

= Obesity hypoventilation syndrome =

Obesity hypoventilation syndrome (also known as Pickwickian syndrome) is a condition in which severely overweight people fail to breathe rapidly enough or deeply enough , resulting in low blood oxygen levels and high blood carbon dioxide (CO₂) levels . Many people with this condition also frequently stop breathing altogether for short periods of time during sleep (obstructive sleep apnea) , resulting in many partial awakenings during the night , which leads to continual sleepiness during the day . The disease puts strain on the heart , which eventually may lead to the symptoms of heart failure , such as leg swelling and various other related symptoms . The most effective treatment is weight loss , but it is often possible to relieve the symptoms by nocturnal ventilation with positive airway pressure (CPAP) or related methods .

Obesity hypoventilation syndrome is defined as the combination of obesity (body mass index above 30 kg / m²) , hypoxemia (falling oxygen levels in blood) during sleep , and hypercapnia (increased blood carbon dioxide levels) during the day , resulting from hypoventilation (excessively slow or shallow breathing) . The disease has been known since the 1950s , initially as " Pickwickian syndrome " in reference to a Dickensian character but currently under a more descriptive name .

= = Classification = =

Obesity hypoventilation syndrome is a form of sleep disordered breathing . Two subtypes are recognized , depending on the nature of disordered breathing detected on further investigations . The first is OHS in the context of obstructive sleep apnea ; this is confirmed by the occurrence of 5 or more episodes of apnea , hypopnea or respiratory @-@ related arousals per hour (high apnea @-@ hypopnea index) during sleep . The second is OHS primarily due to " sleep hypoventilation syndrome " ; this requires a rise of CO₂ levels by 10 mmHg (1 @.@ 3 kPa) after sleep compared to awake measurements and overnight drops in oxygen levels without simultaneous apnea or hypopnea . Overall , 90 % of all people with OHS fall into the first category , and 10 % in the second .

= = Signs and symptoms = =

Most people with obesity hypoventilation syndrome have concurrent obstructive sleep apnea , a condition characterized by snoring , brief episodes of apnea (cessation of breathing) during the night , interrupted sleep and excessive daytime sleepiness . In OHS , sleepiness may be worsened by elevated blood levels of carbon dioxide , which causes drowsiness (" CO₂ narcosis ") . Other symptoms present in both conditions are depression , and hypertension (high blood pressure) that is difficult to control with medication . The high carbon dioxide can also cause headaches , which tend to be worse in the morning .

The low oxygen level leads to excessive strain on the right side of the heart , known as cor pulmonale . Symptoms of this disorder occur because the heart has difficulty pumping blood from the body through the lungs . Fluid may therefore accumulate in the skin of the legs in the form of edema (swelling) , and in the abdominal cavity in the form of ascites ; decreased exercise tolerance and exertional chest pain may occur . On physical examination , characteristic findings are the presence of a raised jugular venous pressure , a palpable parasternal heave , a heart murmur due to blood leaking through the tricuspid valve , hepatomegaly (an enlarged liver) , ascites and leg edema . Cor pulmonale occurs in about a third of all people with OHS .

= = Mechanism = =

It is not fully understood why some obese people develop obesity hypoventilation syndrome while others do not . It is likely that it is the result of an interplay of various processes . Firstly , work of breathing is increased as adipose tissue restricts the normal movement of the chest muscles and makes the chest wall less compliant , the diaphragm moves less effectively , respiratory muscles are

fatigued more easily , and airflow in and out of the lung is impaired by excessive tissue in the head and neck area . Hence , people with obesity need to expend more energy to breathe effectively . These factors together lead to sleep @-@ disordered breathing and inadequate removal of carbon dioxide from the circulation and hence hypercapnia ; given that carbon dioxide in aqueous solution combines with water to form an acid ($\text{CO}_2 [\text{g}] + \text{H}_2\text{O} [\text{l}] + \text{excess H}_2\text{O} [\text{l}] \rightarrow \text{H}_2\text{CO}_3 [\text{aq}]$) , this causes acidosis (increased acidity of the blood) . Under normal circumstances , central chemoreceptors in the brain stem detect the acidity , and respond by increasing the respiratory rate ; in OHS , this " ventilatory response " is blunted .

