Demonstration report on the incorporation of hyperbaric oxygen therapy into the new severe coronavirus pneumonia treatment plan.

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Clinical reports and pathological anatomy results of the show that progressive hypoxemia is the main cause of the deterioration of patients with new coronary pneumonia. Zhong Nanshan, academician February 27 stressed that "Wuhan critically ill patients mortality rate Close to 60%, we think of ways to solve the problem of hypoxia." Hyperbaric oxygen therapy (HBOT) is the strongest non-invasive oxygen therapy technology. The clinical treatment of 5 cases of severely critically ill patients with new coronary pneumonia in the early stage has verified that the excellent curative effect of extensive use of HBOT in treating hypoxia for a long time is also applicable to patients with new coronary pneumonia. Increasing the effect of HBOT once a day is better than normal-pressure high-flow oxygen and mechanical ventilation. It is suggested that HBOT be further promoted as severely ill patients new coronary pneumonia oxygen therapy method for with, which is expected to greatly improve the efficiency of treatment, reduce medical care pressure and risk of infection, and reduce severe mortality. It has practical significance for further accelerating the overall victory of this war epidemic and achieving the maximum effective treatment and infection prevention and control.

A, HBOT used to evaluate the effectiveness of the new crown patients with severe pneumonia oxygen therapy

(a) five cases of critically ill patients respond to treatment HBOT oxygen therapy is very consistent with the General

Hospital of Wuhan Yangtze River, Director of Hyperbaric department Zhong Xiaoling, conduct five new cases of pneumonia crown. The treatment of HBOT in severe patients (2 critical cases and 3 severe cases) has significant effect. The first case reports for the patient have been published first. The analysis of clinical data of 5 cases shows:

1. The effect of correcting progressive hypoxemia in severe patients.

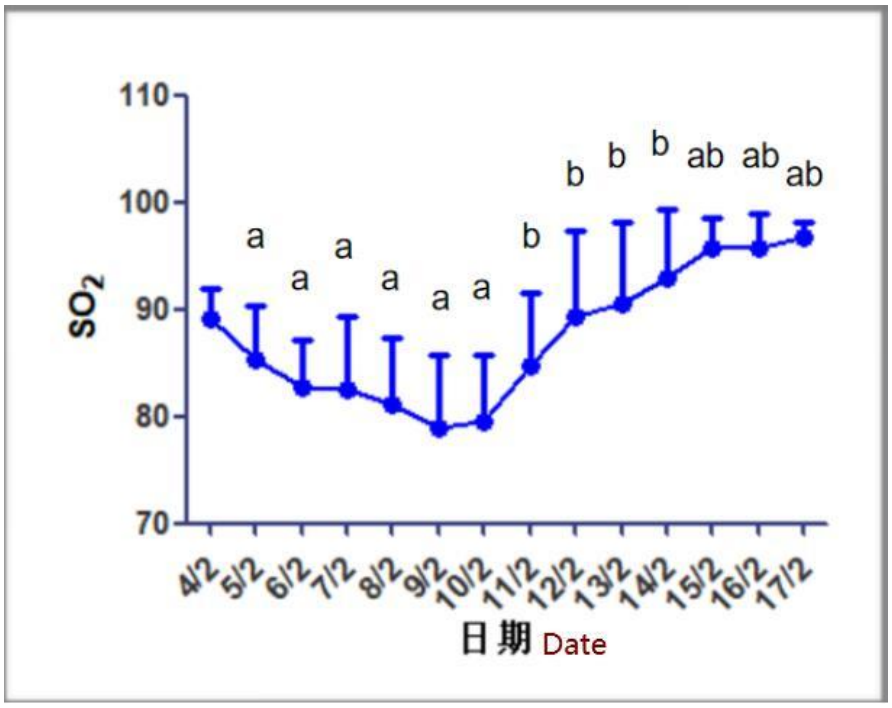
First, the hypoxia symptoms are rapidly relieved. All five patients had obvious progressive hypoxia signs and symptoms of. After the first HBOT, symptoms such as dyspnea and chest pain were alleviated immediately. After the second HBOT, the symptoms were basically relieved. The

respiratory frequency decreased day by day, but the shortness of breath after the action was slower.

