

# Physiology of fluid balance essay sample

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For P4, I'm going to outline the physiological overview of the kidneys and then I am going to explain the renal system. Also I am going to explain the kidneys in more detail. The physiological overview involves the kidneys processing blood by eliminating any excess mineral salts, urea and water as this provides homeostasis and it enables the body to work effectively. The nephron (which is part of the kidneys) for example, is in charge of the reabsorption of amino acids, glucose, some chloride and sodium. It is composed of the Bowman's capsule which is connected to a coiled tubule, which then moves into a hairpin loop called the loop of Henle. There is also a straight collecting duct and second loop that clears out at the end of the pyramid. Both the collecting duct and loop of Henle are located in the medulla. Relating this back to the kidneys, they perform these jobs (for example, the reabsorption of products as I mentioned above) by regulating acid-base balance, electrolytes and water.

They also remove the waste products of metabolism, for example: the final products from the haemoglobin breaking down, urea from extra amino acids, "creatinine from creatine in muscle and uric acid from nucleic acids" as stated by (Stretch et. al: p174). In addition, they remove unnecessary chemicals from the blood, for example toxins, pesticides, drugs and food additives. Last of all, they secrete a hormone that manages the production of renin and blood cells. This is known as erythropoietin which has an effect of blood pressure. The renal system is also part of the kidneys as it consists of: the urethra, two ureters (tubes), two kidneys and the bladder. The kidneys therefore are positioned on the posterior wall above the waist, one "on each side of the vertebral column" as mentioned by (Stretch et. al: p173). As well

as this, the system relates to the blood supply because it has two small renal arteries that arrive in each kidney from the aorta (main artery leaving the heart) and two small renal veins that originate from each kidney to unite the inferior vena cava (a vein that carries deoxygenated blood to the heart from the lower body).

It is important to note that each nephron within each kidney has its individual afferent arteriole which disintegrates into a lump of capillaries called the glomerulus; thus it is formed into a cup shape by the Bowman's capsule. " Each kidney is bean-shaped and dark red in colour" as cited by (Stretch et. al: p176). The circled area labelled on the diagram is the hilum. But before the renal artery enters the kidney at this area, the renal vein and ureter has to appear from the kidney. Plus the conical adrenal gland surrounds the kidney and both the adrenal glands and kidneys are enclosed by adipose tissue. Besides, the kidney has a dark external cortex and a pale internal medulla when sectioned lengthways. For this reason, the medulla is made up of numerous pyramids shaped as a cone, with the end sticking out into the pelvis, where the ureter unites the kidney. The Bowman's capsule on the other hand, consists of " two layers of simple squamous epithelium, with a small fluid-filled gap between them" as quoted by (Stretch et. al: p176). As a matter of fact, the internal layers of epithelial cells have been particularly adapted and have legs with gaps in between so that fluid can escape through.

The only obstacle to the fluid is the capillary wall and the basement membrane of the Bowman's capsule, in other words it is termed as selectively permeable. Lastly, the podocytes are the name of the particularly

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modified cells. Yet, the Bowman's capsule is the only place where ultrafiltration occurs. First of all, the blood from the renal artery arrives in tinier arterioles in the cortex. Then each arteriole divides into the glomerulus and " this is where ultrafiltration takes place" as stated by (Parson's, R: p128). Consequently, the efferent arteriole, which filters blood away from the glomerulus, is tinier in diameter than the afferent arteriole, which carries blood into each glomerulus. This puts blood under high pressure in the glomerulus; thus it forces tiny molecules and liquid out of the capillary and into the Bowman's capsule. Soon afterwards, the tiny and liquid molecules cross the epithelium of the Bowman's capsule, the basement membrane and capillary wall in order to get into the Bowman's capsule and to arrive in the nephron tubules.

The consequence of this is that the filtrate (the tiny and liquid molecules) pass along the remainder of the nephron and helpful substances are reabsorbed along the route. Last of all, " the filtrate flows through the collecting duct and passes out of the kidney along the ureter" as mentioned by (Parson's, R: p128). Selective reabsorption occurs straight after ultrafiltration and this involves the filtrate running along the proximal convoluted tubule (PCT), " through the loop of Henle, and along the distal convoluted tubule" as cited by (Parson's, R: p129). But it is important to note that the proximal convoluted tubule's walls contain microvilli which supply a big surface area for the reabsorption of helpful materials from the filtrate into the blood. Other helpful solutes, for example vitamins, amino acids, glucose and several salts are reabsorbed along the proximal convoluted tubule via facilitated diffusion and active transport. However, " water is

reabsorbed from the loop of Henle, distal convoluted tubule and the collecting duct” as quoted by (Parson’s, R: p129). For this reason, water arrives in the blood via osmosis for the reason that the water potential of the filtrate is higher than the blood.

The remaining filtrate is urine, which takes place along the ureter to the bladder and it is reabsorbed via diffusion. Furthermore, the loop of Henle consists of two limbs known as the descending limb and the ascending limb. Also the tissue fluid enclosing the loop is hyperosmotic (increased osmotic pressure) because of the sodium ions. As well as this, both limbs help establish a mechanism known as the counter current multiplier mechanism. This therefore aids the reabsorption of water back into the blood.

