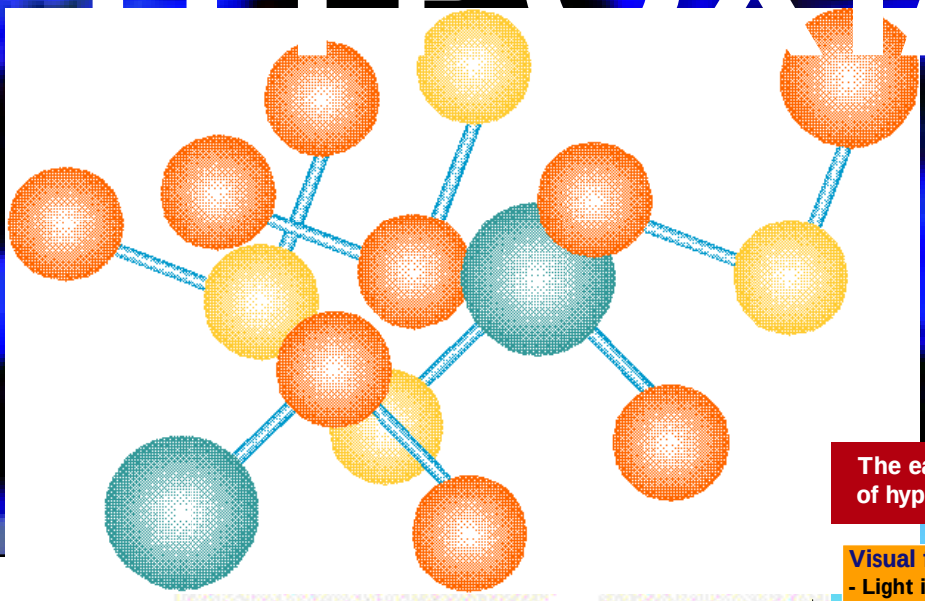
HYPOXIA



Flying fox (2)

Without oxygen the body cannot function. Reduced oxygen intake can degrade mental and physical performance – even at altitudes as low as 4,000ft.

JEFF BROCK & ROD BENCKE

"YOU OKAY, DAVE?" I WAS TALKING, but he wasn't answering. "Dave!" It was close to a shout. "Huh?" I'd woken him at last.

"Check your altitude, you're climbing like a homesick angel."

Dave was a competent pilot, but on this day he was having some trouble. He didn't seem focussed, and he was all over the sky. We'd been flying for an hour. He was fine when we started, but he seemed to be having a difficult time as the flight progressed. We were going from Jervis Bay to Wagga, and as we climbed over the Snowy mountains, Dave's condition worsened. He corrected the errant climb and I returned my attention to the open chart in front of me.

Suddenly, I had this feeling that something was wrong. I looked up to see trees in front of us on a 6,000ft ridge. And they appeared to be coming closer.

The chart flew off my lap as I grabbed the yoke. I didn't think about stalling, I just wanted to see sky again. I pulled back hard and the aircraft nosed up, a little lower than I'd have liked, but enough. Dave didn't fight me, he just let me correct him.

"I got it Dave." The trees below rustled, leaves loosened by our wake were scattered about. Dave let go as the windscreen went from green, to blue and back to half-green and half-blue on top. I looked over at him and he stared back at me, vacant but scared. "You okay?", I asked. "Uh?", he answered, still staring vacantly. I flew the rest of the way.

I later realised that Dave was suffering from hypoxia, a lack of oxygen – I knew I wasn't affected, but I should have known sooner that Dave was in trouble.

So what happened? One reason Dave was affected by hypoxia and I wasn't is that Dave smokes a packet of cigarettes a day. That means when Dave and I are lying on the beach, he is still doing flight time. Physiologically, he's at 5,000ft, while, as a non-smoker, I'm still at sea level. Smokers absorb far more carbon monoxide into their blood than non-smokers, and the carbon monoxide reduces the blood's ability to carry oxygen. The bottom line is: if you smoke you may be affected by hypoxia at a much lower altitude than a non-smoker.