The second is rapid correction of hypoxemia. Arterial blood gas analysis under mask oxygen (5 ~ 8L / min) conditions before HBOT treatment in 5 patients showed that PaO2 was 37, 65, 60, 78,68mmHg, respectively.
SO2The downward trend of was reversed immediately, and the of SO from the 5th day2daily average reached 95%(Figure 1). Taking the data of 5 cases of HBOT daily before the cabin as the treatment effect on the previous day, it showed a significant upward trend day by day (Figure

2 left).

The SO2 after HBOT was higher than 93%, suggesting that each treatment immediately resolved the patient's systemic hypoxia problem. Arterial blood gas results showed a marked recovery of



the indicators (Figure 2 right).

FIG1 Changes in daily SO2 before and after HBOT (11/2) in the first critically ill patient

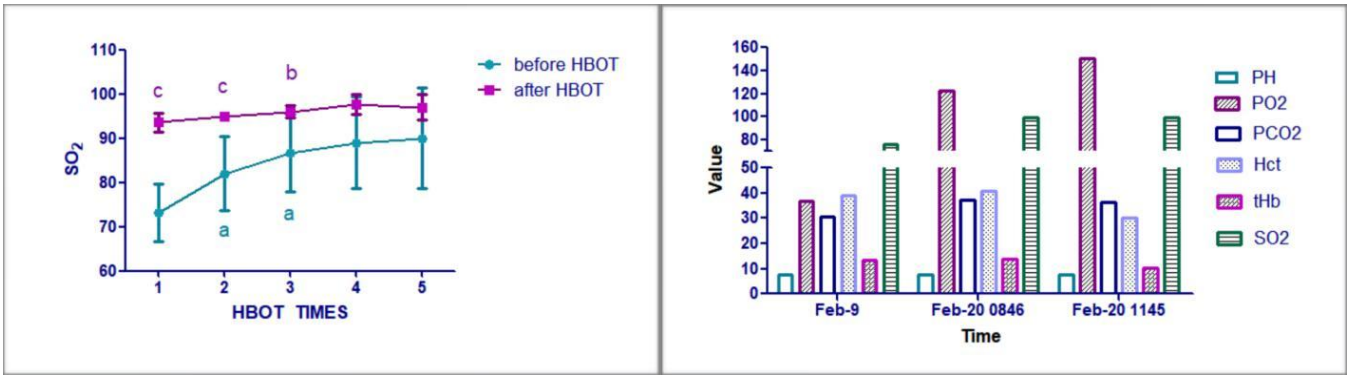


FIG2. 25 patients SpO_2 before and after daily entrance to HBOT and arterial blood gas analysis Change

2. Comprehensive treatment effect of HBOT oxygen therapy in critically ill patients

First, The overall condition is reversed. In addition to the relief of hypoxic symptoms in all patients, the general state was significantly reversed. Gastrointestinal symptoms are reduced and appetite is restored. Symptoms such as headache disappeared and mental state improved.

Second, clinical objective detection indicators improved. In to finger veins and arterial blood gas oxygen significantly the Addition the changed, response of the immune function in leukocyte count gradually restored, coagulation reaction improvement peripheral circulatory disorders, liver function and cardiac index reaction had improved injury (Figure. 3).

Third， is the improvement of lung pathological changes. Re-examination of the lung CT after treatment showed that lung five patients inflammation in all was significantly improved (Figure 4).

