Appropriate use of oxygen in acute medicine

Oxygen use in acute medicine requires regular monitoring to maintain saturation levels within the prescribed range

A core and firm principle of the TSANZ guidelines is to formalise the use of oxygen as a drug that is rationally and precisely prescribed

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It may seem intuitive that oxygen is "good", so, for the ill or even just distressed, more must be better! However, the evidence for this common clinical approach is at best anecdotal and mainly cultural.[1] In fact, both (very) low and high oxygen levels are bad and, indeed, inappropriate use of oxygen in acute medical treatment may be harmful.[2-4] Hyperoxia leads to vasoconstriction, and oxygen uptake actually falls.[5] Overly vigorous prehospital use of oxygen may well be a significant contributor to death in common acute medical conditions.[6]

When is a human truly hypoxaemic?

Technically, hypoxaemia occurs when tissues begin to produce lactic acid because of anaerobic metabolism. In the 1960s, a study showed that heart muscle in healthy people did not produce lactic acid until the circulating blood oxygen saturation level was in the region of 50% (equivalent to a partial pressure of less than 30 mmHg), but in people with ischaemic heart disease, oxygen saturation levels were usually in the range of 70%–79%, occasionally as high as 85%, (around 55 mmHg) when cardiac lactate was produced.[5] In practice, hypoxaemia has been arbitrarily and conservatively assumed at a saturation level of 88%–90%, although humans can cope quite well at lower levels than this, for example, during sleep, on mountains and when flying. This threshold for hypoxia is also above the point at which central cyanosis is likely (ie, less than 85%). Thus, in clinical situations the target of 88%–90% in arterial oxygen saturation should provide a very adequate buffer. Of course, supply of oxygen to the tissues also depends vitally on haemoglobin concentration and cardiac output, and elevating the central oxygen saturation will not compensate for tissue hypoxia if that is due to abnormalities in oxygen carrying capacity.

Thoracic Society of Australia and New Zealand guidelines

In an attempt to provide evidence-based interpretation in this currently confusing clinical area, the Thoracic Society of Australia and New Zealand (TSANZ) has developed new guidelines for oxygen use in the acute medical setting. These guidelines used the evidence base of the 2008 British Thoracic Society guidelines[7] and the draft of an update to these guidelines due to be published in 2015. However, the TSANZ guidelines differ in some practical ways, aiming to avoid the worst "compromises" made to achieve professional consensus in the United Kingdom. The TSANZ guidelines will shortly be published in the journal, *Respirology*, but have already been endorsed by the Board of the TSANZ and a wide range of other professional medical, nursing and allied health bodies.

A core and firm principle of the TSANZ guidelines is to formalise the use of oxygen as a drug that is rationally and precisely prescribed — that is, with a specified mode of delivery (our practical preference is by nasal cannulae), flow rate (or FiO_2) and rational target range of oxygen saturation. The latter would be 88%–92% in patients with chronic obstructive pulmonary disease or other chronic respiratory conditions in which carbon dioxide retention is a possibility, and 92%–96% for most other medical conditions requiring oxygen supplementation. For the reasons discussed, 92%–96% is probably unnecessarily high, but it is the Australian guidelines' compromise so as not to cause controversy. This range does allow both deterioration and improvement in the patient's condition to be detected easily and in a timely way, rather than being masked by overoxygenation. Regular and iterative monitoring is necessary to determine if saturation levels are remaining within the prescribed range. If the patient's need for oxygen decreases, then oxygen flow rates are adjusted down to stay within the prescribed range of oxygen saturation. Conversely, if a patient's oxygen needs increase and flow rates need to be increased to keep saturation levels within the prescribed range, then medical review is needed and the patient may need to be moved to a high dependency unit. The emphasis is on heeding changes in the levels of oxygen saturation, not for their own sake, but as a reflection of the underlying condition.

The TSANZ guidelines support initial arterial blood gas measurements to define the true oxygen and carbon dioxide status of the patient. They discuss the usefulness of currently overpopular venous blood gas assessments (which cannot assess oxygenation and have problems with assessing carbon dioxide levels)[8] and underutilised arterialised capillary blood gas assessments.

The most practical way to monitor oxygenation is with a pulse oximeter. Most manufacturers of oximeters quote an accuracy of ± 2%, although older published data quote higher variability.[9] A new study with modern equipment is urgently needed, but the TSANZ guidelines include sufficient safety margins to make the variability of oximeters relatively unimportant.

It needs to be stressed that oxygen is not indicated for breathlessness without hypoxia. Further, acute hypoxaemia is commonly caused by hypoventilation and carbon dioxide retention, which must be recognised (by measuring arterial blood gases), and may mean that the patient requires assisted ventilation in an appropriate setting.[10]

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