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What is hyperbaric oxygen therapy?

Hyperbaric oxygen therapy (HBOT) – or hyperbaric medicine – involves the medicinal use of oxygen at levels higher than atmospheric pressure. The treatment enhances the body’s natural healing process through the inhalation of 100% pure oxygen. The operation is performed to a predetermined schedule by trained personnel, who monitor the patient and adjust the schedule if required.

Under normal circumstances, oxygen is transported throughout the body only by red blood cells. With HBOT, oxygen is dissolved into all of the body’s fluids, plasma, central nervous system, bones and the lymph, and can be carried to areas where circulation is diminished or blocked. In this way, extra oxygen can reach all damaged tissue and the body can support its own healing process. The increased oxygen greatly enhances the ability of white blood cells to kill bacteria, reduces swelling and allows new blood vessels to grow more rapidly into the affected areas. It is a simple, non-invasive and painless treatment.

Benefits of HBOT

It has long been known that healing in many areas of the body cannot take place without appropriate oxygen levels in the tissue. Most illnesses and injuries occur, and often linger, at the cellular or tissue level. In many cases, such as circulatory problems, non-healing wounds and strokes, adequate oxygen cannot reach the damaged area and the body’s natural healing ability is unable to function properly. HBOT provides this extra oxygen naturally and with minimal side effects.

HBOT improves the patient’s quality of life in many areas when standard medicine is insufficient or ineffective. Many conditions such as stroke, cerebral palsy, head injuries and chronic fatigue have responded favourably to HBOT.

Conditions

HBOT is used to treat conditions that benefit from increased tissue oxygen availability, as well as infections where it can be used for its antibiotic properties, either as primary therapy or in conjunction with other drugs. Depending on your country/insurance, a growing number of conditions for HBOT are covered for payment, and scientific research also demonstrates the benefits of HBOT for other conditions not yet covered. The number of people utilising this therapy has continued to rise.

Examples of conditions that benefit from HBOT:

- air or gas embolism
- carbon monoxide poisoning
- decompression sickness (bends)
- diabetic and other wounds
- exceptional blood loss (anaemia)
- gas gangrene
- intracranial abscesses
- necrotising soft tissue infections
- osteoradionecrosis and radiation tissue damage
- osteomyelitis (refractory)
- skin grafts and (compromised) flaps
- thermal burns.

Regulations

IHC Hytech hyperbaric oxygen (HBO) chambers are designed and constructed to meet the latest stringent rules and regulations for medical technology in Europe, and comply with annex IV of the Council Directive 93/42/EEC and the EN guidelines 14931 (MDD). This means that IHC Hytech’s chambers are assembled and manufactured using the highest quality materials and components, all of which are accepted by the notified bodies for use in hyperbaric chambers.

The pressure vessel of a hyperbaric oxygen treatment system is designed and manufactured according to the European Pressure Equipment Directive (PED) 2014/68/EU, and all parts of the HBO chamber are designed according to the highest standards. For example, the HBO chambers are outfitted with a hyperbaric firefighting system built according to EN16081. However, IHC Hytech is by no means limited to this European standard, and can also manufacture in accordance with other international standards such as the ASME. A third party approves the entire hyperbaric system after completion.

The management system of IHC Hytech has been awarded with ISO 9001:2008 and ISO 13485:2012 certificates. The latter places emphasis on: meeting regulatory as well as customer requirements; risk management; and maintaining effective processes – namely, the processes specific to the safe design, manufacture and distribution of medical devices.
IHC Hytech strives to deliver the best value to its customers. It is a partner of choice for innovative, sustainable and integrated HBO treatment systems. IHC Hytech’s solutions are reliable, efficient and flexible to meet the demands of challenging HBOT projects. With its extensive knowledge and in-house design capabilities, IHC Hytech ensures compliance with the latest technological developments, strictest safety regulations and most stringent environmental standards.

Reliable
IHC Hytech excels at managing the complexity inherent within the development of hyperbaric systems. Each project is approached with care, creativity and adaptability, so that customers can depend on delivery within the terms of the agreement.

IHC Hytech is Royal IHC’s in-house specialist for high-quality hyperbaric systems and diving equipment. With a broad customer base that includes various hospitals and private clinics, navies, government organisations, salvage companies and inshore/offshore diving contractors (both domestic and international), it has extensive experience in designing and manufacturing safe and reliable hyperbaric equipment.

