Effects of Hyperbaric Oxygen Therapy on Hypertensive Patients

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ABSTRACT. The scope of this research is to determine the affect of hyperbaric oxygen therapy to patients of Asyifa hyperbaric clinic that suffers from hypertension. There are 20 participants participate thisresearch with the range of their age between 31-76 years old, along with various kind of sleep duration in between 5,5 – 10 hours of sleep. Some of the patients took medicine for hypertension or any other disease that related to the other disease. Participants of Asyifa Hyperbaric Clinic that participate this research have done at least 5 times of conducting hyperbaric oxygen therapy. This research will involve of using statistical packages for social science program (SPSS) The results of paired t test shows that the N value are the correlation on blood tension systole shows 0.951, while the correlation on blood tension diastole shows 0.916. If the correlation value is closeto 1,000 then it shows that there is a correlation effect of hyperbaric oxygen therapy on hypertension. This shows that HBOT does affecting patients that has hypertension and it helps lowering down high blood pressure.

Keywords: Hypertension, Hyperbaric Oxygen Therapy, Liaison Journal of Engineering; International University Liaison Indonesia

1. INTRODUCTION

Hyperbaric oxygen therapy has been employed on a variety of occasions. It was contested and changed before being finally accepted in a number of patient care settings. Hyperbaric therapy is used in many patient care settings, including wound care and military applications, in both single-chamber monoplace settings as well as larger multiplace chamber settings. In September 1964, hyperbaric oxygen therapies (HBOT) were gaining a lot of attention, and their use grew throughout the 1970s and into the 1980s. The potential application of hyperbaric oxygen therapy in the medical field has generated curiosity and drawn attention to resources other than those that have traditionally played a role in medical treatment. It was noted that hyperbaric therapy can be useful and helpful for people with hypertension when administered correctly and carefully. The effectiveness of hyperbaric oxygen has been the subject of extensive research. Hypertension is a major contributor to the organ consequences of hypoxia or ischemia. Hyperbaric oxygen's effectiveness in treating diseases is being researched. The majority of the current uses for hyperbaric oxygen are supported by data from unrestricted clinical trials. Hyperbaric oxygen has been found to have an impact on cardiac tissue and blood, forcing oxygen not just into hemoglobin (Hb) but also into plasma.

2. LITERATURE REVIEW

HBOT or Hyperbaric oxygen therapy is a method of therapeutical access of patients inside air tight augmented pressurized chamber with the aid of exposure of pure oxygen (O_2) concentration based on atmospheric pressure [1]. The medical device itself called Hyperbaric chamber. The pressure inside hyperbaric chamber is between 2 – 3 absolute atmospheres (ATA) during the therapy process. Hyperbaric oxygen is use as diving medicine and others forms of therapy. Although the oxygen molecule was discovered in the year 1772, Henshaw employed compressed air for medical purposes in 1662, which is the first confirmed documented usage of a hyperbaric as a therapy equipment [2].

Based on the capacity of chamber that can hold persons into it, it could be divided into 2:

- Monoplace hyperbaric chamber. This chamber is design to be use for a single person. It's a long shape tube, its appearance looks like a computed tomography scan (CT scan). The user of mono hyperbaric chamber needs to take sleep position in order to fit inside the chamber. The chamber gradually will be pressurised with air and will be given oxygen.

The advantage of Monoplace hyperbaric chamber utilization:

1. The chamber handles a single patient for each therapy conducted, hence privacy of the patient guaranteed and safe for isolation if there's infection.
2. appropriate for people with acute illnesses or injuries who must stay in bed
3. Patient inside the chamber is easy to be observe, since the outer tube are made of acrylic.
4. The cost of monoplace hyperbaric chamber is the cheapest among other kinds of hyperbaric chamber model.
5. It saves more space since its dimensions is small compare other hyperbaric chamber.

The disadvantage of Monoplace hyperbaric chamber utilization:

1. Most monoplace hyperbaric chamber design in a fix standing point, hence its arduous to move into other place promptly
2. Monoplace hyperbaric chamber design to hold capacity for a single person, the minimum requirement capacity of device.
3. It requires a lot of time to conduct therapies since it can't hold more person simultaneously.

The advantage of Multiplace hyperbaric chamber utilization:

1. It is feasible to treat many patients simultaneously.
2. They are necessary for treatments that call for the presence of a doctor and specialized tools.
3. It consumes less time due to carries more patients simultaneously.
4. The chamber can be used for physical therapy, such as sports physiology and physical therapy for stroke, peripheral vascular disease, and myocardial ischemia patients to use treadmill inside the chamber.

The disadvantage of Multiplace hyperbaric chamber utilization:

1. Multiplace hyperbaric chamber has bigger size than monoplace hyperbaric chamber, hence it requires more space in order to apply it.
2. Same as monoplace chamber, multiplace hyperbaric chamber are design in a fix standing point, hence it's impossible to move into other place due to its weight and bigger dimensions
3. Patients inside the multiplace chamber are vulnerable to be infected if one of the patients has an active infectious disease.

Mobile hyperbaric chamber. It has the same function and principal as other hyperbaric chambers; however, it can be mobilized. Both monoplace and multiplace hyperbaric chamber have the mobile variants in order for practical carriage. It designed non fixate standing point and it made of lighter material properties, hence it can be carried.

The advantage of Multiplace hyperbaric chamber utilization:

1. It can be moved as necessary.
2. Suitable for emergency situations: stroke, myocardial infarction, central nervous system injury patients, patients who can carry out long-distance transportation. It is suitable for military use as it can be transported to a base hospital in the event of war.

The disadvantage of Mobile hyperbaric chamber utilization:

1. The chamber has lower tolerance withstand of maximum pressure threshold due to the use of material properties that are weaker than fixed standpoint of hyperbaric chamber.

COMPONENTS AND MATERIAL PROPERTIES OF HYPERBARIC

The main components of Hyperbaric chamber as medical device without arguably are the chamber itself. The chamber itself must withstand pressure until the specific amount of pressure require for the therapy, and must have several toleration pressures distances between the amount of pressure needed for therapy against the maximum acceptable pressure of the cylinder. Fixated standing points of hyperbaric chambers constructed using hard shell metal to withstand pressure as well as can sustain multiple patients inside. Hyperbaric chamber needs visible gap in order to observe the treated patient inside. The visible gap is made of PMMA acrylic.

PMMA, also referred to as acrylic or polymethyl methacrylate, is a translucent thermoplastic. Due to its qualities as a substitute for glass, namely its light weight and shatter resilience, it is frequently utilized in sheet form. When high strength is not required, polycarbonate is frequently replaced by it as an affordable option. Strong and lightweight are two qualities of acrylic. Acrylic has a density of between 1.17 and 1.20 g/cm3, which is half that of glass. PMMA has a stronger impact resistance than glass and polysterene. 3mm of PMMA thickness, can transmit up to 92% of visible light. It can reflect up to 4% of light off its surface due to its refractive index of 1.4905

at 589.3 nm. Because of its transparency and durability, acrylic is a material that is currently employed in a variety of applications. Its main function is to ensure high levels of transparency in various glass components [4]. A test must be performed to determine the durability of PMMA, and using fatigue analysis will help determine how long the structure will function before failing. A numerical investigation of random vibration fatigue was carried out. The specimen is fastened to a fixture with a fixed support boundary condition and has an attached end mass of 0.0098 kg. With the specimen being pulled to failure at a constant crosshead speed of 1 mm/min, the elastic modulus across the stress was measured. The ten test specimens had narrow parallel sided sections that measured 8 x 1 x 0.286 cm in size. Tensile testing was conducted at standard room temperature. The ratio of nominal stress to corresponding strain at a location of interest on the stress-strain curve is known as the secant modulus. The poisons ratio is 0.42 and the tensile yield stress, which is often about the same as the ultimate tensile strength. As can be observed from the data, the fatigue life has a standard deviation of 105 and ranges from 164 s to 548 s in the maximum.

Table 1. Fatigue Life experiment result

Experimental Fatigue life														
Specimen	1	2	3	4	5	6	7	8	9	10	11	12	Average	StDev
Fatigue life (s)	318	548	164	276	333	316	350	192	172	308	237	364	298	105

Table 1 above are explaining about the fatigue life (durability) of PMMA conducted in 12 different experiments. The results number are explaining about the duration of specimen can withstand when it being pressed gradually. The range duration between 12 specimens is variative, the lowest is on specimen 3 with could only withstand gradual pressure for 163 seconds while specimen 2 are the longest among the other specimens with the duration of fatigue life for 548 seconds. The average number of fatigue life are 298 seconds with the standard deviation of 105 seconds.

