# APPROVED INDICATIONS FOR HYPERBARIC OXYGEN THERAPY

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In the United States, HBOT is reimbursable for 14 conditions according to the Health Care Financing Administration of the Department of Health and Human Services. These 14 conditions are the accepted indications for Medicare and, consequently, for most insurance carriers and HMOs. Many hospitals and clinics with hyperbaric facilities will only treat patients for these HCFA-approved indications.

Many problems exist with this list. In 2000, the Office of the Inspector General of the DHHS published a report called "Hyperbaric Oxygen Therapy: Its Use and Appropriateness." The OIG admits in its report that carriers and intermediaries vary in interpreting and implementing the Medicare Coverage Instruction Manual. Also, it admits that a 1999 Blue Cross and Blue Shield report found adequate scientific evidence to support a few conditions not specifically covered by Medicare, and, at the same time, *in*adequate evidence to support other conditions that it *does* cover. Finally, the OIG admits that the United States is very conservative compared to other countries in its acceptance of HBOT as a treatment for many conditions.

Despite these inconsistencies, the HCFA list is a logical starting point for examination of HBOT treatment. Here is an explanation, in lay language, of the pathophysiology and the treatment for each of the 14 indications:

**1) Acute carbon monoxide (CO) intoxication** occurs by inhaling CO, either accidentally or intentionally. CO binds very strongly to hemoglobin in red blood cells, displacing the oxygen and resulting in hypoxia (lack of oxygen). Hypoxia affects all systems of the body, but most particularly those with high blood flow, such as the brain and the heart. A mild case of CO poisoning might cause headache, dizziness or confusion; a severe case, coma or death. HBO works by immediately saturating plasma (the watery portion of the blood) with life-sustaining oxygen, meanwhile clearing the CO from the blood.

2) **Decompression illness** is commonly caused when a diver returns to the surface too rapidly. At high pressures deep underwater, additional oxygen and nitrogen dissolve in body tissues. The lungs eliminate the excess nitrogen during a gradual ascent, but if ascent is too rapid, nitrogen bubbles form in body fluids and tissues. Gas bubbles in the blood may lead to embolism (see below). In the central nervous system, embolism may cause opening of the blood-brain barrier, cerebral edema, and demyelination. HBOT redissolves the gases into the tissue; a gradual return to normal atmospheric pressure allows the gases to be expelled by the body.

**3) Gas embolism** occurs when gases enter blood vessels, the bubbles acting like clots. This condition is commonly the result of air entering veins or arteries during surgery or other invasive medical procedures. Less commonly, gas embolism results from too-rapid decompression in diving or submarine ascent, or in flight training altitude chambers. Rarely, it occurs from trauma, ingestion of hydrogen peroxide, or other causes. The gas bubbles block or reduce blood flow and hence oxygen delivery. Ischemia (stroke) may result. Fluid may leak into surrounding tissues and cause swelling. Since the gas bubbles act like foreign bodies, a number of biochemical reactions may also ensue. Putting a patient in a HBO chamber pressurized to 6ATA (six times the pressure at sea level) reduces the bubbles to a sixth of their size, allowing them to pass through the blood vessels.

**4) Gas gangrene** is an infection of the soft tissues caused by the *clostridia* bacteria. The bacteria usually enter the body at the site of a wound or a surgery. Gas gangrene spreads rapidly and can cause death within 12 hours. *Clostridia* thrive in a low-oxygen environment. Treatment consists of antibiotics, surgery to remove the necrotized tissue, and HBOT. While it has no effect on the dead tissue, by delivering oxygen to healthy tissue and in the vicinity of infected tissue HBOT prevents the spread of the bacteria.

**5) Acute traumatic peripheral ischemia** is lack of circulation to an extremity as a result of external force or violence. A variety of causes, from gunshot wounds to frostbite, can cause ATPI. HBOT increases oxygen to the injured tissues, reduces edema (swelling), fights infection, and allows healing to occur. It also prevents reperfusion injury, which is damage to tissue caused when blood supply returns after a period of oxygen deprivation.

**6) Crush injuries** are severe trauma to body tissues, commonly caused by vehicle accidents, falls, and gunshot wounds. Trauma leads to tissue death, which leads to edema (swelling), and contributes to ischemia (stroke), which in turn causes hypoxia (lack of oxygen). This becomes a vicious circle which may be interrupted by the supplying of oxygen to the tissues.