Partnership
Specific demands require bespoke designs. IHC Hytech provides cost-effective products, not only when newly acquired, but also throughout their working lives. The IHC Hytech team works closely with the customer and becomes an extension of their organisation, so that both parties can complement each other’s expertise. It can, for example, advise on the design, regulations and structure of the project or the location. This reduces risk and cost to create a smoother process, which leads to better end results.

Efficient solutions
IHC Hytech constructs custom-built systems and equipment to meet customer-specific requirements, as well as standard systems with a ready-to-build design.

Conducting business in a medical environment involves knowing exactly what regulations apply. Safety is the key aspect to every project, and technical and financial risks are also significant. Efficiency, reliability and durability are important factors for success; IHC Hytech understands its customers’ needs and has the ability to provide innovative and efficient solutions for a variety of HBOT projects.
IHC Hytech hyperbaric oxygen treatment chambers are manufactured to exact customer specifications, with diameters varying from 1,700 to 3,000mm, and an adaptable length to suit the number of patients and/or the size of the building. Round-shaped chambers weigh less and use fewer materials than rectangular chambers, and both are available with double or triple lock systems. A triple lock chamber features two entrance lock compartments, each of which can normally accommodate two people and has the same communication devices as the main chamber.

The doors of the chamber can be fitted with hinges or integrated as a sliding door to reduce unused space. The rectangular doorframe is wide enough to allow easy access for intensive care patients on full-sized hospital beds. Treatment sessions are performed in the main chamber, and the entrance lock is used to lock patients or personnel in or out of the main chamber when it is pressurised. Comfortable seats for patients are easily removed from the chamber in order to allow for the use of full-sized hospital beds, wheelchairs or medical stretchers.

IHC Hytech is not only limited to designing and manufacturing hyperbaric chambers. It can also provide turnkey solutions – for example, architectural support on the layout of a facility, and assistance with floor load assessments. In this way, IHC Hytech becomes an extension of the customer’s organisation in order to ensure the end product is utilised in the most effective way.

**HBO chamber**

**Safety features inside the chamber**

IHC Hytech HBO chambers are equipped with several reliable safety features. Only the highest industrial standard materials are used, such as corrosion-resistant Tungum alloy tubing, which is suitable for oxygen/breathable air. Flexible oxygen and air supply hoses are not used inside the HBO chamber.

All electrical cabling is composed of halogen-free material, which is non-toxic in the event of a fire, and all seats are made of fire-retardant fabric. When the water fire-suppression system (sprinklers) is activated, water fog (70%) and droplets (30%) cover the entire area of the chamber. Each compartment has its own system. In addition, UV sensors form part of the advanced fire-detection system.

**Patient comfort**

The chamber’s interior and exterior design can be chosen by the customer. This includes unique hospital or corporate colours, or a thematic approach to create a patient-friendly appearance. Efficient LED lights are installed inside the chamber and optional gradient temperatures help to reduce the cold, white-light effect. Each patient is provided with an individual seat with foldable armrest and integrated headrest, and the fabric is easy to clean. An optional footrest provides maximum comfort.

Patients are offered an individual entertainment system consisting of a headset with audio connections, video channel connections, volume controls, a channel selection switch for the audio system and an individual light output control.

**Breathing system**

IHC Hytech HBO chambers are supplied with a sophisticated oxygen breathing system, allowing patients to breathe comfortably, with a low inhalation and exhalation resistance of 3mbar. The therapeutic gas (oxygen) is supplied to patients by means of an oral/nasal mask or an oxygen free-flow hood system, whereby the flow to each patient can be adjusted separately.

Connections for the oxygen supply, entertainment system and patient monitoring devices are installed in the overhead panel. Connection points are also available for the supply of oxygen and/or air to medical equipment such as patient ventilators.

**LCD touch screen**

The chamber can be controlled from the inside using the LCD touch screen. It displays session parameters such as depth and temperature, and the attendant inside the chamber can control the inlet and exhaust valves.