This research was conducted at the "Hyperbaric chamber Clinic Asyifa". The hyperbaric used in this study is a multiplace chamber that has a capacity of 6 people with dimensions of 1950 mm in outer diameter, 2438 mm in length, and 10mm in thickness. The capacity of the air space contained in this chamber is 7000 litres with a pressure strength of up to 3 barG. The specifications contained in this chamber are manufacturing standards from a company experienced in making hyperbaric chambers, "PT. hyperbaric medical Solusindo". This hyperbaric chamber has been certified and recognized by the Ministry of Manpower of the Republic of Indonesia. The most often used metal in the production of medical and laboratory equipment is stainless steel type 316, which is a versatile material utilized in the medical sector. Due to this material's durability, stability, and simplicity of maintenance, it has become so widely used. Stainless steel has a low thickness and strong strength. It is extremely recyclable, just like carbon steel. Type 316 stainless steel alloys must have at least 11% chromium, but typically contain between 16 and 18%. This alloy has around 0.08 percent carbon added to it, along with 2% to 3% molybdenum, 70% ferrum, and 10% to 14% nickel. Long service life, dependability, appropriate mechanical qualities, and aesthetic considerations are the primary factors. Even though chromium is specifically used to prevent rust, it is nonetheless sensitive to high temperatures. Alloys of type 316 stainless steel are also known as austenitic stainless. It is a type of stainless steel that augments the iron base with considerable levels of nitrogen, manganese, molybdenum, and chromium [28].

Table 2. Composition of stainless steel, https://www.researchgate.net/figure/Typical-chemical-composition-of-304-304L-316-316L-and-316LN-austenitic stainless_tbl1_341305420.

max %	304	304L	316	316L	316LN	316H
Fe	Balance	Balance	Balance	Balance	Balance	Balance
Cr	18% - 20%	18% - 20%	16% - 18%	16% - 18%	16% - 18%	16% - 18%
Ni	8,0% - 10,5%	8,0% - 10,5%	10,0% - 14,0%	10,0% - 14,0%	10,0% - 14,0%	10,0% - 14,0%
Mo	-	-	2% - 3%	2% - 3%	2% - 3%	2% - 3%
Mn	2,00%	2,00%	2,00%	2,00%	2,00%	2,00%
Si	0,75%	0,75%	0,75%	0,75%	0,75%	0,75%
N	0,10%	0,10%	0,10%	0,10%	0,10% - 0,30%	-
P	0,045%	0,045%	0,045%	0,045%	0,045%	0,045%
C	max. 0,08%	max. 0,03%	max. 0,08%	max. 0,03%	max. 0,03%	0,04% - 0,10%

Picture 1. A picture of Multiplace chamber in Asyifa Remopa Hyperbaric Clinic. The chamber is made of stainless steel and the glass use PMMA, Picture by Roderick Osman Chandra

MECHANISM OF HYPERBARIC

The system for hyperbaric oxygen (HBO2) therapy is based on a rise of both the hydrostatic pressure and the partial pressure of inspired oxygen. The patients inside the chamber are expose to oxygen (O_2) in pure concentrations. It is possible to cure patient illnesses when gas bubbles are present in the body and cause the disease using this mechanism, which operates on a compression of filled air spaces in the body (Boyle's Law) [3]. Patients are given oxygen that is pure and pressurized to 2-3 absolute atmospheric pressures (ATA) through masks or nasal cannulas. Depending on the clinical permission, therapy sessions typically last between 75 and 120 minutes. They are repeated a couple of times per week. The amount of oxygen that dissolves into blood is reflected in the inhaled air's raised partial oxygen pressure (PO_2), which permits more oxygen to enter the body. The compressor sucks up air and will be distributed into tanks (air bank) to be stored before usage, during the utilization of hyperbaric chamber the stored air will be distribute inside the hyperbaric chamber to give pressure inside the chamber by the operator. The containment inside hyperbaric chamber required to be air tight in order to be pressurized. Operators distribute pure oxygen to the patients and patients requires using nasal canula or mask in order to receive pure oxygen effectively during the therapy. The oxygen is distributed from the pipe that connect into the chamber. The therapy last between 75 and 120 minutes depending on the disease and clinical authority permission including compression and decompression phase. The pressurized air from the storage will be drain out during decompression, along with water condensation. The temperature inside hyperbaric chamber will increase during compression (approximately 2-3^oC), however the temperature will gradually back to normal once it reaches the maximum depth (according to clinical therapy). Once it reaches decompression phase, the temperature will be decrease (approximately 2-3^oC).

Picture 2. Picture of Oxygen tube (smaller tank in front) with air bank (Bigger tank at the back), picture by Roderick Osman Chandra.

PHYSICAL EFFECTS ON PRESSURE

The connection between pressure and the depth of sea are correlated. The pressure inside a body of water appears no other than from water itself. The absolute pressure exerted by sea water in vertical line that is approximately 10 m (in metric units) or 33 ft (in imperial units) high is equal to 760 mmHg (measured using mercury barometer) and is known as 1 ATA (absolute atmosphere), or equivalent to 1.013 bar. A person will therefore be exposed to 3 ATA of pressure if they are 20 meters (66 feet) below sea level. In addition to the 1 ATA provided by the air above the water, 2 ATA are calculated depending on the weight of the water. The use of Boyle's law can be used to explain how depth affects volume gasses.

The amount a particular quantity of gas that is compressed depends inversely on pressure [2].

The formula of Boyle's law is written as:

$$P_1V_1 = P_2V_2 \quad \text{.....(1)}$$

P_1= First pressure

P_2= Second pressure

V_1= First volume

V_2= Second volume

Boyle's law states a phenomenon of compression and expansion of gas are proportionally inverse to the volume during same or constant temperature.

EFFECTS OF HIGH PRESSURE ON BLOOD AND CARDIOVASCULAR

The heart, arteries, veins, and capillaries make up the cardiovascular system, which has control over the amount and rate of blood flow through the vessels. It supplies blood to the entire body. Blood is pumped through the veins by the heart. The process of exchanging blood carrying carbon dioxide and oxygen occurs in alveoli, and blood contains oxygen that is distributed throughout the body [29]. Pressurized air at 2 until 3 ATA during Oxygen [O_2] 100% concentration is administered regullarly during 1.5–2 hours per session and repeated, depending on the clinical condition sessions vary in number. The inhalated air came from an external elevated PO2, hence positive gradient allows higher oxygen entry, which per diffusion will be higher also in alveoli, bloodstream and therefore there will be greater arrival to tissues. This effect of "hyperoxemia" and "hyperoxia" is independent from haemoglobin (Hb), then will lessen hypoxia in tissues. This will result in a major supply of reactive oxygen species (ROS) and reactive nitrite species (RNS), with a consequent higher expression of growth factors and promotion of neovascularization and enhanced immunomodulatory properties [1].

TYPES OF BLOOD PRESSURE

High blood pressure can be both a sickness and a significant risk factor for other diseases. An individual's blood pressure is very varied, making it difficult to characterize from just one or a few measurements. Rising blood pressure (from systolic blood pressures above 120 mmHg) is associated with an increased risk of cardiovascular events like premature mortality, atrial fibrillation, myocardial infarction, heart failure, and stroke [5]. Blood pressure can be defined according to several category based on the amount of blood flow through cardiovascular valves (tricuspid and mitral). Systolic and diastolic pressure can be measured using blood tension device. Systolic blood pressure measures the amount of blood pressure enters inside the heart through tricuspid and mitral valve it can be distinguish on the first segment of heart rate. Diastolic blood pressure measures the amount of blood pressure exit from the heart through pulmonary and aortic valve, it can be distinguished on the second segment of heart rate.

BLOOD PRESSURE GRADE

Stage 3 hypertension can also be called as Crysis hypertension, it can be classified into 2 parts: Urgency hypertension and emergency hypertension. Based on the amount of blood that flows in circulatory system it could be divided into several categories:

Table 3. Category of blood intensity flow in cardiovascular system.