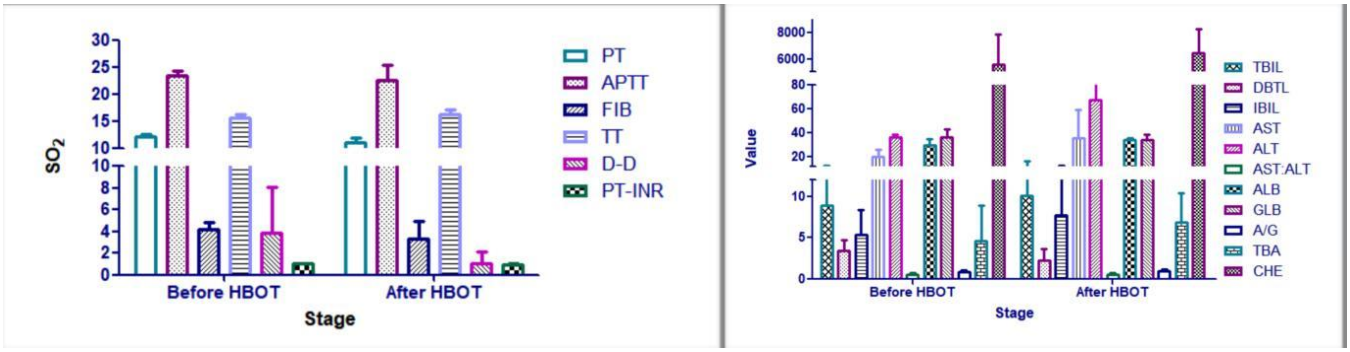


Figure 3 Changes in blood coagulation function and blood biochemistry before and after HBOT treatment in 5 patients

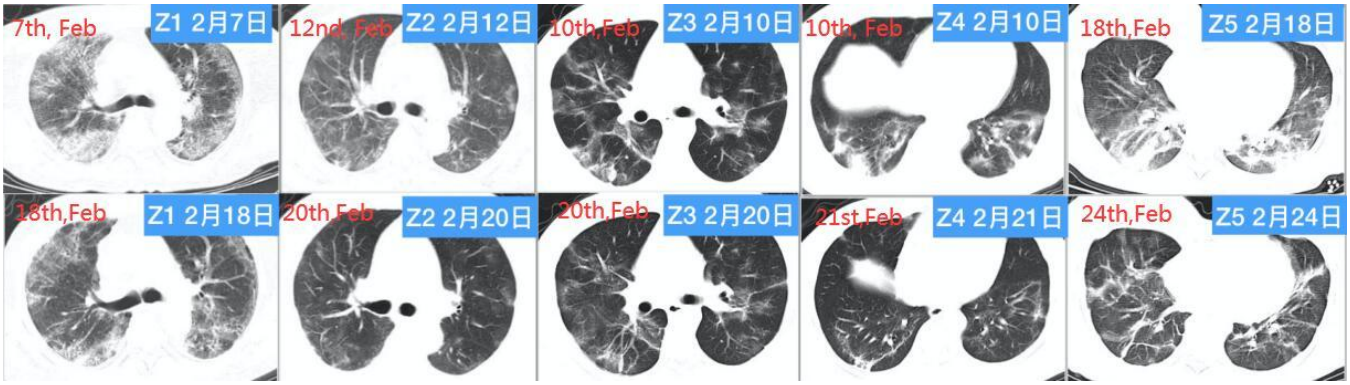


Figure 4 CT imaging changes before and after 4-7 HBOT in 5 patients.

(b) Mechanism of HBOT oxygen therapy. The difference between HBOT oxygen therapy and atmospheric oxygen therapy is clear. In other words, it is the use of high-pressure oxygen inhalation to comprehensively and greatly improve the efficiency of oxygen transportation from the outside world to tissue cells in the body.

The mechanism of HBOT oxygen therapy is to use the physical properties of gas to greatly increase the oxygen partial pressure in the environment and reduce the need for human body's own oxygen exchange and transportation capacity to achieve the best oxygen therapy effect.

The mechanism of HBOT oxygen therapy is shown in Figure 5.Compared with atmospheric oxygen technology, the advantages are reflected in the following aspects:

First, it has a higher partial pressure oxygen diffusion rate and several times from atmospheric oxygen, can be better overcome inflammatory lung gas exchange thickened blood barrier caused due to the higher and

solubility dissolution times of oxygen in the blood pressure of oxygen, and The effect of blood circulation air ratio is further overcome.
Second, it is more effective to increase blood oxygen partial pressure than mechanical ventilation to increase oxygenation index.