There are things other than smoking that can speed up the onset of hypoxia, or worsen its severity. Alcohol and its lingering effects can leave you physiologically 2,000ft higher than someone who is not hung over. Illicit drugs, prescribed medications and even some over-the-counter cold medications can worsen the effects of hypoxia. If you have a chest infection you are already

The early (covert) cerebral features of hypobaric hypoxia:

Visual function
- Light intensity perceived as reduced
- Visual acuity diminished in poor illumination
- Light threshold increased
- Peripheral vision narrowed

Psychomotor function
- Choice reaction time impaired
- Eye-hand co-ordination impaired

Cognitive function
- Memory impaired

The overt features of acute hypobaric hypoxia:

- Personality change
- Lack of insight
- Loss of judgement
- Loss of self-criticism
- Euphoria
- Loss of memory
- Mental uncoordination
- Muscular uncoordination
- Sensory loss
- *Hyperventilation*
- Semi-consciousness
- Unconsciousness
- Death

- Dizziness
- Lightheadedness
- Feeling of unreality
- Feeling of apprehension
- Neuromuscular irritability
- Paraesthesia of face extremities
- Carpo-pedal spasm

source: Aviation Medicine. J.Ernsting, P.King, 1998

Improved performance

ANDREW THOM

The benefits of using supplemental oxygen for long flights below 10,000ft.

A PILOT'S PERFORMANCE AFTER A couple of hours at 5-8,000ft does seem to be different. How come the engineer who did 4 years of university maths can't even add up in the air?

I remember arriving at Essendon in the mid 1980s, after a flight from Adelaide in a 172. It was 2am and I had come alone, at 8,000ft and over the top from the Adelaide Hills to Bacchus Marsh. The fatigue was extreme and I would have avoided any task that required actual thought. But was it only fatigue?

Someone recently suggested to me that there are significant advantages in using oxygen below 10,000ft where it is not mandatory. So I tried it.

What a difference! The extreme fatigue was not there, and calculation did not meet the same block. Other pilots who use oxygen at low levels report similar effects.

The Australian regulations say that over 10,000ft you must use supplemental oxygen.

Rob Fox

Andrew Thom says when he uses supplemental oxygen he experiences less fatigue and improved concentration. Other pilots report similar effects.

The US Federal Aviation Administration (FAA) limits unpressurised commercial flying with no oxygen to 10,000ft, but permits private pilots to operate to 12,500ft, as a concession to their terrain.

In 1996 the FAA's Civil Aeromedical Institute studied the performance of 20 private pilots in simulator flights while breathing oxygen concentrations equivalent to sea level, 8,000ft, 10,000ft and 12,500ft. The study concluded: "Errors made by the reduced oxygen group were far more serious".

Until the 1950s and 1960s, oxygen equipment was awkward, heavy and expensive, and introduced a new set of risks and skills for the pilot, so general aviation grew up without it.

In the early 1980s, a development in an unrelated field offered to change the situation. Smoking related and other illnesses produced a large number of patients discharged from hospitals with reduced lung function. There was a need for lighter, portable equipment to allow these people some mobility. The nasal cannula went part of the way, by feeding the oxygen up the nostrils and leaving the mouth free. It still consumed the same flow of oxygen.

Then the Oxymizer nasal cannula was developed. It maintains the same blood oxygen level with only one-third of the flow needed by a mask.

Applied to aviation, these devices open some new possibilities. With cannula flow rates of only 0.7 litres per minute at FL180, as opposed to 1.8 for a mask, a 5kg portable cylinder (C size) will last for 11 hours. At 10,000ft, using only 0.3 litres per minute, the same cylinder goes for 24 hours.

Because of the large existing market, C size medical oxygen cylinders are available at over 800 distributors throughout Australia. These can be used in an Approved System to supply supplemental oxygen to aircrew.

As well as permitting operation up to 18,000ft with only simple nasal dispensers, these developments make it practical to use supplemental oxygen below 10,000ft.

Why would a pilot want to? Well, that is hard to answer for anyone who hasn't used it and experienced the difference in alertness and fatigue.

Those who have don't need convincing.

Andrew Thom is the director of Electronic Force Management and chief pilot for Melbourne Air Taxis.

starting higher than someone else.

If you have ever felt exhausted after a prolonged flight at 8,000ft or 9,000ft, wondered why you get headaches during or after these flights, or ever caught yourself fudging navigation calculations because your brain seemed a bit fuzzy, you were probably hypoxic.

So what is hypoxia, and what are its effects?

Deprived tissues: Hypoxia is a physiological state where tissues are deprived of adequate oxygen and organs such as the lungs, brain, heart, and the eye, are adversely affected.