Source: European Society of Hypertension-European Society of Cardiology (ESH-ESC) 2013

Category	Systolic		Diastolic
	Blood pressure		
	(mm Hg)		
Optimal	< 120	and/or	< 80
Normal	120 – 129	and/or	80 – 84
Upper normal	130 – 139	and/or	85 – 89
Stage 1 Hypertension	140 – 159	and/or	90 – 99
Stage 2 Hypertension	160 – 179	and/or	100 – 109
Stage 3 Hypertension	≥ 180	and/or	≥ 110
isolated systolic hypertension	≥ 140	and/or	< 90

URGENCY HYPERTENSION

Urgency hypertension is acute, significant blood pressure elevation without any signs of harm to the target organ, such as pulmonary edema, myocardial ischemia, neurologic impairments, or acute renal failure, is known as hypertensive urgency. There have been suggested specific cut offs, equally pressure blood systolic of 180 mmHg or a pressure blood diastolic of 110 mmHg. Blood

pressure thresholds that indicate urgency hypertension are arbitrary and unrelated to short term morbidity and mortality. Individuals with hypertension urgency should receive the proper care; else, end-organ damage may result from a hypertensive emergency [7] [38].

EMERGENCY HYPERTENSION

When urgent hypertension is left untreated, it causes a substantial increase in blood pressure that is linked to symptoms of target organ damage. Complications can include eclampsia, aortic dissection, acute renal failure, pulmonary edema, heart ischemia, and neurologic impairments. If the patient's organ function has suddenly deteriorated, it is imperative to immediately lower blood pressure. Patients with a persistent hypertension diagnosis experience the majority of hypertensive emergencies. Individuals need to be admitted with ongoing blood pressure monitoring if they have a hypertensive emergency. Examine the target organ for damage and begin parenteral treatment as necessary [8] [38].

ETIOLOGY OF HYPERTENSION

Numerous factors could prompt hypertension. Some of factors are related to conducting poor life style for instance: Drinking too much alcohol, low potassium levels, excessive salt, tobacco use or vaping, lack of exercise, and obesity. However, there are as well some factors that triggers hypertension to a person that aren't a consequence result for their lifestyles, for instance: Age, Race, Pregnancy, genetics.

As people get older, arterial stiffness, which causes hypertension and other cardiovascular diseases, becomes more common. According to epidemiological research, the prevalence of hypertension is greater than twice as high in the old population as it is in the young. With time, the walls of big conduit arteries, particularly the aorta, thicken and lose their flexibility, which causes an increase in pulse wave velocity [13]. The loss of function of elastin fibres causes them to transfer load-bearing onto stiffer collagen fibrils, which immediately causes a large rise in arterial stiffness. This occurs because elastic fibres (in vivo) have a very low turnover rate, which permits the build-up of aging-related alterations brought on by fragmentation, calcification, and metalloproteinase destruction [30] [31].

Based on ethnicity, there are considerable disparities in blood pressure prevalence and control rates. Based on National Health and Nutrition Examination Surveys, about 45% of adults in the United States have hypertension, which is indicated by blood pressure readings below 130/80 mm Hg. Only 24% of persons in the United States with hypertension have regulated blood pressure (below 130/80 mm Hg), despite the fact that 81% of them are being treated with antihypertensive drugs and lifestyle changes. Comparing African American adults (59%) to White (47%), Asian (45%), and Hispanic (44%) individuals, African American adults have the highest prevalence of hypertension. Moreover, compared to White (24%) people, the frequency is higher in American Native (Indian and Alaskan) adults (27.2%) [14] [15].

It is unclear exactly how pregnancy-related hypertension develops. According to recent studies, one important factor in the development of gestational hypertension is inappropriate trophoblast differentiation during endothelial invasion caused by aberrant cytokine, adhesion, major histocompatibility complex, and metalloproteinase regulation and/or production. Spiral arteries in the deep myometrial tissues mature abnormally and undergo abnormal remodelling due to faulty regulation and/or synthesis of these molecules. Placental hypoperfusion and ischemia result from this. Systemic endothelial dysfunction, which is brought on by antiangiogenic substances secreted by placental tissue, can lead to systemic hypertension [16] [39].

No singular factor directly influences genetic hypertension; rather, a number of genes, each having minor effects, react to multiple environmental cues to affect blood pressure. According to research on the heritable aspect of blood pressure, 30% to 50% of the variance in blood pressure measurements can be attributed to genetic heredity and the remaining 50% to environmental variables. Angiotensin-converting enzyme II (ACE II), a molecule that narrows blood arteries, has been linked to hypertension. High blood pressure can result from this constriction, which also makes the

heart work harder. Genes involved in the renin-angiotensin-aldosterone system that controls blood pressure and saline homeostasis, proteins in the hormonal regulation of blood pressure (mineralocorticoid and glucocorticoid enzymes and receptors), involved in sodium handling in the regulation of blood pressure channel and receptor signalling pathways) and proteins encoded by genes involved in the structure and/or regulation of vascular tone (endothelins and their receptors) [17].

RISK OF HYPERTENSION IN LIFE STYLE

a) Drinking too much alcohol
Alcohol intake has always been correlated with increased in blood pressure. An alcoholic person may have higher blood pressure compared to other person who don't drink alcohol. The safe amount of alcohol that could be consume by men and woman are different. The maximum amount of alcohol of men are two drink a day, while woman is one drink a day (1 serve of 4,7% alcohol of beer is 350ml, while 1 serve of 40% spirit is 35ml). The exact dose of liquor that could take by men and woman are depend on the alcohol concentration of the liquor (higher concentration of liquor will have lower maximum acceptable tolerance) [11][12].

b) Low potassium levels

A person blood pressure can be lowered by consuming more potassium. Salt homeostasis in the body's cells is aided by potassium. Potassium lowers blood pressure and prevents muscle cramps by relaxing the blood vessel walls. Low potassium levels may be caused by a diet low in potassium or by certain medical conditions, such as dehydration [11][12].

c) Excessive salt

Electrolytes like salt help a person body function normally by preserving blood volume and fluid levels. The presence of Natrium inside the body can lead to fluid retention. A person is more susceptible to high blood pressure if they eat a diet that is too rich in Natrium and too low in potassium. The heart must work harder to pump blood in order to maintain an even distribution of oxygen throughout the body if the body retains too much fluid (raising viscosity). Consuming much sodium raises blood pressure. Food is the main source of salt consumption [11][12].

d) Tobacco use or vaping

The risk of high blood pressure increases if you smoke, chew tobacco, or use vape products. Smoking can harm blood vessels and the heart. It accelerates the artery hardening process. Smoking tobacco causes carbon monoxide, which lowers the quantity of oxygen a person blood can carry, and nicotine, which elevates blood pressure [11][12].

e) Lack of exercise

Lack of exercise can lead to weight gain. Hence, gaining weight increases the risk of having high blood pressure. Moreover, inactive people frequently have greater heart rates. Regular physical exercise lowers blood pressure through maintaining the strength and health of the heart and blood vessels. Frequent exercise can also assist a person in maintaining their weight [11][12].

f) Obesity
Obesity is defined as having too much body fat, which will cause weight gain. The blood arteries, kidneys, and other organs of the body change as a result of excess weight, which makes the heart work harder to circulate blood and oxygen. Frequently, these modifications raise blood pressure. Further increasing the risk of heart disease and the other risk factors, such as high cholesterol, is being overweight or obese [11][12].

DISEASE CAUSED BY HYPERTENSION

High blood pressure is an early stage that may lead for the emergence of other chronic diseases. There are various kind of disease may affect to human body that was caused by hypertension. Uncontrolled blood pressure may lead into complications such as: eclampsia, aortic dissection, acute renal failure, pulmonary edema, heart ischemia, and neurologic impairments.

According to medical terminology, neurological disorders are conditions that affect the spinal cord, brain, and body's nerves. Hypertension alters the shape and function of the cerebral blood arteries, causing ischemia damage to areas of the white matter that are

essential for thinking, remembering, and learning. It may also hasten the progression of Alzheimer's disease [18].

It's possible that heart failure and increased systemic vascular resistance brought on by sympathetic neurohormonal activation, rather than fluid accumulation, is what causes life-threatening acute pulmonary edema. Even higher peripheral vascular resistance and increased sodium and water absorption are the effects of this, which is brought on by the activation of the renin angiotensin aldosterone system, also known as RAAS. Both pulmonary venous return and heart function deteriorate. This causes hypoxia, dyspnea, and an additional sympathetic surge as intravascular fluid shifts into the pulmonary interstitium and alveoli [19].

High blood pressure may cause tear on aortic intima and media layer and eventually will rupture. The media of the aorta experiences a longitudinal tear, making it a disorder that frequently results in death. The intima-media region becomes bloody as the dissection progresses farther. 2 An exit tear forms a genuine and a false lumen, while an intimal tear connects the media with the aortic lumen [20].

Cardiac ischemia is a condition where there is a lack of blood flow to the heart muscle due to blockages in the blood vessels. Blockages in blood vessels are generally caused by atherosclerosis or the build-up of cholesterol fat in the walls of blood vessels. Blood that cannot be channelled due to a blockage will result in a build-up of blood on one side which in turn increases blood pressure, but at the same time, on the other hand, there is a shortage of blood.