Nevertheless, there are four key stages that enable this mechanism to work. The first stage involves sodium and chloride ions being actively expelled into the medulla, near the top of the ascending limb. Since this limb is impermeable to water, the water stays inside the tubule and this produces a low water potential in the medulla due to the high concentration of ions. The second stage consists of the water moving out of the descending limb into the medulla via osmosis, given that there is higher water potential in the descending limb than in the medulla.

The consequence of this is that the filtrate is more concentrated because the ions cannot diffuse out; plus the descending limb is impermeable to them. As a result, “ the water in the medulla is reabsorbed into the blood through the capillary network” as stated by (Parson’s, R: p130). The third stage involves the sodium and chloride ions diffusing out into the medulla, near the bottom of the ascending limb. Thus it lowers the water potential in the medulla and <https://assignbuster.com/physiology-of-fluid-balance-essay-sample/>

the ascending limb remains in the tubule as it is impermeable to water. The last stage consists of the above stages increasing the ion concentration in the medulla; hence it lowers the water potential which “ causes water to move out of the collecting duct by osmosis” as mentioned by (Parson’s, R: p130). Finally, osmoregulation involves the kidneys and this is a homeostatic control which relates to the blood being at the right concentration.

Therefore, too much concentration of blood means that water is well-maintained. As a result, the urine becomes further concentrated and less urine is created.

On the other hand, blood that is too diluted means that more water is distributed in the urine as long as normal concentration is restored. The phenomenon is the hormone that is in charge for this. In addition, a portion of the brain called the hypothalamus contains osmoreceptors which are specialist neurones that check the concentration of adjacent blood. Also the cells stimulate the pituitary gland when the blood is excessively concentrated. The consequence of this is the fact that an antidiuretic hormone is being secreted by the pituitary gland. For this reason, the cells of the collecting tubule and distal convoluted tubule become more permeable to water. Since the tubule distributes through the hyperosmotic area in the medulla, water distributes out via osmosis into the blood and tissue fluid. Yet, very little antidiuretic hormone is created when the blood is excessively dilute. This makes sure that the tubule stays waterproof and this leaves water to distribute through into the urine. Last of all, the summer months increases the antidiuretic hormone because the water is being lost as sweat.

However, if the individual drinks lots of fluids and does not sweat this decreases the antidiuretic hormone. For P5 and M3, I am going to explain the dysfunctions that relate to the balance between water intake and the disturbance of water output. Then I am going to discuss it in more detail. Oedema, also known as dropsy, is one of the dysfunctions and this is when there is too much fluid retention in the body. In other words, the accumulation of fluids causes the tissue to be swollen. The swelling can take place in one specific area of the body and it usually results in particular health conditions, for example heart failure and kidney failure. The reason why it can cause heart failure is because the heart is incapable to push blood onwards efficiently and the pressure accumulates in the congested veins. This therefore causes a higher capillary pressure, thus it is larger than the osmotic pressure of the plasma proteins which are attempting to return tissue fluid to the blood. As a result, there is a build-up of tissue fluid. From this and other health conditions, oedema can cause the following symptoms: increase or decrease in weight, aching limbs, skin discolouration, increased pulse rate and blood pressure and rigid joints.

However, the most common cause of fluid accumulation in the body's tissues is lymphoedema. It takes place when the lymphatic system, the network of vessels through which lymph drains from tissues into the blood, is harmed or disturbed. So to sum it up, any illness that lowers the osmotic pressure of the plasma proteins in the blood can cause oedema, for example cirrhosis of the liver, alcoholism or malnutrition. Yet, this can be treated by getting self-help from the general practitioner or by taking diuretics. The general practitioner can therefore recommend particular ideas to decrease fluid retention, such

as: obtaining frequent exercise, avoid standing for lengthy times of the day, losing weight and lifting the legs on a regular basis to enhance the circulation. Whereas diuretics, a kind of medication that may be prescribed to help decrease fluid accumulation, operates by enlarging the quantity of urine produced. Chronic kidney disease is another dysfunction and it “ is a long-term condition where the kidneys do not work effectively” as cited by (NHS, 2012). So the two most common causes of this condition are diabetes and hypertension (high blood pressure).

Diabetes for example, is where the body does not create sufficient insulin, known as type 1 diabetes, or does not create valuable use of insulin, known as type 2 diabetes. But if this is badly controlled, excessive amounts of glucose can accumulate in the blood. This can harm the small filters in the kidneys; hence that it has an effect on the kidneys to filter out fluids and waste products. Consequently, the initial sign of diabetic kidney disease is the emergence of low levels of protein in the urine. As a result, the general practitioner will request an annual urine test to detect any kidney disease as early as possible. Nevertheless, hypertension causes harm by placing strain on the little blood vessels in the kidneys. For this reason, it stops the filtering process from functioning correctly. Even though there is no cure for this disease, treatment can help stop the development of the disease and relieve the symptoms. Renal dialysis is one of the treatments and there are key types, known as “ haemodialysis and continuous ambulatory peritoneal dialysis” as quoted by (Stretch et. al: p181).

