

HYPOXIA

This chapter deals with one of our most important physiological problems. One factor that tends to make hypoxia so dangerous is its insidious onset. Any aviator who flies above 12,000 feet in an unpressurized aircraft without supplemental oxygen is a potential hypoxia case.

TYPES OF HYPOXIA

Hypoxia is described as a state of oxygen deficiency in the blood, tissues, and cells sufficient to cause an impairment of body functions. Anything that impedes the arrival or utilization of oxygen to the cell, places the body in a hypoxic state. There are many conditions that can interrupt the normal flow of oxygen to the cells. The following table describes the various levels at which hypoxia can occur:

Location of Impediment	Common Name	Explanation
Lungs	Hypoxic Hypoxia	Any condition that interrupts the flow of O ₂ into the lungs. This is the type of hypoxia encountered at altitude due to the reduction of the partial pressure of O ₂ .
Blood	Hypemic Hypoxia	Any condition that interferes with the ability of the blood to carry oxygen. Anemia and carbon monoxide poisoning are two conditions that can keep the O ₂ from attaching to the hemoglobin within the red blood cell.
Blood Transport	Stagnant Hypoxia	Any condition that interferes with the normal circulation of the blood arriving to the cells. Heart failure, shock, and positive G force along the Z axis will bring about this condition.
Cell	Histotoxic Hypoxia	Any condition that interferes with the normal utilization of O ₂ in the cell. Alcohol, narcotics and cyanide all can interfere with the cell's ability to use the oxygen in support of metabolism.

(TABLE 7)

From the table, it is plain to see that any condition that interferes with oxygen's normal path to the cells will bring on hypoxia. While all cells require oxygen to function, some cells require more oxygen than others. Most cells have the ability to store an

emergency supply of O₂. The central nervous system (made up of the brain and spinal cord) do not have this ability and also demand a great deal of oxygen (approximately 20% of all oxygen that you inhale feeds the brain). So, if the oxygen supply to the body is reduced, the brain will be one of the first organs to be affected. Another problem is that when the brain starts to feel the effects of hypoxia, the higher reasoning portion of the brain is the first affected. This means that judgment and cognitive skills diminish from the very start.

HYPOXIA SIGNS AND SYMPTOMS

Signs of hypoxia can be detected on an individual by an **observer**. Signs aren't a very effective tool for the victim to use to recognize hypoxia in themselves. Therefore, these signs should not be included with the personal symptoms one gets while experiencing hypoxia. *Symptoms* are the sensations a person can detect while in a hypoxic state. Personal symptoms of hypoxia are as individual as the person experiencing them. A group of people who are hypoxic will, a majority of the time, get the same symptoms. But, the symptoms will appear in a different order and in varying intensities. The greatest benefit in hypoxia symptoms is that the order and the intensity of the symptoms will usually remain constant over the years. This is a great gift, because a pilot will always know what to look for to keep hypoxia in check. Some of the more common signs and symptoms of hypoxia are:

SIGNS	SYMPTOMS
Rapid Breathing	Air Hunger
Cyanosis (Bluing effect of the skin)	Fatigue
Poor Coordination	Nausea
Lethargy	Headache
Executing Poor Judgment	Dizziness
	Hot & Cold flashes
	Tingling
	Visual Impairment
	Euphoria

(TABLE 8)

Of the listed symptoms, visual impairment is probably the least reliable. Your visual field will be affected, but, at such a slow rate that it could go unnoticed. Generally, symptoms will appear before unconsciousness occurs. Except for headache and nausea, there are no other uncomfortable symptoms. Of all the symptoms, euphoria (a false sense of well being) is probably the most dangerous. It puts the pilot in such a state of mind that individual well being, as well as that of the passengers, is a low priority. Another consideration is that, in most cases, hypoxia is very insidious. Any preoccupation with flying duties could be enough of a distraction to allow the hypoxia to progress beyond the point of self help.

EFFECTIVE PERFORMANCE TIME / TIME OF USEFUL CONSCIOUSNESS

Effective Performance Time and the *Time of Useful Consciousness* are two broad and interchangeable terms used to describe the time/hypoxia limit. **Time of Useful Consciousness (TUC)** is described as the period of time from interruption of the oxygen supply or exposure to an oxygen-poor environment to the time when an individual is no longer capable of taking proper corrective and protective action. **Effective Performance Time (EPT)** is described as the amount of time an individual is able to perform flying duties efficiently in an environment with inadequate oxygen supply. The following table will show the TUC/EPT for various altitudes:

ALTITUDE	TUC/EPT
18,000	20 - 30 Min
22,000	10 Min
25,000	3 - 5 Min
28,000	2.5 - 3 Min
30,000	1 - 2 Min
35,000	.5 - 1 Min
40,000	15 - 20 Sec
43,000	9 - 12 Sec
50,000	9 - 12 Sec

(TABLE 9)

The above times are to be used as averages only and are based on an individual at rest. Physical activity at altitude, fatigue, self-imposed stress, and individual variation will make the times vary. Some of the more common factors that will cause your EPT/TUC to vary are:

Rate of Ascent	The faster you ascend to altitude, the shorter your EPT/TUC becomes.
Physical Activity	Any physical activity will reduce your EPT/TUC. For example, if you did 10 deep knee bends at 25,000 feet with your oxygen mask off, your EPT/TUC would be reduced by 50%.
Fatigue	If you enter the cock-pit in a fatigued state, you are less resistant to hypoxia.

Poor Nutrition	The brain feeds exclusively from glucose (blood sugar), so, if your glucose is low, as in hypoglycemia, you're more prone to hypoxia.
Alcohol	Alcohol brings about its own form of hypoxia. When altitude is coupled alcohol, you are a strong candidate for a hypoxic episode.
Over the Counter Medication	Some drugs will cause cells not to utilize oxygen properly and therefore will make you less altitude resistant.

(TABLE 10)

One fact to keep in mind is that, with a rapid decompression to and above 30,000 feet, the average EPT/TUC will be reduced from 1/3 to 1/2 of its original value. This is due to a phenomenon known as reverse diffusion or fulminating hypoxia. This phenomenon is where oxygen, due to the rapid expansion of gas during a decompression, is forced from the lungs and creates a very acute hypoxia that is immediate.

PREVENTIVE MEASURES AGAINST HYPOXIA

There are certain counter-measures pilots can use to prevent hypoxia.

1. Fly at an altitude where oxygen is not required
2. Fly in a pressurized cabin
3. Fly in accordance with FARs (in reference to the use of supplemental oxygen) 12,500 - 14,000 feet for not more than 30 mins.

NOTE

CAMI recommends that on any unpressurized flight to or above 10,000 feet, supplemental oxygen should be used.

TREATMENT FOR HYPOXIA

Hypoxia, under most situations, will be insidious in its onset; thus, its dangerous nature. Fortunately, once the hypoxia is detected and 100% oxygen is administered, recovery is usually only a matter of seconds. Because of the rapid breathing associated with hypoxia, you must slow your breathing rate to prevent hyperventilation.

CONCLUSION

Hypoxia is a constant danger. Many people suffer from ground level hypoxia before they even step inside the aircraft. The insidious nature of hypoxia is its true danger. You must always be on the look-out for hypoxia symptoms. Once hypoxia is recognized, recovery is only seconds away. Know your symptoms. Know your oxygen system and be ready to battle this potential threat to safe flight.