Information Paper

Hypoxia

This information paper raises pilot's awareness of the dangers of chronic, low-level hypoxia that may be experienced at substantially lower than expected altitudes.

1. INTRODUCTION:

Where an increased risk of hypoxia exists, good risk management practices should be used for flight planning. Because the effects of hypoxia can be insidious, recognition of early symptoms of hypoxia can increase the time available to react, descend and resolve any issue. Remembering all the symptoms can be a challenge for some. Prevention of hypoxia is what we should all aim for however recognising the early symptoms of hypobaric hypoxia (most common form for pilots) is imperative for safe flying, so to refresh your memory:

2. SIGNS AND SYMPTOMS OF HYPOBARIC HYPOXIA INCLUDE REASONS MAY BE NUMEROUS AND VARY. SOME MAY BE:

- darkening and restriction of the visual field and loss of peripheral vision
- increased heart rate, hyperventilation, and light-headedness
- syncope (fainting/unconsciousness, pallor, sweating, nausea, and vomiting)
- cyanosis (bluish colouration of the skin, nail beds and mucous membranes)
- impairment of mental performance and neuromuscular control, slowed reaction time.
- muscular spasms

Preparation and provision of supplemental oxygen for altitudes exceeding 10,000 feet is paramount hence CASA requirements for supplemental oxygen for flights above 10,000 feet altitude for unpressurised aircraft.

3. CAO 20.4 PROVISION AND USE OF OXYGEN AND PROTECTIVE BREATHING EQUIPMENT

6.1 A flight crew member who is on flight deck duty in an unpressurised aircraft must be provided with, and continuously use, supplemental oxygen at all times during which the aircraft flies above 10 000 feet altitude.

At first appreciation, these requirements would appear to be reasonable and adequate to prevent hypoxia. After all, we know that climbers of Mount Everest have been able to face the extreme, hostile conditions of the mountain and climb to 29,029 feet without supplemental oxygen! Therefore, would it not seem reasonable that a pilot could fly below the Flight Levels (below 18,000 feet) and perform well, without the use of supplemental oxygen? As always, real answers to this question can be found by referring to the research literature and understanding what researchers have found in well-conducted studies.

Without delving too deeply into the details of published studies on hypoxia at moderate altitudes, a nice summary of this body of research literature can be found in work by Petrassi et al., in an edition of Aviation Space and Environmental Medicine ("Hypoxic Hypoxia at Moderate Altitudes: Review of the State of the Science, 2012 Oct;83(10):975-84.)

These authors carried out a systematic review of the literature regarding hypoxic impairment of mental functions, sensory deficits, and other aviation related duties at moderate altitudes (between 8,000 to 15,000 feet). **Briefly, they concluded that activities such as learning, reaction time, decision-making and certain types of memory are affected at these altitudes in subjects not receiving supplemental oxygen. Clearly, these are important activities for a pilot involved in flight-critical actions and decision-making.**

To further complicate matters, there is a well-known and normal physiologic response of increasing breathing rate (hyperventilation) in response to altitudes above 8,000 to 10,000 feet. This mild, almost imperceptible, hyperventilation will reduce blood arterial carbon dioxide levels (hypocapnea) that in turn, result in a complex interaction between reduced blood oxygen levels (hypoxia) and brain (cerebral) blood flow.

The net result of this complex interaction between blood arterial blood gases and cerebral blood flow is that individuals will have a widely variable response to the effects of altitude regarding performance of complex tasks. In addition, it has been shown that experienced pilots are able to make better speed and accuracy decisions and thus, perhaps, better able to compensate for altitude related performance decrements than less experienced pilots.

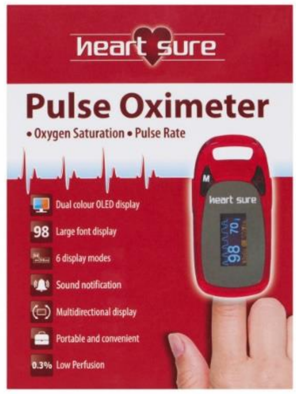
Taken altogether, these observations explain why some pilots may appear to be more susceptible to the effects of moderate altitude than others. Under low light conditions (i.e.-night), visual degradation has been demonstrated at altitudes between 4,000 to 5,000 feet. In addition, under daylight conditions, visual degradation has been shown to occur at 10,000 feet.

Surprised by how susceptible these test subjects appear to be to mild hypoxia at moderate altitudes? Probably shouldn't be, even when compared to your own flight experience(s). These results are not referring to dramatic changes, such as blindness or suddenly becoming so cognitively "stupid" that you couldn't repeat your name. Instead, the review of this research should warn that even the healthiest of pilots are susceptible to subtle changes in performance, cognition and vision occurring at altitudes that we are frequently completely content to fly at, without considering the use of supplemental oxygen.

Furthermore, less-than-perfect pilot specimens (e.g.- older pilots with age related illness, smokers, pilots with mild anemia (a condition in which you lack enough healthy red blood cells to carry adequate oxygen to your body's tissues) and other acute or chronic diseases would be expected to experience greater effects or decrement in performance at **lower altitudes.**

One obvious solution would be to fly at lower altitudes. However, taking this approach would be negating some real advantages of flying at moderate altitudes. For example, one could enjoy the benefits of contending with less traffic, higher true airspeed's, potentially greater effects of tailwinds and in some cases, avoiding low level weather, simply by flying at altitudes between 8,000 to 18,000 feet.

With the assumption that one wants to take advantage of high(er) altitude flight, let us examine what constitutes best operating practices for such an endeavour. Since there is much variation in an individual pilot's response to altitude, the only way to truly guard against insidious hypoxia is by measuring the pilot's blood oxygen saturation with a pulse oximeter. These finger clip pulse oximeters are relatively inexpensive and widely available from several sources, from ebay to chemists to pilot shops. Also available are watches which incorporate an oximeter such as Apple Watch and Fitbits which are an alternative to the finger attached device.



For today's recreational or GA pilot, flying above 10,000 feet without pulse oximeter readings is equivalent to flying without current charts!

As a rule, a pilot should strive to maintain their oxygen saturation, as indicated by the pulse oximeter, to be at least 90%, or higher. Do not rely on your subjective sense of wellbeing or perceived performance, as a substitute for obtaining real data regarding blood oxygen saturation from a pulse oximeter! If oxygen saturation levels are lower than 95%, the pilot has one of two choices: a) descend to a lower altitude or b) utilise supplemental oxygen (or both).

- A person's normal blood oxy sat should be in the 95-99% range. Anything below is cause for concern.
- If it starts falling continuously from or stays below 95% - it's getting serious – you must do something – descend or turn-on / increase oxy flow.
  Below 90% - you're technically defined as being hypoxaemic. **Hypoxaemia** refers to a lower-than-normal arterial blood oxygen level, measured either as oxygen saturation (SaO2) or partial pressure of oxygen (PaO2).

  Falling below 90% you are getting into SERIOUS trouble where a rapid remedy is required – BEFORE you get to the point where you lose the insight to recognise you have a problem and then – that's the beginning of the end.

Where an increased risk of hypoxia exists, good risk management practices should be used for flight planning. Consider how your current health or habits may potentially reduce the 10,000 feet limit for supplemental oxygen.