The management of hypertension in chronic renal disease is influenced by a number of factors that contribute to its development. The renin-angiotensin-aldosterone system, which encourages salt and water retention, is upregulated when estimates of the glomerulus filtrations rate drop. This is made worse by the blood pressure's enhanced salt sensitivity. With an estimated glomerulus filtrations rate of less than 30 mL/min/1.73 m2, endothelial dysfunction is a hallmark of severe chronic renal disease, and its link to hypertension is well known. The mechanical implications of endothelial dysfunction result in increased arterial stiffness. It was brought on by the artery walls' lack of nitric oxide (NO). Increased oxidative metabolism may be one of the consequences of hypertension, leading to relative nephric ischemia [21].

DIAGNOSIS IN HYPERTENSION

Most of people that has potentially hypertension with high blood pressure don't feel or visible any symptoms. However, people that has stage 3 hypertension starting to feel severe headaches, chest pain, blurred vision, nausea, etc [10]. Assessment of the cardiovascular risk, target organ damage, concurrent clinical disorders that potentially affect blood pressure or related to targeting damaged organ, and recognition of characteristics suggestive of secondary hypertension should all be part of the evaluation of a patient with hypertension. The repeated blood pressure readings taken under the authority's supervision are a standard method of diagnosing hypertension. Patients with hypertension must have their blood pressure monitored on a regular basis to maintain their blood pressure. Most cases of primary hypertension are asymptomatic [9].

UNDERSTANDING BLOOD MECHANISM

The circulatory system inside the human body connects all organ systems throughout the body in order to capable sustaining life. The arteries, veins, and lymphatics make up the three primary vascular systems that make up the circulatory system. With aorta as the largest arteries progressively feeding to smaller diameter arteries, arterioles, and capillaries, the arterial system transports blood away from the heart. The venous system circulates blood from the capillaries back to the heart, returning it through progressively bigger venules and veins. By draining into lymphatic ducts that flow into the subclavian veins, the lymphatic system draws lymph from tissues and restores it to circulation [22].

All of the blood inside the heart pumped from the left ventricle throughout the body organs eventually will returns to the right ventricle from where it is pushed into the lungs because the systemic circulation and pulmonary circulation are connected in series through the four chambers of the heart. The organs of the system are connected and the blood flows in

parallel. However, the blood first travels through just one organ before being distributed uniformly through all of the human body's organs, whereas the stroke volume discharged from the left ventricle of the heart is divided to numerous organs. While the blood pressure to each organ remains constant, the blood flow to each organ has the same composition and is separately controlled [23].

The lung, ensures proper exchange between oxygen and carbon dioxide, the kidney, which maintains electrolyte composition and fluid balance during blood filtration, the gut, which supervises nutrient absorption, and the skin, which regulates body temperature are a few examples of specific organs that contribute to the specific purpose. The typical amount of blood in a human is 5 liters, and it contains several compounds that are necessary for keeping the body's organs healthy and functioning properly. White blood cells make up the least proportion of the remaining blood composition and account for the majority of plasma, which makes up between 52% and 62% of blood. Red blood cells, which carry oxygen and are responsible for the colour of blood, account for 38% to 48% of blood composition. Less than 2% of its components were made up of it [24].

HYPERTENSION CURE

Diseases such as aortic dissection, acute renal failure, pulmonary edema, heart ischemia, and neurologic impairments have one common cause, namely hypertension. These diseases occur and are interconnected with one another. Increased blood pressure can be caused by blockages in the blood vessels or hardening of the blood vessel walls [30]. High blood pressure in the blood vessels can result in excess blood pressure, especially at certain points which can result in tearing of the aortic intima and media layers which ultimately ruptures the blood vessels [20]. On the other hand, an increase in blood vessels caused by blockage or hardening of the walls of blood vessels can reduce the intensity of blood that should supply the organs of the body such as the kidneys, heart, brain and others. Lack of blood supply to the heart and kidneys can cause heart ischemia (heart ischemia is a result of heart failure) and renal ischemia while lack of blood supply to the brain can cause neurologic impairments [19].

Pulmonary edema occurs when blood rises back up into the veins and eventually returns to the lungs after the heart fails to pump efficiently. This phenomenon occurs because the pressure in these blood vessels increases, and fluid is pushed into the alveoli in the lungs.

Molecules such as nitric oxide (NO) and potassium can help relax or flex the muscles in the walls of blood vessels. Nitric oxide (NO) can be produced naturally by the body, but this is not the case with potassium [11] [12]. The thiazide-sensitive NaCl cotransporter located at kidney is activated by low potassium diet. This action, which was reliant on plasma potassium, resulted in salt retention and raised blood pressure. Changes in intracellular chloride brought on by variations in membrane voltage served as the mediator for this action [37]. Therefore, it is necessary to consume foods that contain potassium to help relax or flex the muscles in the blood vessels. Blockages in blood circulation generally occur due to the accumulation of excess oil in the blood vessels which can reduce it to completely block the flow of blood circulation [36]. This condition is called atherosclerosis. Atherosclerosis can be prevented by reducing eating foods that contain excess oil and exercising.

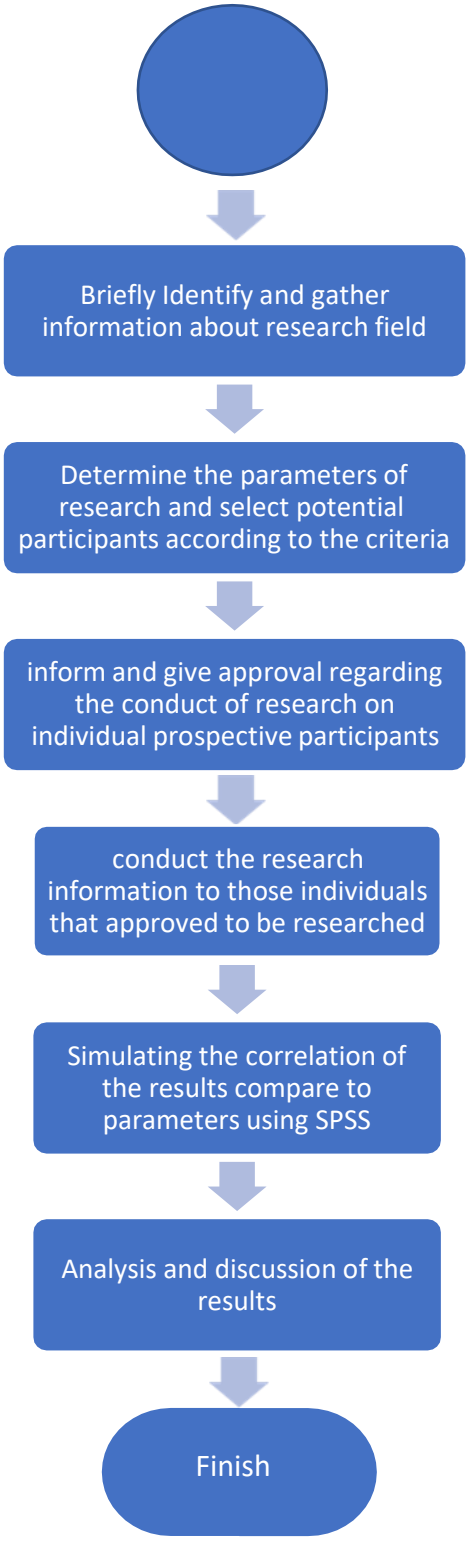
Hyperbaric oxygen therapy conducts by applying air pressure inside an airtight chamber with the aid of pure oxygen distributed to each of patients through nasal canula or mask. The appliances of pressure in hyperbaric chamber help hemoglobin (Hb) to bond more oxygen. The increment of partial pressure of air increase (which contains oxygen) may make hemoglobin (Hb) able to bond more oxygen, and pure oxygen are distributed during the therapy to maximize its efficacy of bonding. At sea level, ambient air typically contains about 21% oxygen, resulting in an alveolar oxygen pressure (PAO_2) of roughly 100 mmHg. Under these circumstances, with an assumed hemoglobin (Hb) concentration of 12 g/dL, whole blood has a combined blood oxygen content of approximately 16.2 mL O2/dL. Henry's law states that the combined oxygen content in whole blood grows to 23.0 mL O_2/dL under hyperbaric settings breathing 100% oxygen at 3 absolutes atmospheric (ATA), increasing the alveolar oxygen pressure value to

around 2280 mmHg. Nearly all of this 42% increase over the baseline is due to an increase in oxygen dissolved in plasma. HBOT is based on an increase in arterial oxygen tension and oxygen supply [25] [35]. According to a study, hyperbaric oxygen therapy has an impact on people's blood pressure. 72 naval divers with hypertension participated the test. The participants were split into two groups at random: The first groups were given 10 mg of amlodipine and 2.5 ATA hyperbaric chambers supplied by 96% of oxygen through oxygen hoods. Only 10 mg of Amlodipine were given to the second group. Prior to each session and every two weeks for the first year of therapy, the blood pressure of both groups was similar. After at least two months of treatment, the experimental groups' average heart rates were much lower. After three months of treatment, the experimental groups' average systolic blood pressure was noticeably lower; nevertheless, until one year, there was no discernible difference in diastolic blood pressure between the two groups [26].