After a session starts, the display will show the Patient Information Screen. This presents information including pressure, temperature, elapsed and remaining session time. The attendant in the chamber can switch to the Doctor Information Screen, which shows more information about the session, including:

- pressure graph
- depth
- ascent/descent speed in msw/minute
- oxygen level
- CO₂ level
- temperature
- PPO₂ (partial pressure oxygen) level
- PPCO₂ (partial pressure carbon dioxide) level
- humidity (relative).

**Vacuum system**

There are two vacuum control panels inside the main chamber. The vacuum system is designed to work with Baxter Medevac or equivalent containers.
IHC Hytech HBO chambers are supplied with state-of-the-art computer control technology. Integrated into an ergonomically designed stand, the control panel has all controls and displays required to operate the system and monitor the patients under normal working conditions.

The control panel consists of the following items:

- **Touch-screen operating interface**
  Various functions are controlled using the touch screen, such as: compressors; cooling units; heaters; CO₂ and O₂ levels; water levels; alarm statuses; pressure levels; and lighting inside the chamber.

- **Data recorder**
  A data recorder takes note of the pressure data during a session.

- **Analysation**
  Two analysis points assess the quality of environmental gas inside the chamber.

- **Operator presence confirmation (OPC) button**
  An additional safety feature, this button must be pressed to confirm the presence of the operator when required by the system.

- **Emergency telephones**
  Three battery-powered handsets, which are connected together.

- **Firefighting controls**
  The sprinkler installation is activated in two ways: by using either the control panel or via a button inside the chamber.

- **Observation system**
  Several cameras are installed inside the main chamber and entrance lock. Monitors are mounted on the control panel and can be operated via the controls on the hard disk recorder.

- **Breathing gas selection**
  The operator can select which breathing gas is supplied to the masks (air or oxygen).

- **Supply selection**
  A valve is used to select between main and back-up air supplies.

- **HBO communication system**
  Communication is possible between the control panel, the entrance lock and the main chamber. This includes discrete communication between operator and patient, as well as open communication to all patients. A built-in patient call system enables a patient to contact the operator at the touch of a button. Each patient can also choose from five entertainment audio channels.

- **Flush control**
  The chamber must be flushed to provide the occupants with fresh air.

- **Entertainment system controls**
  Control functions for the radio, CD and DVD players.

- **Profile controllers**
  Manual and computer-controlled operation is possible.

- **Control panel**
  The computer and monitor installed in the control panel operate as a feedback system for the PLC and display the following parameters:
  - actual pressure against time
  - lapsed time/pressure and time/pressure to go pressure increase/decrease of both compartments and speed of pressurisation
  - chamber pressures in both compartments (msw/bar)
  - temperature and relative humidity
  - oxygen percentage and partial pressure.

At any time during a treatment session, the pressure or time profile can be changed, and relevant comments and patient data can be entered for future use.
As the pressure inside the chamber increases, so does the temperature. This is caused by:
- incoming air from the compressors, which will be compressed in the chamber
- the body temperature of the people in the chamber.

The IHC Hytech cooling installation is designed to control the temperature inside the chamber, mainly through cooling, and to control the level of relative humidity. This system contains the following fundamental components.

**Cold water machine**
Fitted with a circulation pump, and storage and expansion tanks.

**Hot water unit**
With the temperature set at 55°C.

**Heat exchange unit**
A radiator-style heat exchange unit, provided with air circulation channels and fans. The hot air is pumped into the patient chamber via the overhead gutter system, which is outfitted with electric fans. The system is installed in special silenced housing in the main chamber, and is capable of maintaining the temperature inside the chamber at approx. 21°C.

**HP and LP supply system**
The high-pressure air supply system consists of one HP compressor for pressurising HP air cylinders, and several HP pressure cylinders for the main and back-up supplies.

The low-pressure air supply system consists of one LP compressor for pressurising LP buffers, several low-pressure vessels and one filter unit.

**D-MAS HyperSat**
The DanMedical hyperbaric remote patient monitoring system (D-MAS HyperSat) is a computer-based device that provides medical diagnostics and patient monitoring in one self-contained unit for use in saturation diving applications and hyperbaric chambers. It is intrinsically safe for use in pressurised environments, and delivers a full range of remote healthcare diagnostic and monitoring support options with built-in clinical interpretation. The system is Microsoft-based and can be loaded with the customer’s own suite of software tools, including desktop sharing and video conferencing. Divers can be viewed and monitored in real time from anywhere in the world via a standard internet connection.