The blunted ventilatory response is attributed to several factors . Obese people tend to have raised levels of the hormone leptin , which is secreted by adipose tissue and under normal circumstances increases ventilation . In OHS , this effect is reduced . Furthermore , episodes of nighttime acidosis (e.g. due to sleep apnea) lead to compensation by the kidneys with retention of the alkali bicarbonate . This normalizes the acidity of the blood . However , bicarbonate stays around in the bloodstream for longer , and further episodes of hypercapnia lead to relatively mild acidosis and reduced ventilatory response in a vicious circle .

Low oxygen levels lead to hypoxic pulmonary vasoconstriction , the tightening of small blood vessels in the lung to create an optimal distribution of blood through the lung . Persistently low oxygen levels causing chronic vasoconstriction leads to increased pressure on the pulmonary artery (pulmonary hypertension) , which in turn puts strain on the right ventricle , the part of the heart that pumps blood to the lungs . The right ventricle undergoes remodeling , becomes distended and is less able to remove blood from the veins . When this is the case , raised hydrostatic pressure leads to accumulation of fluid in the skin (edema) , and in more severe cases the liver and the abdominal cavity .

The chronically low oxygen levels in the blood also lead to increased release of erythropoietin and the activation of erythropoiesis , the production of red blood cells . This results in polycythemia , abnormally increased numbers of circulating red blood cells and an elevated hematocrit .

= = Diagnosis = =

Formal criteria for diagnosis of OHS are :

Body mass index over 30 kg / m² (a measure of obesity , obtained by taking one 's weight in kilograms and dividing it by one 's height in meters squared)

Arterial carbon dioxide level over 45 mmHg or 6 @.@ 0 kPa as determined by arterial blood gas measurement

No alternative explanation for hypoventilation , such as use of narcotics , severe obstructive or interstitial lung disease , severe chest wall disorders such as kyphoscoliosis , severe hypothyroidism (underactive thyroid) , neuromuscular disease or congenital central hypoventilation syndrome

If OHS is suspected , various tests are required for its confirmation . The most important initial test is the demonstration of elevated carbon dioxide in the blood . This requires an arterial blood gas determination , which involves taking a blood sample from an artery , usually the radial artery . Given that it would be complicated to perform this test on every patient with sleep @-@ related breathing problems , some suggest that measuring bicarbonate levels in normal (venous) blood would be a reasonable screening test . If this is elevated (27 mmol / l or higher) , blood gases should be measured .

To distinguish various subtypes , polysomnography is required . This usually requires brief admission to a hospital with a specialized sleep medicine department where a number of different measurements are conducted while the subject is asleep ; this includes electroencephalography (electronic registration of electrical activity in the brain) , electrocardiography (same for electrical activity in the heart) , pulse oximetry (measurement of oxygen levels) and often other modalities . Blood tests are also recommended for the identification of hypothyroidism and polycythemia .

To distinguish between OHS and various other lung diseases that can cause similar symptoms , medical imaging of the lungs (such as a chest X @-@ ray or CT / CAT scan) , spirometry , electrocardiography and echocardiography may be performed . Echo- and electrocardiography may

also show strain on the right side of the heart caused by OHS , and spirometry may show a restrictive pattern related to obesity .

= = Treatment = =

In people with stable OHS , the most important treatment is weight loss ? by diet , through exercise , with medication , or sometimes weight loss surgery (bariatric surgery) . This has been shown to improve the symptoms of OHS and resolution of the high carbon dioxide levels . Weight loss may take a long time and is not always successful . Bariatric surgery is avoided if possible , given the high rate of complications , but may be considered if other treatment modalities are ineffective in improving oxygen levels and symptoms . If the symptoms are significant , nighttime positive airway pressure (PAP) treatment is tried ; this involves the use of a machine to assist with breathing . PAP exists in various forms , and the ideal strategy is uncertain . Some medications have been tried to stimulate breathing or correct underlying abnormalities ; their benefit is again uncertain .