3. METHODOLOGY

SAMPLING PROCEDURE

In order to learn about specific procedures or approaches utilized to identify on this research, both qualitative and quantitative methods are being applied in this study. To critically assess a study's overall validity and reliability, the materials that were obtained were chosen based on the parameters, processed, and analysed the information regarding this topic. The qualitative methods of this research will be required by taking the data screening of the patients to acquire some crucial factors for this research. The quantitative method of this research will involve of using statistical packages for social science program (SPSS) in order to obtain the result of correlations of variables. The results of the processed data will be analyze and explain on statistical method to prove if there's a correlation on the efficacy of hyperbaric therapy to patients that suffers from hypertension. The following flowchart below explain the complete roadmap of methodology on conducting this research.



Flowchart 1. Method on conducting the research.

BIOGRAPHICAL INFORMATION

This research will be conduct on 20 participants. There aren't any age restriction, sleep duration, or drug consumption for conducting the experiments, participants age are variety between 31-76 years old, along with various kind of sleep duration in between 5,5 – 10 hours of sleep. Some of the patients took medicine for hypertension or any other disease that related to the other disease. In order to obtain the empirical and accurate results, statistical program will be required. This experiment conducts specific test on statistical packages for social sciences (SPSS). The research will be participated by multi hyperbaric therapy patients who have a history of high blood pressure. The selection of candidate participants in this study need to conduct 6 times of hyperbaric therapy in less than 1 year period, but it is not limited by factors such as age, years of service, area of specification, etc.

Table 4. Population and information of participants.

			Sleep duration	132/90	127/87	Drug consumption	Vitamin Consumption	Gender	Other disease
1	Participant 1	age 47	7 hours	153/53	151/93	Yes	Yes	Female	Yes
				119/80	123/88				
				130/97	132/95				
				138/94	151/88				
				126/85	149/87				
2	Participant 2	age 49	6 hours	159/124	186/130	Yes	Yes	Male	Yes
				188/131	176/117				
				174/129	185/130				
				179/120	188/125				
				116/82	101/73				
				123/86	131/87				
3	Participant 3	age 62	6,5 hours	167/92	153/90	Yes	Yes	Female	No
				174/96	159/84				
				114/72	117/72				
				156/74	164/94				
				137/74	173/93				
				126/72	124/81				
4	Participant 4	age 68	7 hours	106/67	96/61	Yes	Yes	Female	Yes
				110/67	113/72				
				112/66	113/71				
				133/78	133/83				
				114/73	121/72				
				120/70	119/74				
				117/74	113/67				
5	Participant 5	age 67	7 hours	107/67	119/75	Yes	Yes	Female	Yes
				141/80	168/81				
				154/77	143/83				
				138/75	149/82				
				156/69	147/81				
				133/72	152/85				
6	Participant 6	age 31	8 hours	102/54	111/63	Yes	Yes	Female	Yes
				97/69	99/73				
				90/64	105/65				
				104/72	108/62				
				99/61	110/62				
				100/50	96/60				
7	Participant 7	age 68	8 hours	150/82	157/86	Yes	No	Male	Yes
				146/79	135/75				
				142/82	152/86				
				124/60	168/70				
				151/89	137/70				
				141/77	113/58				
8	Participant 8	age 60	5	151/91	182/116	No	No	Male	No
				153/90	158/98				
				159/101	186/111				
				159/124	188/130				
				135/86	154/94				
				141/90	166/106				
9	Participant 9	age 54	7,5 hours	130/92	137/108	No	No	Male	No
				129/79	139/82				
				137/83	125/71				
				138/85	183/113				
				125/79	123/72				
				150/89	149/88				
10	Participant 10	age 42	7 hours	150/82	168/94	No	No	Male	Yes
				146/79	135/75				
				142/82	152/86				
				124/83	123/88				
				151/89	137/70				
				122/85	141/94				
11	Participant 11	age 56	7	164/101	158/85	No	No	Female	No
				154/90	165/106				
				163/97	164/105				
				161/102	178/114				
				160/93	168/101				
				176/116	176/109				
12	Participant 12	age 76	10 hours	160/80	156/108	Yes	No	Male	Yes
				145/82	145/71				
				144/70	161/88				
				137/75	105/72				
				123/71	170/97				
				136/86	160/85				
13	Participant 13	age 51	5 hours	117/73	120/81	No	No	Male	Yes
				116/71	140/89				
				116/71	140/89				
				135/79	147/89				
				155/100	122/99				
				171/106	174/104				
14	Participant 14	age 54	7 hours	164/106	172/110	Yes	No	Female	No
				112/84	107/72				
				125/81	118/72				
				104/67	110/71				
				115/72	107/78				
				89/55	101/62				
15	Participant 15	age 52	5 hours	146/95	103/74	Yes	Yes	Female	No
				100/103	153/103				
				146/100	134/86				
				141/94	145/94				
				136/95	128/91				
				152/88	142/102				
16	Participant 16	age 43	6	169/115	157/104	Yes	No	Male	Yes
				147/96	156/109				
				126/87	137/92				
				137/91	140/91				
				134/92	135/86				
				118/82	131/88				
17	Participant 17	age 64	9 hours	144/116	151/120	Yes	No	Female	Yes
				159/93	164/94				
				163/97	184/104				
				162/97	126/85				
				148/87	170/89				
				155/91	160/95				
18	Participant 18	age 49	6 hours	148/105	148/102	No	No	Male	Yes
				145/102	151/100				
				146/100	144/102				
				148/101	182/118				
				143/107	144/104				
				141/145	134/99				
19	Participant 19	age 40	6 hours	130/96	130/97	Yes	No	Female	Yes
				112/78	126/83				
				105/96	109/69				
				115/87	116/82				
				120/83	119/77				
				119/86	123/91				
20	Participant 20	age 70	5,5 hours	145/85	163/97	Yes	Yes	Male	Yes
				152/74	154/86				
				156/102	170/106				
				141/78	141/100				
				151/91	165/99				
				168/96	149/99				

The following tables above shows information each of the participants age, blood pressure, pulse, medicine consumption, gender, and complications/ other disease.

The graph above are the final results of populations information after conducting qualitative method. The numbers of blood pressure on the left side are taken before therapy while the right side measured after on the same attempt of therapy. The therapy itself conducted to monitor the development of outcomes. The disparity of population age has wide difference, as well as the sleep duration. Sleep duration can be divided into 2 groups: short sleep duration (5-7 hours of sleep) and long sleep duration (8 – 10 hours of sleep).

4. RESULTS AND DISCUSSION

RESULTS

The statistical population of participants can be divided into 3 categories: Sleep Duration, Gender, and Drug Consumption. There aren't any age restriction, sleep duration, or drug consumption for conducting the experiments, participants age is variety between 31-76 years old, along with various kind of sleep duration in between 5,5 – 10 hours of sleep. This was considerate due the limited amount of participant that participate on the research as well as the limited amount of time on conducting the research. Data were obtained through patients screening.

This pie chart represents the duration time of sleep, it could be classified into 2 parts: short duration sleep and long duration sleep. Short duration sleep are categorized if the duration of sleep in between 5 – 7 hours of sleep, while long duration sleep are categorized if the duration of sleep more than 8 hours. The majority of participants had short duration of sleep, makes up to 80% of participants (16 participants), the rest of 20% participants had longer duration sleep than the majority (4 participants).

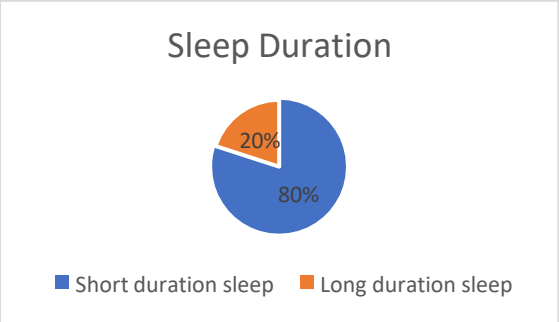


Chart 1. Percentage of duration time of sleep on participants.

