When the diaphragm and external intercostal muscles contract the volume of the thorax

Normal breathing movements - Breathing movements bring oxygen into the alve vesicers and expel carbon dioxide. The lungs are located in the pleural cavity of the thorax and are packed in the pleural membrane. The lungs are unable to expand by themselves. Instead, they are inflated by the expansion and contraction movements of the diaphragm and the ribs that shape the thorax. The muscles used for silent breathing are not the same as those used during heavy breathing. Breathing movements during silent breathing are first described. The muscles that contribute to calm breathing are the external intercostal muscles and the diaphragm. (The external and internal intercostals are the muscles that fill the gaps between the ribs.) When pulling breath (i.e. during inspiration), the external intercostal muscles and diaphragm contract simultaneously. This causes the thorax to expand and inflate the lungs by creating negative pressure in the chest cavity. During the passage, the contraction of these muscles ceases, causing them to relax. The lungs can contract in a way that looks like a deflating balloon. When the muscles that extend the thorax are relaxed, the lungs contract by their own elastic recoil forces so that the breath has expired. In other words, no muscles are used for expiration in silent breathing. The movement of the ribs during silent breathing is described below. Why does the thorax expand when the external intercostal muscles contract? The external intercostal muscles fill the gaps between the ribs, but are only partially visible in this video. The ribs are attached to the thoracic vertebrae by joints, from which they are tilted forward and downward. When the external intercostal muscles contract, the ribs are increased with the thoracic vertebral joints acting as fulcrums, causing a large expansion in the anterior/posterior size of the thorax and a slight increase in lateral size. As a result, the volume of the thorax increases. Additional muscles called internal intercostal muscles are located in the external intercostal muscles, but these do not contribute to a calm breathing. (Silent breathing is called thoracic breathing. A bucket handle provides a handy illustration of how this mechanism works. When the handle is lifted away from the side of a bucket, it takes up a larger area as seen from above. Similarly, when the ribs expand, the cross-section area of the rib cage increases.) The movement of the diaphragm during silent breathing is then described. Why does the thorax expand when the diaphragm shrinks? The diaphragm is a sheet of muscle up to the head is arched. The base of this dome is attached to the chest wall, so when the diaphragm muscle contracts, the top of the dome moves downwards and flattens the diaphragm. As a result, the thorax expands and negative pressure is formed in the thoracic thoracic causing the lungs to inflate. (At this time, the intra-abdominal pressure increases, causing the abdomen to bulge. This is called abdominal breathing.) The diaphragm and intercostal muscles both relax when exhaling. This allows the lungs to contract through their own elastic recoil forces, so that the thorax returns to its original size and the air in the lungs is gently exhaled. The diaphragm does more work than the external intercostal muscles and is responsible for 70-80% of the effort in silent breathing. Then, breathing movements during heavy or laborious breathing are described. During deep breathing, the external intercostal muscles and diaphragm work as hard as possible, while a number of other muscles, accessory-breathing muscles, help. The accessory respiratory muscles that help the work of the external intercostal muscles include the scalenus, sternocleidomastoid, levatores costarum, pectoralis major and pectoralis minor. This contract during inspiration to help extend the ribs. The increase in the ribs is also assisted by the spinal erector muscles, which flex the spine in the posterior direction. The accessory respiratory muscles that work during breathing include the internal intercostal and abdominal muscles. The functioning of the abdominal muscles is much more important than that of the internal intercostal muscles. Breathing is generally divided into thoracic breathing and abdominal breathing. Thoracic deep breathing is one of the deep breathing methods. Thoracic breathing is a breathing method in which mainly movement of the ribs, where inspiration involves the external intercostal muscles and the accessory muscles of inspiration, and expiration includes the internal intercostal muscles. During the inspiration, the external intercostal muscles and accessory muscles of inspiration contract strongly to help the drawing of the breath by applying a large upward lift to the ribs. During expiration, the internal intercostal muscles relax and the thorax contracts, allowing air to be exhaled. Abdominal diepademhaling is a form of abdominal breathing. The muscles used in abdominal breathing are the diaphragm for inspiration and the abdominal muscles for expiration. During the inspiration, the diaphragm contracts strongly, causing a large expansion of the thorax vertically. At the same time, the intra-abdominal pressure increases and the abdomen becomes bulge. During the passage, the diaphragm relaxes and the abdominal muscles contract, causing the abdomen to flatten. This increases intra-abdominal pressure and pushes strongly against the diaphragm, which helps with expiration. (As a result, the pressure in the thorax increases and the breath has expired. One of the differences