D-MAS HyperSat meets the requirements for physiological monitoring, recording and data transfer for remote viewing as part of health surveillance for professional divers. The standard D-MAS HyperSat is installed with D-MAS medical software suite 2015. Medical devices now included as standard are:
- blood pressure cuffs in three sizes (S,M,L)
- pulse CO-oximetry with Masimo SET finger clip sensor for SpO₂ (saturated oxygen)
- resting ECG (10-lead)
- extended ECG
- core temperature measurement
- D-MAS webcam for still images
- D-MAS software licence for 12 months.

Several other medical functions are available as additional extras.

**Masks and hoods**
IHC Hytech can deliver a range of oxygen masks and hoods. The mask covers nose and mouth and is suitable for various respiratory applications. The oxygen treatment hood has been designed for use in clinical hyperbaric chambers with the patient’s comfort in mind, and is easy to use for the attendant. The hood is made of clear medical-grade vinyl with an optical-quality, extra-large viewing window on the front. It is simple for the attendant to clean because it is welded to the neck ring. This also reduces the risk of bacteria becoming trapped between the neck ring and the hood.

**Disinfectants**
SanZide Plus® disinfects and deodorises without abrasives or bleach, and kills TB, HIV, CA-MRSA, MRSA, Hepatitis A, B, and C, and H1N1. It is a non-flammable, alcohol-free formulation, and can also be used to control mould and mildew.

**Clothing**
IHC Hytech can provide special clothing for patients to wear in hyperbaric chambers. Manufactured by Medline, the clothing is in blue in colour and the reversible hyperbaric scrub top features a left chest pocket – inside and out – and set-in sleeves. It is fitted with a V-neck collar with colour-coded neck bias for easy size identification. The pants are made of a four-panel construction with back pockets, both inside and out, and all components including thread, tags and trim are made of 100% cotton with soil-release finish.
IHC Life-cycle support

IHC Hytech customers know that they can rely on dedicated and comprehensive global service throughout the entire life cycle of their investment. Not only does this help to extend the lifespan of the HBO chamber, but also to maintain the correct and safe operation of all IHC products on board.

As the technology innovator, IHC has the ability to enhance the reliability and efficiency of its systems, which in turn boosts the productivity of its customers’ investments. The company’s life-cycle support service maximises the uptime and return on investment, and therefore reduces the total cost of ownership.

Concepts, design and building
IHC’s highly qualified life-cycle support personnel can provide new or improved concepts for complete systems and components, as well as project evaluation and advice on the selection of equipment. The company’s team of experts designs HBO chambers and equipment based on customer requirements and its design, building and operational experience.

Training
IHC Hytech offers its customers the opportunity to receive training support for their crews, which gives personnel the chance to become acquainted with the equipment before gradually assuming control. An introductory course in hyperbaric medicine provided by a third party can also be arranged.

The objective of this jointly offered course is to provide a rigorous introduction to the subject by addressing key fundamental elements and concepts that will assist the participant in practicing hyperbaric medicine safely and effectively.

In addition, the course aims to demonstrate the importance of team training in the hyperbaric environment, including safely operating the hyperbaric equipment and performing emergency drills.

Maintenance management
IHC aims to assist its customers by improving their system availability in the most efficient way. This can be done with a single service offering such as condition monitoring, technical surveys or other maintenance tasks. Alternatively, it can be achieved by integrating several different services from the company’s life-cycle support programme.

Spare parts and component repair
IHC aims to be prepared for every eventuality and provide limitless logistical support to its customers, which includes attention to system availability with the immediate supply of spare parts and repair of components. With this approach, the complete IHC global network of qualified service technicians, sourcing officers and stock locations is available to all customers.

Renovations
The renovation of equipment is a complex process, and IHC possesses the expert knowledge required to research, engineer and install components to such a high standard that these measures will optimise the equipment. This results in the start of a new life cycle for the equipment or the extension of the existing life cycle.

Life-cycle engineering
With the equipment fully engineered and a full set of relevant documentation available, IHC is in a unique position to accurately and quickly provide engineering support for all requests. IHC engineers can liaise with original hyperbaric chamber designers regarding complex issues.