The percentage on the first pie chart were obtained it by doing calculations on each factor contained in it with the total population, in this case between short duration sleep with the total population and long duration sleep with the total population.

$$\frac{(Numbers\ of\ population\ on\ factor\ 1\ or\ factor\ 2)}{(Number\ of\ total\ Population)} \times 100\%$$

Total Population = 20

Short duration sleep population = 16

Long duration sleep Population = 4

Percentage of short duration sleep population:

Percentage of long duration sleep population:

$$\frac{16}{20} \times 100\% = 80\%$$

$$\frac{4}{20} \times 100\% = 20\%$$

Based on Gender that participate the research are divided into male and female. There are equally amounts of male and female participants that participate into the research; male participants make about 50% of

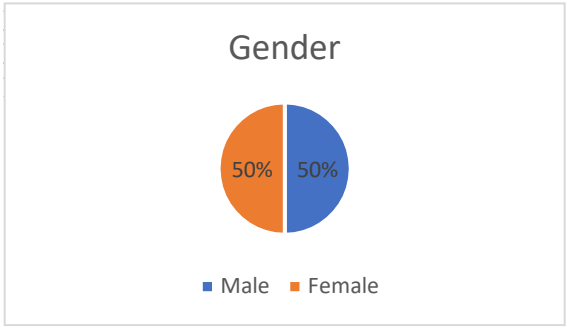


Chart 2. Percentage of participants that participate based on gender.

The percentage on the second pie chart were also obtained it by doing calculations on each factor contained in it with the total population, in this case between male partici ant with the total population and female participant with the total population.

Percentage of male participant population:

Percentage of male participant population:

$$\frac{10}{20} \times 100\% = 50\%$$

Percentage of female participant population:

$$\frac{10}{20} \times 100\% = 50\%$$

The third pie chart represent medicinal consumption on research participants, it could be classified into 2 parts: participants that took medicine as part of their cure besides therapy and don't take any medicine as part of their cure. Types and brands of hypertension medicine were consumed by participants are based on the preferences and the amount of dose needs of each participant. The majority of participants consume medicine as part of their cure besides therapy, makes up to 70% of participants (14 participants), the rest of 30% participants didn't consume medicine as part of

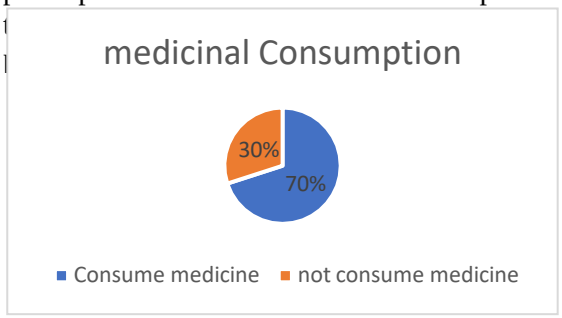


Chart 3. Percentage of participants that consume medicine as part of their cure.

Similar to the pie chart above, the percentage on third second pie chart were also obtained it by doing calculations on each factor contained in it with the total population, in this case betw en participa t that took medical intake with the total population and participant that doesn't take medical intake with the total population.

Percentage of population took medical intake:

$$\frac{14}{20} \times 100\% = 70\%$$

Percentage of population doesn't take medical intake:

$$\frac{6}{20} \times 100\% = 30\%$$

The results of qualitative measure of the research are conducted through average accumulations of participants blood tensions recording before and after conducting on each therapy. Observation of the blood pressure of each participant was carried out for 6 sessions of therapy, hence each session of therapy will be recorded twice; before and after conducting the therapy. Each of the participants are expected to obtain total of 12 blood tensions recording data at the final of observations. The data were accumulated and averaged then processed using SPSS.

The first correlations result on efficacy of hyperbaric chamber to patients that suffers from hypertension can be seen through the table results below. Table. 4 are showing the results of correlations on participants systole towards hyperbaric therapy by using paired sample T test method. The N value shows the number of participant that participate, while the correlation on blood tension systole shows 0.951. If the correlation value is close to 1,000 then it shows that there is a correlation effect of hyperbaric oxygen therapy on hypertension.

Table 5. Results of correlations on participants systole towards hyperbaric therapy.

Paired Sample Correlations

		N	Correlation	Sig.
Pair 1	Systole_Before_Treatment & Systole_After_Treatment	20	.951	.000

The second correlations result on efficacy of hyperbaric chamber to patients that suffers from hypertension can be seen through the table results below. Table. 5 are showing the results of correlations on participants diastole towards hyperbaric therapy by using paired sample T test method. The correlation on blood tension diastole shows 0.916. If the correlation value is close to 1,000 then it shows

that there is a correlation effect of hyperbaric oxygen therapy on hypertension.

Table 6. Results of correlations on participants diastole towards hyperbaric therapy.

Paired Sample Correlations

		N	Correlation	Sig.
Pair 1	Diastole_Before_Treatment & Diastole_After_Treatment	20	.916	.000

To determine if there's a correlation between hypertension and gender, a statistical test need to be conduct. The table below shows the statistical result using SPSS of comparison correlation on systolic blood pressure before and after conducting therapy to the participants genders. Multivarative test are also called as Multivariate analysis of variance (MANOVA) is a test that aims to test the comparison of the means of two or more data groups. Where there are 2 or more dependent variables that are metric in nature and two or more independent variables that are non-metric in nature.

Table 7. MANOVA results comparison of systolic before and after therapy compared to gender.

Multivariative Test

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.990	878.977	2.000	17.000	.000
	Wilks' Lambda	.010	878.977	2.000	17.000	.000
	Hotelling's Trace	103.409	878.977	2.000	17.000	.000
	Roy's Largest Roots	103.409	878.977	2.000	17.000	.000
Gender	Pillai's Trace	.203	2.164	2.000	17.000	.145
	Wilks' Lambda	.797	2.164	2.000	17.000	.145
	Hotelling's Trace	.255	2.164	2.000	17.000	.145
	Roy's Largest Roots	.255	2.164	2.000	17.000	.145

Pillai's trace value shows a positive value of 0.203 with a significance of 0.145. Increasing this value gives a significant value to the model or there is a significant average difference between groups of data. Wilk's lambda value is 0.797 with a significance of 0.145 which means there is an average difference between the data groups. Likewise, for the Hotelling trace and Roy's largest root each obtaining a value of 0.255 and a significance of 0.145. From the four tests, a significance value of more than 0.05 (> 0.05) was obtained, therefore it can be interpreted that there is no effect of systolic blood pressure either before or after therapy on gender.

Table 8. MANOVA results comparison of diastolic before and after therapy compared to gender.

Multivariative Test

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.986	605.498	2.000	17.000	.000
	Wilks' Lambda	.014	605.498	2.000	17.000	.000
	Hotelling's Trace	71.235	605.498	2.000	17.000	.000
	Roy's Largest Roots	71.235	605.498	2.000	17.000	.000
Gender	Pillai's Trace	.137	1.351	2.000	17.000	.137
	Wilks' Lambda	.863	1.351	2.000	17.000	.137
	Hotelling's Trace	.159	1.351	2.000	17.000	.137
	Roy's Largest Roots	.159	1.351	2.000	17.000	.137

Similar from above, Pillai's trace value shows a positive value of 0.137 with a significance of 0.137. Increasing this value gives a significant value to the model or there is a significant average difference between groups of data. Wilk's lambda with the highest value of 0.863 with a significance of 0.137 which means there is an average difference between the data groups. Likewise, for the Hotelling trace and Roy's largest root once again has the same value, each obtaining a value of 0.159 and a significance of 0.137. From the four tests, a significance value of more than 0.05 (> 0.05) was obtained, therefore it can be interpreted that there is no effect of systolic blood pressure either before or after therapy on gender.

DISCUSSION

Descriptions of participants regarding to their age, gender, medical consumption were obtained on patient data screening. The screening data were filled and stored in as part of the clinical standard operations during patient first meeting. Sorting on potential candidate were needed in order to meets the standard requirements. Based on the statistical populations of participants consuming medicine are predominantly practiced by most participants. Participants believe that consume medicine as part of their cure besides doing therapy

Normality test need to be examined in order to decide which statistical method are admirable to be utilize. Normal distribution data result could be concluded if the p-value are less than 0,05. The obtained data were processed statistically using paired sample T test method on statistical packages for social science program (SPSS). Interval data and ratio are suitable using paired sample T test method as well as to conduct hypothetical comparison. Paired sample T test method are also recommended to prove difference of average on samples that are related to one and another. The correlation result could be seen on table 4 and table 5.