Once you climb above sea level, the partial pressure of oxygen in the ambient air decreases and you are exposed to a degree of hypoxia. One of the earliest effects is a subtle impairment of vision.

The onset of the effects of hypoxia can therefore be very subtle. Worse still, self-checking is normally ineffective. This is because one of the body's initial responses to a decrease in ambient concentration of oxygen is a sense of well-being or mild intoxication – you can be quickly lulled into a false sense of well-being.

Increase the altitude and the time of exposure and more serious symptoms occur. General clumsiness and trembling may be noticed, breathing becomes rapid, vision is degraded further, questions and answers may be ignored, and appreciation of aircraft attitude and situation may not be noted until after some delay.

You can expect mood changes which can take the form of hilarity, pugnacity or drowsy apathy. In extreme cases and at higher altitudes, you will lose consciousness.

Vision, judgement and lung function: Because the retina uses more oxygen than other tissues, vision is the first function to be impaired by hypoxia (especially night vision). A reduction in the ability to see dimly-lit objects – particularly during twilight – can be detected as low as 4,000ft.

When you fly in twilight, you are using your mesopic vision – a time when your vision receptors in the retina are working in truly adverse circumstances – the rods for night vision, and the cones for colour. In conditions of dim light, the retina uses the last remnants of colour from the cones and is only beginning to utilise the rods, which are not truly effective yet.

If you are hypoxic and flying during this twilight-time, your vision will be compromised. If you climb to a higher altitude, the effects will worsen.

If you are flying at night above 4,000ft, it is wise to turn up the intensity of the light

HOW HYPOXIA STARTS

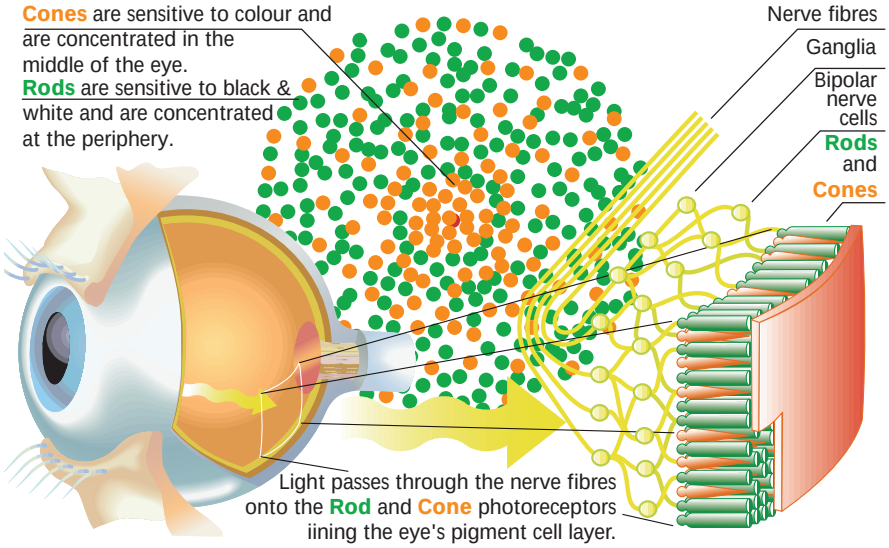
HYPOXIA AFFECTS THE GASEOUS exchange of carbon dioxide and oxygen in the body. At sea level, healthy people may have a 97-99 per cent oxygen saturation in their blood haemoglobin.

The body is a little like a heat machine. Just like an engine, it takes in fuel (food) and burns it to create energy. The burning process requires oxygen, and the correct amount of oxygen.

Oxygen from the air enters the blood-stream by passing across the surface of the lungs. Gaseous waste products, such as carbon dioxide, travel in the opposite direction – from blood to the atmosphere. The passage of oxygen into the blood-stream is governed by the partial pressure exerted by that gas in the lungs (approximately 21 per cent atmospheric pressure). While the proportion of oxygen in the atmosphere remains the same as one gains altitude, the total atmospheric pressure falls. Therefore the partial pressure of oxygen falls and so less pressure is exerted to achieve the transfer from lungs to blood. The blood receives less oxygen, which means the body is unable to burn its fuel properly and so starts to function less well.

To overcome this reduction in the partial pressure of oxygen, flight crew can increase the proportion of oxygen they breath by the use of an appropriate oxygen system.