between deep breathing and silent breathing is that in deep breathing, the play an important role in the passage.) Then a breathing breathing which uses both thoracic and abdominal breathing. The muscles that contract during inspiration are the external intercostal muscles, the accessory muscles of inspiration, and the diaphragm. The muscles used during expiration are the internal intercostal muscles and abdominal muscles, with the latter doing most of the work. [References] Arai, T., J. Acoust. Soc. Jpn., 68, 272, 2012. Standring, S., Gray's Anatomy, 40th ed., Elsevier, 2009. Both inhalation and exhalation depend on pressure gradients between the lungs and atmosphere, as well as the muscles in the chest cavity. Describe how the structures of the lungs and chest cavity regulate the mechanics of breathing Important pick-up points The mechanics of breathing follows Boyle's law, stating that pressure and volume have an inverse relationship. The inhalation process occurs as a result of an increase in lung volume (membrane contraction and chest wall enlargement) resulting in a decrease in lung pressure compared to the atmosphere; so, air rushes into the airways. The process of exhalation occurs as a result of an elastic recoil of the lung tissue that causes a decrease in volume, resulting in increased pressure compared to the atmosphere; So, air flows out of the airways. There is no contraction of muscles during exhalation; it is considered a passive process. The lung is protected by layers of tissue referred to as the visceral pleura and parietal pleura; the intrapleural space contains a small amount of fluid that protects the tissue by reducing friction. Key Terms visceral pleura: the part of the protective tissue that is directly attached to the lungs parietal pleura: the part of the protective tissue that lines the inner surface of the chest wall and covers the diaphragm The relationship between gas pressure and volume helps to explain the mechanics of breathing. Boyle's Law is the gas law that states that in a closed space, pressure and volume are inversely related. As the volume decreases, the pressure increases and vice versa. When discussing the detailed mechanics of breathing, it is important to keep this inverted relationship in mind. Boyle's law: This graph of data from Boyle's original 1662 experiment shows that pressure and volume are inversely related. No units are given if Boyle uses random units in his experiments. Inhalation and exhalation The chest cavity, or chest cavity, always has a slight, negative pressure that helps to keep the airways of the lungs open. During the inhalation process, the lung volume expands due to the contraction of the diaphragm and intercostal muscles (the muscles associated with the rib cage), causing the chest cavity Extended. This increase in volume reduces the pressure, based on the principles of Boyle's law. This pressure drop in the chest cavity compared to the makes the cavity pressure less than the atmospheric pressure. This pressure gradient between the atmosphere and the chest cavity allows air to flow into the lungs; inhalation is taking place. The resulting increase in volume is largely attributed to an increase in alveololator space because the bronchioles and bronchies are rigid structures that do not change in size. Inhalation and exhalation: The lungs, chest wall and diaphragm are all involved in breathing, both (a) inhalation and (b) expiration. During this process, the chest wall expands and away from the lungs. The lungs are elastic; therefore, when the air fills the lungs, the elastic recoil in the tissues of the lung exerts pressure back to the interior of the lungs. These outer and inner forces compete to inflate the lung and deflate it with every breath. When exhaled, the lungs recoil to force the air out of the lungs. The intercostal muscles relax and bring the chest wall back to its original position. During exhalation, the diaphragm also relaxes and moves higher into the chest cavity. This increases the pressure in the chest cavity relative to the environment. Air flows out of the lungs due to the pressure gradient between the thoracic cavity and the atmosphere. This movement of air from the lungs is classified as a passive event because no muscles contract to expel the air. Protecting the lung each lung is surrounded by an invaginated sac. The layer of tissue that covers the lung and dives into spaces is called the visceral pleura. A second layer of parietal pleura lines the interior of the thorax. The space between these layers, the intrapleural space, contains a small amount of fluid that protects the tissue by reducing the friction generated by rubbing the tissue layers together as the lungs contract and relax. If these layers of tissues become inflamed, this is categorized as pleurisy: a painful inflammation that increases the pressure in the chest cavity, reducing the volume of the lung. Visceral pleura: A tissue layer called pleura surrounds the lung and interior of the chest cavity. Types of breathing in humans include eupnea, hyperpnea, diaphragmatic, and costal breathing; each requires slightly different processes. Distinguishing between the types of breathing in humans, amphibians and birds Main Pick-up Key Points Eupnea is normal silent breathing that requires contraction of the diaphragm and external intercostal muscles. Diaphragmatic breathing requires contraction of the diaphragm and is also called deep breathing. Costal breathing requires contraction of intercostal muscles and is also called shallow breathing. Hyperpnea is forced breathing and requires muscle contractions during both such as