**7) Progressive necrotizing infections** typically occur after trauma, surgery, or around foreign bodies. They are caused by a variety of bacterial organisms, many of them anaerobic (thriving in a low-oxygen environment). Pathophysiology and treatment are similar to that for gas gangrene (see above).

**8) Acute peripheral arterial insufficiency** is sudden obstruction of the peripheral arteries—those furthest from the heart. APAI can be caused by trauma or crush injury. Lack of oxygen, edema (swelling), infection, and tissue death can result, leading to possible amputation or death. HBOT delivers oxygen, reduces swelling, fights infection, and promotes healing.

**9)Compromised skin grafts and flaps** are portions of skin, transferred to cover a wound, which are not healing properly. A graft is skin alone; a flap is skin with its attached deeper tissues and blood supply. For the graft to be successful, a new blood supply must form from the wound to the graft. A graft can fail when the wound does not have sufficient oxygen supplied to it. HBOT supplies oxygen, reduces swelling at the site, and prevents reperfusion injury.

**10) Chronic refractory osteomyelitis** is an infection of the bone which has not responded to appropriate treatment. If the bacteria are anaerobic (disliking oxygen), HBOT treats by delivering oxygen to the infected bone. Even if the bacteria are aerobic (oxygen-requiring), oxygen is needed by the leukocytes (white blood cells) to fight the infection, and by fibroblasts (cells which promote healing).

11) **Osteoradionecrosis (ORN)** is damage to bone, usually the jaw, due to radiation therapy (a common cancer treatment). Bone is almost twice as dense as soft tissue and absorbs more radiation. High doses of radiation damage the blood vessels leading to the surface of the bone, causing osteoporosis and finally bone death. HBOT delivers oxygen to the tissues and promotes healing by stimulating collagen formation at wound edges.

**12) Soft tissue radionecrosis** is damage to skin, muscle, and other soft tissues from radiation therapy. Radiation damage includes ulceration and possibly death of the tissue, and scarring and narrowing of the blood vessels in the treatment area. HBOT functions here as with osteoradionecrosis, delivering oxygen to the tissues and promoting healing by stimulating collagen formation at wound edges.

13) **Cyanide poisoning** is usually a result of smoke inhalation, and carries a high risk of mortality. The usual antidote is an infusion of sodium nitrite, which can impair the oxygen-carrying capacity of hemoglobin. Using HBOT as an adjunct therapy provides a supply of oxygen to blood plasma.

**14) Actinomycosis** is a bacterial infection of the face and neck, or less commonly of the lungs, caused by *Actinomyces israelii*. It commonly occurs after dental surgery or trauma. The bacteria are anaerobic (disliking oxygen). HBOT, which by supplying oxygen to the tissues destroys the anaerobic environment, is indicated when surgical incision and antibiotics have been insufficient.

It can be seen that the same mechanisms of action of HBOT are at work in all of these conditions. They are:

- Dissolution or decrease in bubble size of gases present in the blood vessels and tissues.

- Hyperoxygenation. HBOT drives oxygen not only to the red blood cells which normally carry oxygen, but to the plasma (colorless liquid portion of the blood in which blood cells are suspended) and other fluids in the body. Consequently, oxygen is delivered even to parts of the body not otherwise reached due to poor circulation, damaged blood vessels, or carbon monoxide binding to the red blood cells.

- Effects on microcirculation.  HBOT reduces edema, prevents perfusion injury, and drives oxygen two to three times as far from capillaries into tissues when breathed under pressure. This keeps injured tissue with sparsely functioning blood vessels alive.

- Antibacterial activity.  The presence of oxygen delivered by HBOT creates an environment in which anaerobic bacteria cannot live.  Additionally, oxygen increases the bacteria-killing effectiveness of white blood cells.

Many diseases and conditions not on this list have similar pathophysiologies and might be aided by the same treatment mechanisms.  Indeed, many doctors do treat patients for indications other than these, with good result.  In countries outside of the United States, HBOT is standard and non-controversial for a wide range of conditions.  According to the OIG, as many as 20 classes of indications, relating to 66 specific conditions, are cited by international medical communities.  A great deal of research and clinical evidence has been amassed attesting to the efficacy of HBOT for conditions as diverse as multiple sclerosis, cerebral palsy, and autism.  The Health Care Financing Administration thoroughly reviews the relevant medical literature and scientific evidence before developing a national coverage decision.  Undoubtedly, if well-designed research trials can be undertaken to support this clinical evidence, HBOT will be approved as a treatment modality for a much wider range of indications.