Table 9. Output paired sample on systole statistics table.

Paired Sample Statistic

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Systole_Before_Treatment	138,5000	20	14,73596	3,29506
	Systole_After_Treatment	148,8090	20	16,37044	3,66054

The N values on table 7. Shows numbers of participants that participate on the experiment. Based on paired sample T test results the mean value of participants systole tensions before (top) and after treatment (bottom). Based on the results above, it can be confirmed that the participants have smoother blood circulation after 6 times of hyperbaric therapy.

Table 10. Output paired sample on diastole statistics table

Paired Sample Statistic

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Distole_Before_Treatment	86,8490	20	12,37419	2,76695
	Distole_After_Treatment	89,8675	20	11,76115	2,62987

The N values on table 8. Shows numbers of participants that participate on the experiment. Based on paired sample T test results the mean value of participants diastole tensions before (top) and after treatment (bottom). Based on the results above, it can be confirmed that the participants have smoother blood circulation after 6 times of hyperbaric therapy.

A collection of values' degree of variation or dispersion can be measured using the standard deviation formula. While a high standard deviation suggests that the values are dispersed throughout a larger range, a low standard deviation suggests that the values tend to be near to the established mean. The amount a particular quantity of gas that is compressed depends inversely on pressure. The formula of standard deviation is written :

$$\sigma = \sqrt{\frac{\sum(X_i - \mu)^2}{N}} \quad \text{.....(3)}$$

σ = Population standard deviation

N= Size of population

X_i= each value of the population

μ= population mean

After getting the value of standard deviation, standard error mean need to be figure out to know the variety of mean on the population. One way to calculate the standard deviation of a sample distribution is to utilize the standard error mean of a statistic. It is referred to as SEM. There will be a population of the sampled means, each with its own variance and mean. The formula of standard error mean is written as:

$$\text{Standard error} = \frac{\sigma}{\sqrt{N}} \quad \text{.....(4)}$$

σ_x= Population standard deviation

N= Size of population

To understand the result of table 9 and table 10 below that show the result of normality test of the data, a comprehensive explanation are needed to correlate the table above. To conduct a normality test hypothesis, need to be declare. There are 2 hypotheses need to be declared: null hypothesis (H_0) and alternative hypothesis (H_A)

H_o: There isn't any difference in blood pressure before and after hyperbaric treatment

H_A: There is any difference in blood pressure before and after hyperbaric treatment

After the hypothesis has been established, degree of freedom (df) needs to be known by subtracting one from the total of population (N). Degrees of freedom are the sum of the values in the final statistical calculation that are independent value.

$$N - 1 = df \text{..... (2)}$$

The number of T values already known after the hypothesis and the degree of freedom has been set by checking through table of T values that can be seen on picture 3 below. Based on two tails confidence interval, in this case using 0,05 due to 95% confidence of interval.

cum. prob	$t_{.50}$	$t_{.75}$	$t_{.80}$	$t_{.85}$	$t_{.90}$	$t_{.95}$	$t_{.975}$	$t_{.99}$	$t_{.995}$	$t_{.999}$	$t_{.9995}$
one-tail	0.50	0.25	0.20	0.15	0.10	0.05	0.025	0.01	0.005	0.001	0.0005
two-tails	1.00	0.50	0.40	0.30	0.20	0.10	0.05	0.02	0.01	0.002	0.001
df											
1	0.000	1.000	1.376	1.963	3.078	6.314	12.71	31.82	63.66	318.31	636.62
2	0.000	0.816	1.061	1.386	1.886	2.920	4.303	6.965	9.925	22.327	31.599
3	0.000	0.765	0.978	1.250	1.638	2.353	3.182	4.541	5.841	10.215	12.924
4	0.000	0.741	0.941	1.190	1.533	2.132	2.776	3.747	4.604	7.173	8.610
5	0.000	0.727	0.920	1.156	1.476	2.015	2.571	3.365	4.032	5.893	6.869
6	0.000	0.718	0.906	1.134	1.440	1.943	2.447	3.143	3.707	5.208	5.959
7	0.000	0.711	0.896	1.119	1.415	1.895	2.365	2.998	3.499	4.785	5.408
8	0.000	0.706	0.889	1.108	1.397	1.860	2.306	2.896	3.355	4.501	5.041
9	0.000	0.703	0.883	1.100	1.383	1.833	2.262	2.821	3.250	4.297	4.781
10	0.000	0.700	0.879	1.093	1.372	1.812	2.228	2.764	3.169	4.144	4.587
11	0.000	0.697	0.876	1.088	1.363	1.796	2.201	2.718	3.106	4.025	4.437
12	0.000	0.695	0.873	1.083	1.356	1.782	2.179	2.681	3.055	3.930	4.318
13	0.000	0.694	0.870	1.079	1.350	1.771	2.160	2.650	3.012	3.852	4.221
14	0.000	0.692	0.868	1.076	1.345	1.761	2.145	2.624	2.977	3.787	4.140
15	0.000	0.691	0.866	1.074	1.341	1.753	2.131	2.602	2.947	3.733	4.073
16	0.000	0.690	0.865	1.071	1.337	1.746	2.120	2.583	2.921	3.686	4.015
17	0.000	0.689	0.863	1.069	1.333	1.740	2.110	2.567	2.898	3.646	3.965
18	0.000	0.688	0.862	1.067	1.330	1.734	2.101	2.552	2.878	3.610	3.922
19	0.000	0.688	0.861	1.066	1.328	1.729	2.093	2.539	2.861	3.579	3.883
20	0.000	0.687	0.860	1.064	1.325	1.725	2.086	2.528	2.845	3.552	3.850
21	0.000	0.686	0.859	1.063	1.323	1.721	2.080	2.518	2.831	3.527	3.819
22	0.000	0.686	0.858	1.061	1.321	1.717	2.074	2.508	2.819	3.505	3.792
23	0.000	0.685	0.858	1.060	1.319	1.714	2.069	2.500	2.807	3.485	3.768
24	0.000	0.685	0.857	1.059	1.318	1.711	2.064	2.492	2.797	3.467	3.745
25	0.000	0.684	0.856	1.058	1.316	1.708	2.060	2.485	2.787	3.450	3.725
26	0.000	0.684	0.856	1.058	1.315	1.706	2.056	2.479	2.779	3.435	3.707
27	0.000	0.684	0.855	1.057	1.314	1.703	2.052	2.473	2.771	3.421	3.690
28	0.000	0.683	0.855	1.056	1.313	1.701	2.048	2.467	2.763	3.408	3.674
29	0.000	0.683	0.854	1.055	1.311	1.699	2.045	2.462	2.756	3.396	3.659
30	0.000	0.683	0.854	1.055	1.310	1.697	2.042	2.457	2.750	3.385	3.646
40	0.000	0.681	0.851	1.050	1.303	1.684	2.021	2.423	2.704	3.307	3.551
60	0.000	0.679	0.848	1.045	1.296	1.671	2.000	2.390	2.660	3.232	3.460
80	0.000	0.678	0.846	1.043	1.292	1.664	1.990	2.374	2.639	3.195	3.416
100	0.000	0.677	0.845	1.042	1.290	1.660	1.984	2.364	2.626	3.174	3.390
1000	0.000	0.675	0.842	1.037	1.282	1.646	1.962	2.330	2.581	3.098	3.300
Z	0.000	0.674	0.842	1.036	1.282	1.645	1.960	2.326	2.576	3.090	3.291
	0%	50%	60%	70%	80%	90%	95%	98%	99%	99.8%	99.9%
	Confidence Level										

Table 11. Results of t value and significance 2 tailed value on systole.

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1 Systole_Before_Treatment - Systole_After_Treatme	-5.30900	5.13421	1.14805	-7.71189	-2.90611	-4.624	19	.000

Table 9 above shows the results of the value of t and the significance 2 tailed value. The Significance 2 tailed value on diastole are 0,000 or less than 0,05 (0,000 < 0,05) means null hypothesis is rejected. If the nulls hypothesis is rejected it confirms that hyperbaric has correlations on helping cure patients that suffers hypertensions. Significance 2 tailed value were conducted to find out whether hyperbaric chamber does affect hypertension patients or not. The value of t = -4,624 shows it lays on area of rejection (H_0 is rejected).

Table 12. Results of t value and significance 2 tailed value on diastole.