contraction of the diaphragm, intercostal muscles and accessories muscles. Amphibians use gills for breathing breathing in life and later, primitive lungs develop in their adult lives; In addition, they are able to breathe through their skin. Birds have developed a directional breathing system that allows them to obtain oxygen at high altitudes: air flows in one direction while blood flows into another, allowing efficient gas exchange. Key Terms eupnea: normal, relaxed breathing; Healthy condition of inhalation and exhalation hyperpnea: deep and rapid breathing that normally occurs after exercise or abnormally with fever or various intercostal disorders: between the ribs of an animal or person There are different types, or modes, of breathing that require a slightly different process to allow inspiration and expiration. All mammals have lungs that are the main organs for breathing. The lung capacity has evolved to support the animal's activities. During inhalation, the lungs expand with air and oxygen spreads across the surface of the lung, entering the bloodstream. During exhalation, the lungs decrease the air and lung volume. The different types of breathing, especially in humans, include: 1) Eupnea: a mode of breathing that occurs at rest and does not require the cognitive thought of the individual. During eupnea, also called silent breathing, the diaphragm and the external intercostals must contract. 2) Diaphragmatic breathing: a mode of breathing that requires the diaphragm to contract. When the diaphragm relaxes, the air passively leaves the lungs behind. This type of breathing is also known as deep breathing. Diaphragmatic breathing: Animation of an diaphragm exhaling and inhaling, demonstrating diaphragmatic breathing. During inhalation, the diaphragm is contracted, increasing the volume of the lung cavity. During exhalation, the diaphragm is relaxed, which reduces the volume of the lung cavity. 3) Costal breathing: a mode of breathing that requires contraction of intercostal muscles. As the intercostal muscles relax, the air passively leaves the lungs. This type of breathing is also known as shallow breathing. 4) Hyperpnea: a mode of breathing that may occur during exercise or actions that require the active manipulation of breathing, such as singing. During hyperpnea, also known as forced breathing, inspiration and expiration both occur due to muscle contractions. In addition to the contraction of the diaphragm and intercostal muscles, other accessories muscles must also contract. During forced inspiration, muscles of the neck, including the scalenes, contract and lift the thoracic wall, increasing the lung volume. During forced expiration, accessory muscles of the abdomen, including the oblique, force abdominal organs up against the diaphragm. This helps to push the diaphragm further into the thorax, pushing out more air. In addition, accessories piers (mainly internal intercostals) help to compress the rib cage, which also reduces the volume the chest cavity. Species of breathing in amphibians and birds In animals such as amphibians, there are multiple ways of breathing that have evolved. In young amphibians, such as tadpoles that do not leave the water, gills are used to breathe. There are a number of amphibians that preserve gills for life. As the tadpole grows, the gills disappear and the lungs grow. These lungs are primitive and not as evolved as mammalian lungs. Adult amphibians are missing or have a reduced diaphragm, so breathing through lungs is forced. The other way of breathing for amphibians is diffusion over the skin. To help this diffusion, the amphibian skin must remain moist. Other animals, such as birds, must face a unique challenge regarding breathing, which is that they fly. Flying consumes a lot of energy; therefore birds need a lot of oxygen to help their metabolic processes. They have developed a respiratory system that provides them with the oxygen needed to make flies possible. As with mammals, birds have lungs, which are organs that specialize in gas exchange. Oxygenated air, absorbed during inhalation, spreads across the surface of the lungs into the bloodstream, while carbon dioxide spreads from the blood into the lungs and is expelled during exhalation. However, the details of breathing between birds and mammals differ considerably. In addition to lungs, birds have air sacs in their bodies that are attached to the lungs. Air flows in one direction from the rear air sacs to the lungs and out of the front air pockets. The air flow is in the opposite direction of the blood flow, which makes an efficient gas exchange possible. This type of breathing allows birds to obtain the necessary oxygen, even at higher altitudes where oxygen concentration is low. This directionality of airflow requires two cycles of air intake and exhalation to completely remove the air from the lungs. Bird protection: a) Birds have a flow system in which the air flows one way from the rear sacs into the lungs and then into the front air sacs. The air pockets connect to openings in hollow bones. b) Dinosaurs, from which birds have descended, have similar hollow bones and are believed to have had a similar respiratory system. Breathing includes several components, including power-resistant and elastic work; surfactant production; lung resistance and compliance. Explain the roles played by surfact, current and elastic work, and lung resistance and compliance when inhaling Key Takeaways Key Points Both power-resistant and elastic work are performed during the flow-resistive work involves the alve vesicers and tissues, while elastic work includes the intercostal muscles, chest