While many people with obesity hypoventilation syndrome are cared for on an outpatient basis , some deteriorate suddenly and when admitted to hospital may show severe abnormalities such as markedly deranged blood acidity ($\text{pH} < 7.35$) or depressed level of consciousness due to very high carbon dioxide levels . On occasions , admission to an intensive care unit with intubation and mechanical ventilation is necessary . Otherwise , " bi-level " positive airway pressure (see the next section) is commonly used to stabilize the patient , followed by conventional treatment .

= = = Positive airway pressure = = =

Positive airway pressure , initially in the form of continuous positive airway pressure (CPAP) , is a useful treatment for obesity hypoventilation syndrome , particularly when obstructive sleep apnea co-exists . CPAP requires the use during sleep of a machine that delivers a continuous positive pressure to the airways and preventing the collapse of soft tissues in the throat during breathing ; it is administered through a mask on either the mouth and nose together , or if that is not tolerated on the nose only (nasal CPAP) . This relieves the features of obstructive sleep apnea , and is often sufficient to remove the resultant accumulation of carbon dioxide . The pressure is increased until the obstructive symptoms (snoring and periods of apnea) have disappeared . CPAP alone is effective in more than 50 % of people with OHS .

In some occasions , the oxygen levels are persistently too low (oxygen saturations below 90 %) . In that case , the hypoventilation itself may be improved by switching from CPAP treatment to an alternate device that delivers " bi-level " positive pressure : higher pressure during inspiration (breathing in) and a lower pressure during expiration (breathing out) . If this too is ineffective in increasing oxygen levels , addition of oxygen therapy may be necessary . As a last resort , tracheostomy may be necessary ; this involves making a surgical opening in the trachea to bypass obesity-related airway obstruction in the neck . This may be combined with mechanical ventilation with an assisted breathing device through the opening .

= = = Other treatments = = =

Medroxyprogesterone acetate , a progestin , has been shown to improve the ventilatory response , but this has been poorly studied and is associated with an increased risk of thrombosis . Similarly , the drug acetazolamide can reduce bicarbonate levels , and thereby augment to normal ventilatory response , but this has been researched insufficiently to recommend wide application .

= = Prognosis = =

Obesity hypoventilation syndrome is associated with a reduced quality of life , and people with the condition incur increased healthcare costs , largely due to hospital admissions including observation and treatment on intensive care units . OHS often occurs together with several other disabling

medical conditions , such as asthma (in 18 ? 24 %) and type 2 diabetes (in 30 ? 32 %) . Its main complication of heart failure affects 21 ? 32 % of patients .

Those with abnormalities severe enough to warrant treatment have an increased risk of death , reported to be 23 % over 18 months and 46 % over 50 months . This risk is reduced to less than 10 % in those receiving treatment with PAP . Treatment also reduces the need for hospital admissions and reduces healthcare costs .

= = Epidemiology = =

The exact prevalence of obesity hypoventilation syndrome is unknown , and it is thought that many people with symptoms of OHS have not been diagnosed . About a third of all people with morbid obesity (a body mass index exceeding 40 kg / m²) have elevated carbon dioxide levels in the blood .

When examining groups of people with obstructive sleep apnea , researchers have found that 10 ? 20 % of them meet the criteria for OHS as well . The risk of OHS is much higher in those with more severe obesity , i.e. a body mass index (BMI) of 40 kg / m² or higher . It is twice as common in men compared to women . The average age at diagnosis is 52 . American Black people are more likely to be obese than American whites , and are therefore more likely to develop OHS , but obese Asians are more likely than people of other ethnicities to have OHS at a lower BMI as a result of physical characteristics .

It is anticipated that rates of OHS will rise as the prevalence of obesity rises . This may also explain why OHS is more commonly reported in the United States , where obesity is more common , than in other countries .

= = History = =

The discovery of obesity hypoventilation syndrome is generally attributed to the authors of a 1956 report of a professional poker player who , after gaining weight , became somnolent and fatigued and prone to fall asleep during the day , as well as developing edema of the legs suggesting heart failure . The authors coined the condition " Pickwickian syndrome " after the character Joe from Dickens ' The Posthumous Papers of the Pickwick Club (1837) , who was markedly obese and tended to fall asleep uncontrollably during the day . This report , however , was preceded by other descriptions of hypoventilation in obesity . In the 1960s , various further discoveries were made that led to the distinction between obstructive sleep apnea and sleep hypoventilation .