EYES NEED OXYGEN



Peter Breis

The photo receptors in the eye's retina – the rods and cones – require extraordinary amounts of oxygen when compared with other tissues in the body. Rods are used for night vision, and are not colour sensitive. Cones are used for day and colour vision. Below: night vision is affected by even low-level hypoxia, which can make instrument lighting look dull.

in the cabin to help compensate for the impairment in your visual performance. You should use supplemental oxygen if available.

After vision, the tissues most affected by hypoxia are those areas of the brain associated with judgement, self-criticism and the accurate performance of mental tasks. This occurs at around 10,000ft in fit people with good lungs and at a lower altitude for smokers and others with certain medical conditions.

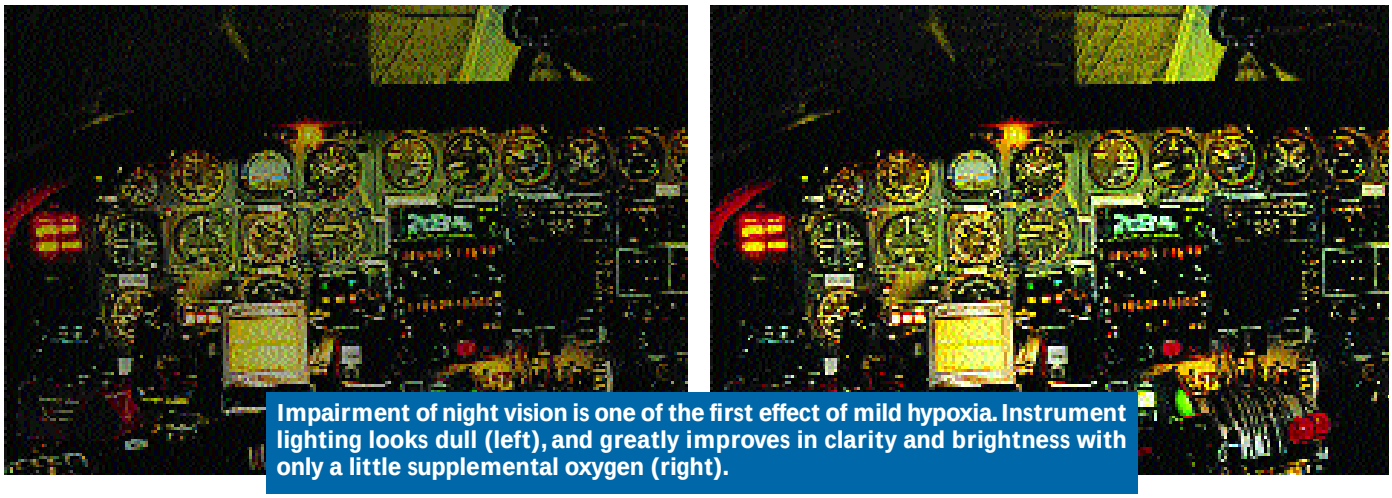
While 10,000ft is the ceiling above which oxygen must be used by flight crew members in unpressurised aircraft, some individuals with reduced lung function will become hypoxic well below that level and should consult their designated aviation medical examiner about the benefits of using supplemental oxygen. This includes people with chest problems such as asthma, chronic obstructive airways disease (emphysema), industrial lung disease, certain forms of anaemia, ischaemic heart disease or even mild degrees of heart failure.

Prevention: If you smoke more than 10 cigarettes a day, you have already rendered your oxygen intake deficient by 10 per cent or more. Smokers should avoid smoking before and during flight as it may degrade the ability to absorb oxygen.

Be wary of self-medication for a cold or hayfever, as these can aggravate the effects of hypoxia. You should be cautious about any medication which can induce drowsiness, as this will be increased by hypoxia – watch out for antihistamines and analgaesics containing a narcotic component (for example, codeine).

Hypoxia is aggravated by the cold, so keep a comfortable cabin temperature.

To ward off the effects of drowsiness, hang over, or lack of sleep, many pilots take stimulants, such as coffee, to keep awake. Caffeine may reduce drowsiness, but it will



PM Photography (2)

Impairment of night vision is one of the first effect of mild hypoxia. Instrument lighting looks dull (left), and greatly improves in clarity and brightness with only a little supplemental oxygen (right).