wall, and diaphragm. This type of work function in an inverted relationship; For example, increasing breathing leads to an increase in the work and a decrease in elastic work. Surfactant is a phospholipid and lipoprotein substance produced in the lungs that functions in the same way as a detergent: it reduces the surface tension between alve alve tissue and air in the alve vesicers, reducing the work required for airway inflation. Lung resistance plays an important role in the ability to exchange gases efficiently; if there is obstruction (resistance) in the airways, the result will be a reduced gas exchange. Lung compliance plays an important role in the ability to exchange gases efficiently; if there is too much of an increase or decrease in lung elasticity, the result will be disruption of the gas exchange, which will cause obstructive or restrictive diseases. Key Terms surfaceactant: a lipoprotein in the tissues of the lung that reduces surface tension and allows a more efficient tidal volume of gas transport: the amount of air that breathes in or out during normal breathing The number of breaths per minute is breathing; in non-exercise conditions, the human respiratory frequency is on average approximately 12-15 breaths/minutes. The breathing rate contributes to the alveololation ventilation, or how much air moves in and out of the alve vesicers, which prevents the build-up of carbon dioxide in the alve vesicides. There are two ways to keep the alveololation contens: increase the respiratory rate while the tidal volume of air per breath (shallow breathing) decreases or the breathing rate decreases while increasing the tide volume per breath. In both cases, the ventilation remains the same, but the work and type of work required are very different. Both the tidal volume and the breathing rate are closely regulated when oxygen demand increases. There are two types of work performed during breathing: flow resistance and elastic work. Flow-resistive work refers to the work of the alve vesicers and tissues in the lung, while elastic work refers to the work of intercostal muscles, chest wall and diaphragm. When the breathing rate is increased, the flow-resistant work of the airways is increased and the elastic work of the muscles is reduced. When the breathing rate is reduced, the flow-resistant work is reduced and the elastic work is increased. Surfactants The air tissue/water interface of the alve vesicles has a high surface tension, which is similar to the surface tension of water on the liquid-air interface of a water droplet that results in the adhesion of the water molecules together. Surfactants are a complex mixture of phospholipids and lipoproteins that works to reduce the surface tension between the alveblade tissue and the air in the alve vesicers. By lowering the surface tension of the alveolator fluid, it reduces the tendency of alveoli to collapse. Surfactants act as a detergent to reduce surface tension, making it easier to push the air weigh-ins into the airway. When a balloon is first It takes a large amount of effort to stretch the plastic and start inflating the balloon. If a little detergent were applied to the interior of the balloon, then the amount of effort or work required to start to inflate the balloon would decrease; It would be much easier. The same principle applies to the airways. A small amount of surfactants on the respiratory tissues reduces the effort or work required to inflate those airways and is also important for preventing collapse of small alve alve vesicers compared to large alve vesicers. Sometimes, in babies born prematurely, there is a lack of surfactant production; as a result, they suffer from respiratory distress syndrome and require more effort to inflate the lungs. Lung resistance and compliance In lung diseases, the rate of gas exchange in and out of the lungs is reduced. Two major causes of reduced gas exchange are compliance (how elastic the lung is) and resistance (how much obstruction there is in the airways). A change in either can dramatically change breathing and the ability to take in oxygen and release carbon dioxide. Examples of restrictive diseases are respiratory distress syndrome and pulmonary fibrosis. In both diseases, the airways are less consistent and rigid or fibrotic, resulting in a decrease in compliance because the lung tissue cannot bend and move. In these types of restrictive diseases, intrapleural pressure is more positive and the airways collapse in exhalation, causing air to be noticed in the lungs. Forced or functional vital capacity (FVC), which is the amount of air that can be forcibly exhaled after taking the deepest breath possible, is much lower than in normal patients; the time it takes to exhale most of the air is greatly extended. A patient suffering from these diseases cannot exhale the normal amount of air. FEV1/FVC ratio: The ratio of FEV1 (the amount of air that can be forcibly exhaled in a second after taking a deep breath) to FVC (the total amount of air that can be exhaled by force) can be used to diagnose whether a person has a restrictive or obstructive pulmonary disease. Obstructive diseases and disorders include emphysema, asthma and pulmonary edema. In emphysema, which usually results from smoking tobacco, the walls of the alve vesicers are destroyed, reducing the surface area for gas exchange. Overall adherence to the lungs is increased, because if the alveololic walls are damaged, the elastic recoil of the lungs decreases due to a loss of elastic fibers; more air is stuck in the lungs at the end of the exhalation. is a disease in which inflammation is caused by environmental factors, which