In breathing and critical medicine, the oxygenation efficiency of clinical respiratory support methods uses oxygenation index (for arterial oxygen partial pressure and inhaled air). The ratio of the oxygen partial pressure [OI = PaO2 / FiO2 (air pressure / 760)] was used as the final evaluation index. Taking the arterial blood oxygen partial pressure as the treatment target, the conversion formula [PaO2 = OI × FiO2 (air pressure / 760)]. Mechanical ventilation technology is to increase PaO2 by increasing OI. HBOT FiO2 can be increased to 1.6 ~ 2.8 times. It can be expected that the patients with HBOT is OI of unchanged, and PaO2 can be increased by 1.6 to 2.8 times, which is equivalent to the effect of 1.6 to 2.8 times of OI. The pre-treatment OI and treatment effects of 5 patients have fully verified this effect. In one case, HBOT reversed the hypoxia problem on the basis of non-invasive mechanical ventilation for 2 days. HBOT technology for patients with invasive mechanical ventilation is mature and has been routinely used in clinical HBOT.

Clinical selection principle is therefore proposed: (1) decreased significantly in patients oxygenation index, natural there is a clear respiratory conditions, it can not be expected to improve the mechanical ventilation oxygenation index 1.5 times, preferentially recommended treatment HBOT; (2) mechanically ventilated patients When the improvement of the lower oxygenation index is less than 2 times of natural respiration, it is recommended to add HBOT treatment once a day on the basis of mechanical ventilation.

Third, it is more effective than ECMO to improve the oxygen acquisition of tissue cells.

Although ECMO has exceeded the ventilation and gas exchange functions of the lungs, and can make Hb completely saturated, it is not as good as HBOT in tissue side oxygen supply. The dissolved oxygen in the blood has

exceeded the amount carried by Hb, and the diffusion distance has been greatly increased, which can relatively overcome the peripheral circulation obstacles caused by pre-hypoxic injury or / and infectious inflammation, and improve the efficiency and absolute of oxygen acquisition by tissue cells. the amount.

Fourth, there is no natural breathing mechanical ventilation for respiratory tract in patients with severe interference HBOT whole is under high pressure, the difference between breathing patterns and atmospheric popular parable is in the highlands, like breathing in and breathing plains are natural breathing. Different from mechanical ventilation, the intervention of the respiratory tract is great, and it needs medical attention and treatment at all times, otherwise various complications such as airway injury are prone to occur.
Fifth, with the current conflict is not severe treatment means, + HBOT mode has treatment effect clear improvement effect.

New crown virus infectious diseases, with the exception of antibodies and vaccines, are currently not effective. All clinical treatments are basically symptomatic and supportive. HBOT is not the etiological treatment of new coronary pneumonia, it is a symptomatic treatment of hypoxia in patients with new coronary pneumonia, and it is a supplement to the existing oxygen treatment technology. In terms of patient treatment procedures, in addition to once a day for 95 to 120 minutes each time

HBOT, they also received existing comprehensive treatment, including mechanical ventilation, in the ICU or intensive care unit. In addition to HBOT, the daily comprehensive treatment of the aforementioned critically ill patients is still the ICU and the intensive care unit responsibility of the clinician. There is no conflict in treatment technology, but it can provide better support for other supportive treatments.