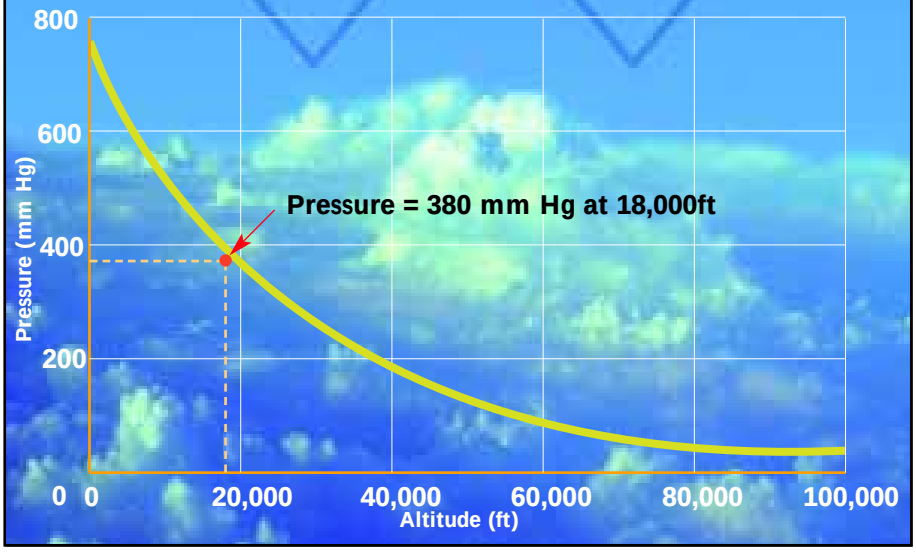
TIME OF USEFUL CONSCIOUSNESS

Altitude (ft)	Consciousness
15,000	30 minutes or more
18,000	20–30 minutes
22,000	5–10 minutes
25,000	3–5 minutes
28,000	2.5–3 minutes
30,000	1–3 minutes
35,000	30–60 seconds
40,000	15–20 seconds
45,000	9–15 seconds
50,000	6–9 seconds

PRESSURE AND ALTITUDE

Altitude ft	Altitude m	Pressure hPa	Pressure lb/in²	Temperature °C
0	0	1,013.25	14.70	+15.0
5,000	1,525	843.1	12.23	+5.1
10,000	3,048	696.8	10.11	-4.8
15,000	4,572	571.8	8.29	-14.7
20,000	6,096	465.6	6.75	-24.6
25,000	7,620	376.0	5.45	-34.5
30,000	9,144	300.9	4.36	-44.4
35,000	10,668	238.4	3.46	-54.2
40,000	12,192	147.5	2.72	-56.5

The exponential relationship between the pressure exerted by the atmosphere and altitude



Flying fox

not improve your tolerance to the effects of hypoxia.

Supplemental oxygen or descending to a lower altitude, if it is safe to do so, are the only ways of treating hypoxia.

CAO 108.26 was amended in January 1996 to enable the use of oxygen canula systems, which deliver oxygen through "nose prongs". This portable system is relatively inexpensive and is very flexible and economical.

If you fly regularly on extended unpressurised flights at or around 10,000ft you should seriously consider the use of supplemental oxygen. Oxygen use also frees the pilot from the 10,000ft altitude limitation, opening up the possibility of superior weather avoidance, particularly in the winter months, and offering greater fuel efficiency and therefore greater range.

Fire danger: When using supplemental oxygen, remember that pure oxygen is a fire danger. You need to make sure that your oxygen cylinder is approved, stowed, serviced, and maintained properly. You should avoid any sources of ignition inside the cabin, such as cigarette lighters. Do not use petroleum-based products – such as vaseline or lipstick – on your face when using supplemental oxygen as these can react adversely when in contact with 100 per cent oxygen. Burns to the lips and mouth have been reported.

Single pilots are most at risk from hypoxia because there is no-one to notice the subtle changes that indicate its presence.

> **"Single pilots are most at risk from hypoxia because there is no-one to notice the subtle changes that indicate its presence."**

It is unlikely to be a large problem below 10,000ft except on long flights, particularly at night, or when the you are fatigued or unwell.

There are a number of unexplained accidents which have occurred on long night flights which are believed to have hypoxia as a cause. Night freight pilots should be particularly vigilant.

The safety message is simple – if you have the opportunity to use supplemental oxygen, then use it.

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