obstruct the airways. The obstruction may be due to edema, smooth muscle spasms in the walls of the bronchioles, increased mucus secretion, damage to the epithelia of the airways, or a combination of these events. People with asthma or edema experience increased occlusion of inflammation of the airways. This tends to block the airways, preventing the proper movement of gases. People with obstructive diseases have caught large amounts of air after exhalation. They breathe at a very high lung volume to compensate for the lack of airway recruitment. Dead space is a broken down or blocked region of the lung that produces a mismatch of air and blood in the lungs (V/Q mismatch). Compare and contrast anatomical and physiological dead space and their role in V/Q mismatch Key Takeaways Key Points Sometimes there is a mismatch between the amount of air (ventilation, V) and the amount of blood (perfusion, Q) in the lungs, referred to as ventilation/perfusion (V/Q) mismatch. The two main types of V/Q mismatch that result in dead space are: anatomical dead space (caused by an anatomical problem) and physiological dead space (caused by a functional problem with the lungs or arteries). Anatomical dead space can occur due to changes in gravity (i.e. posture positions: sit, stand, lie down); it will affect both ventilation (V) and perfusion (Q). Physiological dead space may occur as a result of changes in function, such as in case of infection of the lungs; it will usually affect ventilation as well as the infection in the lungs and will affect perfusion if the functional disorder is in the arteries. In a normal, healthy individual, changes in ventilation or perfusion will result in correction of the other factor to ensure an appropriate V/Q ratio. Key Terms perfuse: to force a liquid to flow over or through something, especially through an organ of the body dead space: air that is inhaled by the body in breathing, but does not participate in gas exchange hydrostatic: from or in relation to fluids, in particular to the pressure they exert or transmit the circulation of lungs: the part of blood circulation that carries low-oxygen blood from the heart, to the lungs, and brings oxygenated blood back to the heart systemic circulation: the part of blood circulation that carries oxygenated blood from the heart to the body, and brings low-oxygen blood back to the heart The pulmonary circulation pressure is very low compared to that of systemic circulation; it is also independent of cardiac output. Recruitment is the process of opening airways that normally remain closed when cardiac output increases. As cardiac output increases, the number of capillaries and arteries that are perfused (filled with blood) increases. These capillaries and arteries are not always in use, but are ready if necessary. However, sometimes there is a mismatch between the amount of air (ventilation, V) and the amount of blood (perfusion, Q) in the This is referred to as ventilation/perfusion (V/Q) mismatch. There are two types of V/Q mismatch that produce dead space. Dead space is characterized by areas of broken down or blocked lung tissue. lung tissue. areas can severely affect breathing as a result of the reduction of the available surface area for gas dispersion. As a result, the amount of oxygen in the blood decreases, while the carbon dioxide content increases. Dead space occurs when there is no ventilation and/or perfusion. Anatomical dead space, or anatomical shunt, arises from an anatomical disturbance, while physiological dead space, or physiological shunt, arises from a functional deterioration of the lungs or arteries. An example of an anatomical shunt is the effect of gravity on the lungs. The lung is particularly sensitive to changes in the size and direction of gravity. When someone stands or sits upright, the pleural pressure gradient leads to increased ventilation further into the lung. As a result, the intrapleural pressure is more negative at the base of the lung than at the top; more air fills the bottom of the lung than the top. It also takes less energy to pump blood to the bottom of the lung than to the top when it is in a sensitive position (lying down). Perfusion of the lung is not uniform while standing or sitting. This is a result of hydrostatic forces combined with the effect of airway pressure. An anatomical shunt develops because the ventilation of the airways does not correspond to the perfusion of the arteries around that airways. As a result, the gas change is reduced. Note that this does not occur when lying down, because in this position, gravity does not preferably pull the bottom of the lung down. When a healthy individual gets up quickly after lying down for a while, both ventilation and perfusion increase. A physiological shunt can develop if there is an infection or edema in the lung that obstructs an area. This reduces ventilation, but does not affect the perfusion; therefore, the V/Q ratio changes and the gas exchange is affected. Pulmonary edema: A physiological shunt can develop if there is an infection or edema in the lung that reduces ventilation but does not affect perfusion; this affects the ventilation/perfusion ratio. Pulmonary edema with small pleural effusions on both sides (as pictured) can cause changes in the V/Q ratio. The lung has the ability to compensate for mismatches in ventilation and perfusion. If the ventilation is larger than perfusion, the arteries and bronchioles narrow, increasing the perfusion and reducing ventilation. Similarly, if the ventilation is less than perfusion, the arteries narrow, while the bronchioles dilate to correct the imbalance. Imbalance.