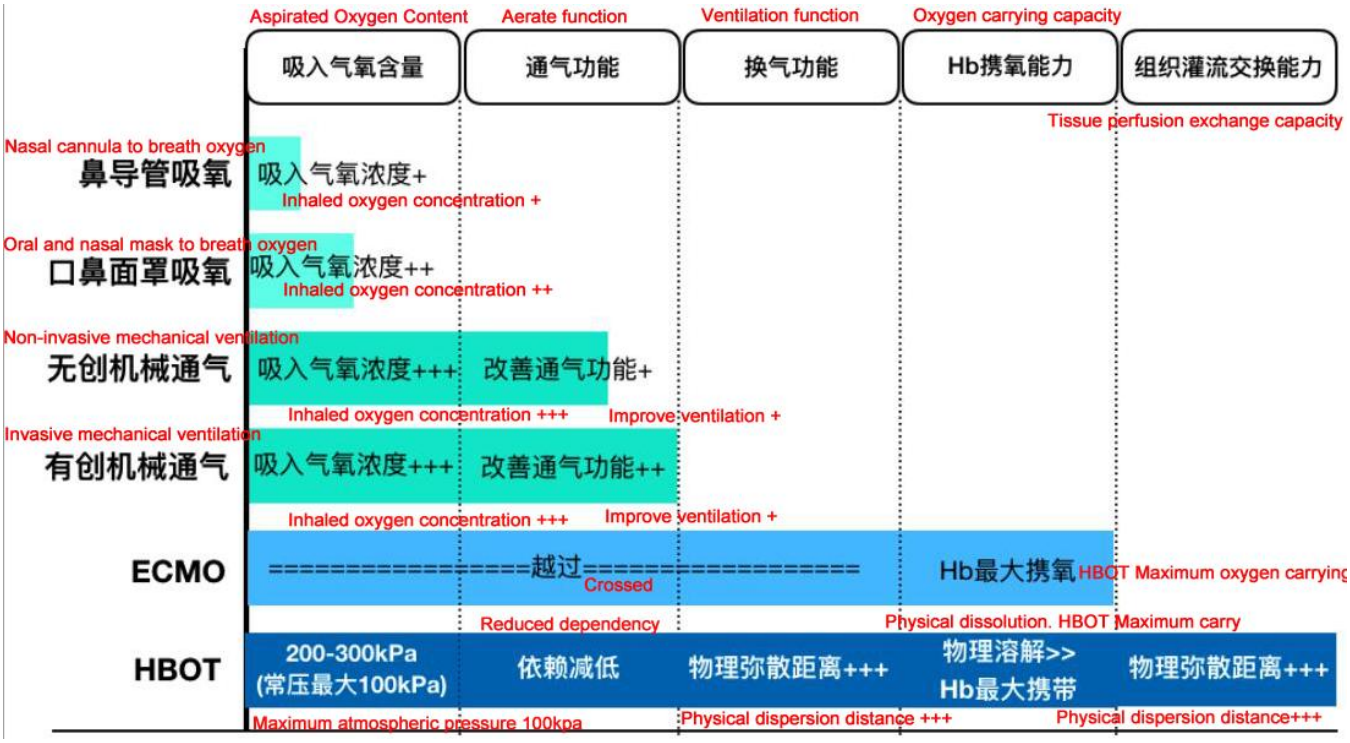


Figure 5 Intervention effects of different oxygen process of oxygen from the external environment to tissues and organs therapies on the(3) HBOT is symptomatic for the

treatment of hypoxia.

The first indication is that hypoxia is the first indication for HBOT. HBOT is a conventional oxygen therapy for clinical intractable hypoxia. HBOT has since it was first used for supportive treatment thoracic surgery in 1956 been widely used in clinical practice for more than half a century of. Domestic top three hospitals are generally equipped with oxygen cabins, and a large number of HBOT for various diseases are carried out daily, especially for the typical a cute is a type of carbon monoxide poisoning

hypoxia, which, which has become a key treatment measure. From the perspective of kinds of diseases disease, HBOT very indications wide. As a conventional method of oxygen therapy, the indication is essentially a "hypoxia", that is, systemic or local intractable hypoxia.

The second is that the diagnosis of hypoxia in severe patients with new coronary pneumonia is clear. The clinical severe hypoxia manifestations of are prominent, the indications of hypoxemia are obvious, and the existence of hypoxia is obvious. In all the clinical scientific literature about COVID-19 published earlier, it is clear that the continuous progressive development of hypoxemia is an important manifestation of disease deterioration. HBOT is treatment of severe coronary pneumonia with

used for the symptomatic treatment of hypoxia in the clear indications.

