time after arrival and it has not been the same since!

The following list includes some of the uses of the pulse oximeter:

1. It is a teaching tool showing the physiology of oxygen delivery.
2. It is especially useful to evaluate the efficacy of oxygen therapy during recovery from anaesthesia and surgery and on the ward.
3. It shows when tracheal intubation is too slow. It shows when the tube is in the wrong place or blocked or when any complication has arisen with the oxygen supply at any place in the anaesthesia circuit, or due to patient airway obstruction. Furthermore, it shows these things early on.

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4. It shows heart rate, not very accurately, and if circulatory arrest has occurred.
5. It is a research tool to detect drugs that cause hypoxia, e.g. ketamine given by fast IV injection.
6. It can be used to help diagnose chest infections and cyanotic heart disease.

Since its introduction only a few years ago, the pulse oximeter is now so highly regarded, that in Europe and North America almost every operating theatre has one. In the USA it is now considered malpractice to give anaesthesia without the pulse oximeter connected to the patient.

However, it does have some limitations:

1. In shock and other low cardiac output states it is difficult to get a reading at all because of poor capillary perfusion. These are unfortunately the very cases when monitoring would be most useful.
2. If the BP falls there is usually no indication on the oximeter.
3. Readings may be difficult to get in babies.
4. It can give false low readings of oxygen saturation.

The current cost of the pulse oximeter is around K 7,500 to K 10,000.