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1 Diastole_Before_Treatment - Diastole_After_Treatment	-3.11850	4.99276	1.11642	-5.45519	-.78181	-2.793	19	.012

Table 10 above shows the results of the value of t and the significance 2 tailed value. The Significance 2 tailed value on diastole are 0,012 or less than 0,05 (0,012 < 0,05) means null hypothesis is rejected. If the nulls hypothesis is rejected it confirms that hyperbaric has correlations on helping cure patients that suffers hypertensions. Significance 2 tailed value were conducted to find out whether hyperbaric chamber does affect hypertension patients or not. The value of t = -2,793 shows it lays on area of rejection (H_0 is rejected).

Table 13. Normality test result on systolic blood pressure

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Systole_Before_Treatment	.204	20	.028	.923	20	.114
Systole_After_Treatment	.134	20	.200*	.960	20	.548

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Table 11. shows the result of normality test of the significant value both shows 0,114 and 0,548 respectively on Shapiro-Wilk method, more than 0,05 (0,05>) means the data are normally distributed. Shapiro-Wilk method were use due to the total populations of participants are less than 50 participants (20 participants).

Table 14. Normality test result on diastolic blood pressure

Tests of Normality

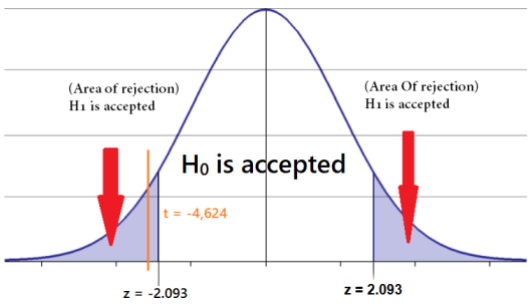
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Diastole_Before_Treatment	.191	20	.054	.952	20	.393
Diastole_After_Treatment	.087	20	.200*	.980	20	.938

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

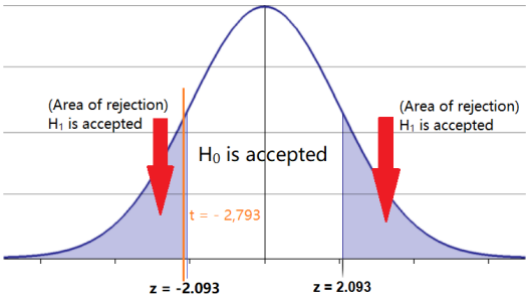
Similar to the table above, table 12. shows the result of normality test of the significant value both shows 0,393 and 0,938 respectively on Shapiro-Wilk method, more than 0,05 (0,05>) means the data are normally distributed. Shapiro-Wilk method were use due to the total populations of participants are less than 50 participants (20 participants).

Picture 3 shows the T value is ±2,093 means it is set up as measurement on relative difference size of variation in this data sample. If the t value on paired sample test exceeds on this range, hence the alternative hypothesis are accepted, and if the t value are within this range means the alternative hypothesis are rejected. Picture 4. Below shows the normal distribution graph of systole before treatment and after treatment result on normality test. The t value are exceed beyond the range (t = -4,624) resulting the rejection of null hypothesis and accepting alternative hypothesis.



Picture 4. Picture of normal distribution graph of systole before and after treatment.

Picture 5. Below shows the normal distribution graph of diastole before treatment and after treatment result on normality test. The t value is exceeded beyond the range (t = -2,793) resulting the rejection of null hypothesis and accepting alternative hypothesis.



Picture 5. Picture of normal distribution graph of diastole before and after treatment.

CORRELATION ON BLOOD PRESSURE AND HEART RATE ON HYPERBARIC THERAPY

Numerous interventions, causes, and mechanisms, including neuronal, hormonal, metabolic, nutritional, psychological, and the autoregulatory system, have an impact on blood pressure and heart rate. Heart rates are lowered by hyperbaric oxygen (HBO_2). Pre-hyperbaric oxygen therapy resulted in considerably greater blood pressure in patients with hypertension compared to participants with normal blood pressure. Blood pressure significantly increased and pulse rate significantly decreased after receiving hyperbaric oxygen. After receiving hyperbaric oxygen therapy, blood pressure rises more in patients with systolic blood pressure greater than 140 mmHg (those who are presumed to be hypertensive or to have high blood pressure). Patients with hypertension and normal blood pressure exhibit a lower reduction in heart rate following post-hyperbaric oxygen therapy. Patients with hypertension get reductions in systolic and diastolic blood pressure that range from 6 to 13% and 8 to 20%, respectively. When compared to people taking other drugs, beta blockers are responsible for the blood pressure increase. The heart rate is affected by the autonomic nervous system.

Therapy results in an increase in parasympathetic activity.

The production of Endothelin-1 is dramatically boosted during hyperbaric oxygen treatment. Endothelial cells release endotelin-1, an amino acid peptide that acts as a vasoconstrictor stimulant. Vasoconstriction caused by endothelin-1 may thus have a role in this process. Vasoconstriction, which is characterized by the narrowing of blood vessels as a result of muscular contraction on blood vessel walls, raises blood pressure and eventually activates the baroreflex, which may enhance parasympathetic activity. Acetylcholine should be released to reduce heart rate. In the hyperbaric environment, sympathetic activity is primarily responsible for lowering HR; during therapy, sympathetic activity may rise in part due to the patient's fear and the intervention [32] [33] [34] [38].

5. CONCLUSION AND RECOMMENDATION

CONCLCUSION

The results of SPSS using Multivariative test (MANOVA) explain about the comparison correlation on systolic blood pressure before and after conducting therapy to the participants genders. Pillai's trace, Wilk's lambda, Hotelling trace and Roy's largest root value on systolic blood pressure shows a significance of 0.145, while Pillai's trace, Wilk's lambda, Hotelling trace and Roy's largest root value on diastolic blood pressure shows 0.137 of the significance value. From the four tests, a significance value of more than 0.05 (> 0.05) was obtained, therefore it can be interpreted that there is no effect of systolic blood pressure either before or after therapy on gender. The other results of SPSS using paired sample t test method (parametric) shows the results of paired t test shows that the N value are the correlation on blood tension systole shows 0.951, while the correlation on blood tension diastole shows 0.916. If the correlation value is close to 1,000 then it shows that there is a correlation effect of hyperbaric oxygen therapy on hypertension. This shows that HBOT does affecting patients that has hypertension and it helps lowering down high blood pressure. Based on the effects of high pressure on blood and cardiovascular, inhaled air comes from an external elevated PO2 Pressurized air at 2 or 3 ATA at 100% Oxygen [O_2] concentration is administered have positive trend that allows higher oxygen entry, which per diffusion will be higher also in alveoli, bloodstream and therefore there will be greater arrival to tissues. This is happened due all molecule inside blood capillary is smaller caused by pressure, hence absorption of oxygen can be more effective.

RECOMMENDATION

Based on the results above, it is recommended to a person with hypertension to consider more frequent HBOT treatments 3 to 5 times a week to achieve significant changes in blood pressure. Future studies should further investigate on the individual variations conditions and potential factors including adding more variables of research in patients undergoing HBOT. Additionally, exploring the long-term effects of HBOT blood pressure could provide valuable information for optimizing treatment protocols and improving patient outcomes.

1. Treatment Frequency: As Consideration of the significant changes observed in blood pressure, frequent hyperbaric oxygen therapy (HBOT) treatments are recommended, such as three times a week or more to show more significant alterations in physiological parameters and may potentially lead to improved therapeutic outcomes.
2. Long-term Effects of blood pressure post HBOT treatment: Further research is recommended to explore more of its long-term effects of conducting HBOT on blood pressure. Individual control should be developed more comprehensive to observe specific reaction on patient-specific factors like age, underlying health conditions, and sleep duration, to optimize the effectiveness of HBOT. Studying the sustained effect of HBOT over extended periods can provide insights

into the maintenance of physiological changes and help optimize treatment protocols for long-term benefits.

3. Addition of variables on research: Variables like age, sleep duration, and drug consumption are recommended on the further research to gain more empirical result data on the affection of HBOT therapy that are depend on several factors condition. Continuous evaluation of these parameters can provide valuable feedback on the effectiveness of the treatment and guide adjustments to treatment plans if necessary.
4. Multidisciplinary Collaboration: Collaboration between healthcare professionals, and similar medicinal branch sectors including hyperbaric medicine specialists, cardiologists, and respiratory therapists, is crucial in optimizing HBOT treatment protocols. A multidisciplinary approach can ensure comprehensive patient care, monitoring, and evaluation of physiological responses.

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