Efficacy five patients were very significant, and are for the first time after HBOT subjective and objective clinical Indicators are displayed immediately discontinued in patients with systemic hypoxia deterioration state followed by gradual recovery. Such a consistent treatment response cannot be explained by chance in accordance with statistical rules. The above mechanism demonstration verified that the efficacy of HBOT in 5 patients was not accidental. The treatment effect of HBOT on hypoxia is effects of in the treatment

a scientific summary of the HBOT of intractable and refractory hypoxia in various diseases for a long time. The relevant scientific papers, literatures and works are numerous. HBOT in solving with new coronary

The superiority of severe hypoxia in patients pneumonia is clearly scientific. Efficacy and newly developed therapies or drugs still in various stages of scientific hypothesis does not require clinical trials to verify, oxygen therapy and other means have been used clinically, such as mechanical ventilation or ECMO, be to fair use.

In summary, the current treatment of critically ill patients with severe pathophysiological encountered correction of problems hypoxia, the use of HBOT can have a clear clinical benefit. HBOT can be used to treat severe hypoxia in patients with new coronary pneumonia, which can more effectively and comprehensively solve the problem of hypoxemia than normal-pressure

oxygen therapy (high-flow oxygen inhalation, mechanical ventilation), and make deep tissue hypoxia fully corrected and greatly relieved Systemic hypoxic inflammation also has practical clinical significance for the effects of other treatment methods (such as drug support treatment).

B, the safety of oxygen therapy in patients with severe neonatal pneumonia.

HBOT for HBOT has been widely used in clinical practice and standardized for nearly a century. Its own medical safety will not be repeated here. The focus is on the disease prevention and control (CDC) wind caused by Class A infectious diseases risks. HBOT treatment requires special equipment and special procedures need to be from the unit to the patient oxygen transferred back and forth between the tank. Under the transfer process the patient is in an atmospheric environment with a complete set of mature CDC measures, there is no insurmountable technical problems, the General Hospital of Wuhan Yangtze River shipping has form become a really viable of practice, and can be further refined and improved, nor here To repeat. This article focuses on the treatment process of HBOT in the oxygen cabin and the risk of CDC in the hyperbaric oxygen department.

(1) The risk of infection of pathogenic microorganisms by medical staff entering the cabin is not higher than that of the infected ward cabin

First, the risk of CDC for carrying out medical operations in the oxygen is not increased compared with the same operation in the infected ward.

The difference between the microenvironment of the oxygen cabin and the microenvironment of the infection ward is atmospheric pressure. This is of the same nature as the difference between plateau and sea level infection wards. Medical personnel are generally exposed to the tiny environment of the oxygen cabin under high pressure. The pressure on the surface is equal, and the pressure difference not felt (pressure) is. Protective equipment also does not suffer from “compressive” deformation. Hospital infection ward control requirements in the plateau area are not different from those in the plain area. There are no clear environmental pressures differences in CDC requirements for differences in. In the process of medical treatment in the oxygen cabin, compared with the same operation in the infection ward, the risk of CDC did not increase significantly.

The second is that the oxygen cabin is a completely new wind environment.

HBOT usually taken during "ventilation" measures, pressurization and pressure reducing valve opening, the high pressure gas source depressurizing line displacement amount is equal, the cabin to ensure the same gas pressure, same at the time so that the oxygen chamber The air is constantly renewed. The gas flow in the oxygen chamber is in the inlet and the decompression

exhaust are on the diagonals on both sides of the pressurized tank. Under continuous ventilation, the gas flow in the tank is unidirectional, similar to a laminar flow chamber. The gas pressure in the pipeline gradually decreases from the gas source to the exhaust gas. There is no backflow of gas under the pressure gradient. The air sources are filtered, pressurized, and depressurized by an oil-free air compressor advanced purification device to ensure clean air sources.

Third, treatment-patient breathing gas compartment separated from the patient relative to the start with built-in entrance to the respiratory system (Building in breathing system, BIBS) oxygen breathing masks, patient exhaled air pollution mainly oxygen discharge pipe Channel And it is a one-way outward flow. The air in the breathing chamber of the medical staff basically keeps the patient medical staff

and the gas breathing from the from crossing. This is better than the infection ward.

Medical staff pressurize independently. The pressure of the body space of the protective equipment during the pressurization process is small, and the in the cabin Air may enter the body side of the protective equipment as the pressure rises. The hyperbaric oxygen chamber is provided with a transition cabin (small cabin). Medical staff use small cabins to independently pressurize, which can avoid the possibility that a large amount of air in the treatment cabin where the patient is regarded as a contaminated area enters the body side of the protective equipment. On the contrary, during the decompression process there is no risk of CDC.

Fourth, the use of infection ward CDC measures in the oxygen chamber does not require additional evaluation.

The oxygen chamber is managed as a ward for patients with new crown virus. The oxygen tank disinfection process is performed under normal pressure, the disinfection technology and method remain unchanged, and the disinfection effect remains unchanged. The pressurization process is a "new wind". The breathing gas of doctors and patients is relatively independent, and the possible gas pollution is less than the infection ward. In addition, the gas in the cabin under high pressure and the time-infected CDC requirements of the ward are applicable to the sensory management after the pressure in the oxygen cabin is relatively constant.

(2) Hyperbaric oxygen sensing and control measures have been initially formed and are practically feasible. Hyperbaric oxygenation can be used as a treatment area for infected patients. There are clear rules and regulations for the setting of ward isolation areas and personnel protection under normal pressure. A set of effective has also been formed practices, and I will not repeat them here. The focus of sensory control is the purification and disinfection of oxygen from the BIBS system of the patient's breathing and the decompression and exhaust of the oxygen chamber. In this regard, no home and abroad dedicated to the oxygen chamber exhaust gas purification disinfection products. We first adopted strict exhaust and regional control measures to avoid the possible impact on patients in the effective area when the patients exhaled gas

emissions. At the same time, non-standard disinfection measures were adopted temporarily, and the exhaust gas was filtered by the disinfectant solution to further prevent the pollution of the surrounding environment by the exhaust gas to cause virus transmission. At present, oxygen cabin suppliers have purchased medical waste gas emission purification equipment that has been certified by the relevant national authorities for retrofitting. After installation, it can meet the national exhaust gas health standards.

To sum up, the oxygen cabin equipment is a set of closed, unidirectional flow, brand-new air, the gas management system for the separation of medical and patient breathing gas pipelines There is no insurmountable CDC during HBOT treatment technical obstacle in. The Department of Hyperbaric Oxygen of Wuhan Changjiang Shipping General Hospital has established HBOT patients with new coronary pneumonia
a set of sensory control procedures and measures for the treatment of, which has passed the evaluation of the hospital's sensory control department. carried out early stage The HBOT treatment for patients with severe and severe neo-coronary pneumonia that has been in the has exceeded 20 classes, and they have achieved zero infection care. In general, the risk of infection in the HBOT process cabin care is not higher than the infection ward.

HBOT intervention as early as possible, it is expected to reduce the use of mechanical ventilation and accelerate the cure of critically ill and critically ill patients, which can reduce mechanical ventilation and further reduce the risk of infection of critical care workers.

C, the Vulcan Hill Hospital to carry out Hospital's new crown HBOT oxygen therapy in patients with severe pneumonia feasibility assessments

Vulcan Hill will become the last bastion of a new crown for treatment of severe pneumonia. The above discussion that, suggests HBOT new crown for oxygen therapy in patients with severe pneumonia, if they can play the role of clinical significance is obvious. Vulcan Hill Hospital is not equipped with HBOT equipment, is the use of HBOT biggest problem. Given that the treatment of hypoxia is the key and difficult point in the existing severe treatment, it is of practical significance to strive for HBOT oxygen therapy in Vulcan Mountain. to carry out existing + HBOT treatment of Vulcan Mountain

We made the following preliminary recommendations feasibility and promote the process.

The first step: call the nearby high-pressure portable oxygen inhalation equipment for small-scale use, and form a basic treatment process adapted to the actual situation of Vulcan Mountain Hospital.

It can be used for high-pressure oxygen inhalation equipment. In addition to the hyperbaric oxygen chamber, there is also a diving pressurized chamber for the treatment of decompression sickness. Which propelled diving pressurized cabin allotment army troops and the use of Portable pressurized module, meet the requirements of decompression sickness treatment, the patient does not have health care have good oxygen conditions within a short time (120min) carried out under The ability to treat HBOT.

Wuhan Naval University of Engineering's Department of Defense and Rescue is equipped with a motorized diving system (2-person diving

pressurized cabin) and a portable single-person pressurized cabin. Treatment can be carried out in the open area of the hospital, which is controlled according to the contaminated area, and the CDC needs are easily met. With recommendations personnel and equipment operate

to mobilize together to Vulcan Hill Hospital, and five cases of attempt to carry out successful cases of critically ill patients with severe illness similar to the + HBOT treatment. Form the basic treatment procedure and CDC procedure, including:

(1) + HBOT treatment procedure: using 1.6ATA / 120min, full-oxygenation program.

It is expected to achieve 1.6 times the oxygenation effect of oxygen therapy, which is superior to mechanical ventilation, and combined with reasonable use of atmospheric oxygen, the overall treatment effect is significant.

(2) The CDC process of HBOT treatment: The CDC process of hyperbaric oxygen therapy in Wuhan Changjiang Shipping General Hospital has been used in practice and proved to be feasible. It can be optimized and adjusted according to the actual layout of Vulcan Mountain Hospital.

(3) Emergency treatment plan for HBOT treatment: HBOT uses 1.6ATA, which is similar to 6 meters diving depth and does not require decompression. Once the patients condition changes, it can be from within 3 transferred the pressurized cabin minutes. Just take emergency measures at the side of the tank at normal pressure, or return to the ICU ward.

Step two: the portable device can be used for military and civilian concentrated oxygen under high pressure severe popularity possible

in patients with HBOT oxygen 1.6ATA / 120min to meet the treatment of decompression sickness recompression propelled submersible survey system is pressurized, Iuniformed the number of troops prepare preliminary estimate can add HBOT 144 passengers a day. It is expected to reduce the demand for severe mechanical ventilation. The overall effect of improving the pass rate of the wounded is detailed in Annex 1 "Recommendations for the implementation of hyperbaric oxygen

therapy in patients with new coronary pneumonia in Vulcan Mountain Hospital".

Step three: Start the hyperbaric oxygen chamber construction at Vulcan Mountain Hospital. Start a new high-pressure oxygen chamber system construction in Vulcan Mountain, the Wuhan Yangtze River shipping total research hospital hyperbaric oxygen equipment suppliers, installation and commissioning to be completed in 15 days, put into use. HBOT oxygen therapy for patients undergoing endotracheal mechanical ventilation can be further developed. Combined with portable high-pressure oxygen inhalation equipment, the overall effect is expected to be very significant (see Annex 1 for details)

Conclusion

In summary, the new crown of HBOT oxygen therapy in patients with severe pneumonia indications clear, the effect is significant, no uncontrollable sense of control security risks, has formed a complete set of infection control measures and processes to meet the treatment of patients with Class infectious diseases The risk of infection of medical personnel is not greater than that of infection wards. HBOT has a large therapeutic capacity reserve, and some designated hospitals are also equipped with hyperbaric oxygen chambers. Therefore, we are strongly recommended HBOT into the novel coronavirus pneumonia treatment programs, for treatment of the in provide a more effective means of oxygen therapy options doctor charge. As the last bastion of severe coronary pneumonia treatment, Vulcan Mountain Hospital gradually explores and develops large-scale HBOT oxygen therapy, which is expected to significantly improve the efficiency of treatment, reduce medical pressure and infection risk, and reduce mortality.

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