Haemodialysis consists of attaching an individual to a kidney machine for a minimum of four hours a day, at least three times a week. The individual

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therefore needs a fistula operation several months in advance. In spite of this, a low or zero concentration of any substance, such as excess water and waste products needs to be eliminated from the blood in dialysate. This is because the substance can distribute across via osmosis and diffusion. In contrast, a high concentration in the dialysate is reserved for any substance not needing elimination. Lastly, the dialysate moves to waste and the cleaned blood is gone back to the individual. The continuous ambulatory peritoneal dialysis is another treatment and this utilizes the internal lining of the abdomen as the dialysing membrane and the dialysate is presented through a unique tap and catheter (tube). This takes approximately one hour to accomplish. On the other hand, a small amount of clients have home kidney machines, yet the majority haemodialyse in hospital. But the procedure is extremely costly and kidney machines are in short supply.

The semi-permanent solution is transplantation. For this reason, a kidney transplant is required and this is “ the transfer of a healthy kidney from one person (the donor) into the body of a person who has little or no kidney function (the recipient)” as stated by (NHS, 2014). But before the person has a kidney transplant, the staff at the centre will ensure that the person has not got any new medical difficulties and final examinations will be carried out in order for the kidney transplant to go ahead. Therefore, if the kidney transplant is right for the person then he or she will have surgery so that the kidney is inserted and linked to the bladder and blood vessels. As a result, the new kidney will be located in the lower area of the abdomen. Given that a kidney transplant is an important surgical procedure, it does come with a broad variety of potential risks. Increased risk of infections is the most

common short-term risk; therefore the person will begin immune-suppressant medication to stop rejection. However, there are side effects when taking this medication, such as: inflamed gums, acne, diarrhoea, increase in weight and abdominal pain. But this can be prevented by the doctor finding the best dosage to compact these side effects.

Yet, there are other long term risks that arise from having a kidney transplant. Diabetes is one of them for the reason that people feel a lot better and decide to eat more, causing a substantial increase in weight. Even certain kinds of immune-suppressants can develop the chance of diabetes. Another long term risk is high blood pressure because a lot of people who need this transplant already have an increased risk of obtaining high blood pressure and it does not help when taking immune-suppressants as it can make it worse. The other long term risk is cancer because the enduring use of immune-suppressants can increase different types of this condition, for example lymphoma (tumour in lymph node), skin cancer and “ Kaposi’s sarcoma – a type of cancer that can affect both skin and internal organs” as mentioned by (NHS, 2014). For D2, I am going to analyse the influence of water balance dysfunctions on the body. Dehydration for example, is a condition that takes place when the output of water surpasses the consumption.

This may arise because of an illness, known as gastroenteritis, “ where fluid is lost through persistent bouts of diarrhoea and vomiting” as cited by (NHS, 2013). Also it can be simply caused by drinking insufficient amounts of fluid or by fluid that is not replenished and lost, especially when you are sweating too much as a result of exercise, manual work or fever in hot conditions.

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Given that water is lost, it is likely to leave the cells by osmosis because the extracellular fluid becomes even more concentrated. In addition, severe hypothermia may happen because of the thermoregulation mechanism failing and this causes the body to absorb or create further heat than it can fritter away. In severe cases, you might not breathe; you might have a weak or no pulse, resulting to unconsciousness; and you might have dilated pupils due to the waste products building up in the extracellular fluid. Besides, infants tend to become hydrated more than adults because the infants kidneys are less competent to preserve water.

Likewise, elderly people are particularly vulnerable to developing water imbalances for the reason that their age has an impact on their thirst mechanisms and their physical problems may make it hard for them to get sufficient fluids. Therefore the electrolytes and lost water need to be replaced in order to treat this condition. But the consequence of this is the likely production of water intoxication for the reason that the normal concentration of extracellular fluid will become more dilute. Water intoxication is therefore a rare condition by drinking excessive amounts of water, resulting in having seizures. Six month babies for examples, support this theory as they are provided quite a lot of water bottles per day and this causes the tissues to swell with the surplus fluid. Plus, the eyes start to fluster and a seizure happens as a result of a decrease in serum sodium levels. This also leads the water to enter the cells quickly by osmosis as the extracellular fluid has become hypotonic. As well as this, the swelling brain tissues that cause a coma may arise unless water consumption is limited and hypertonic salt solutions are provided.

In infancy, water intoxication occasionally happens with poverty families who dilute the formula to make it last longer; hence that bottled waters that are marketed beside the infant formula is the other source. Consequently, it tips a number of parents to think that these products are sufficient nutritional supplements. But in actual fact, they can be unsafe. As I mentioned earlier in the assignment, oedema is an unusual build-up of extracellular fluid in the body and the following factors can cause it, such as increased capillary permeability, hypoproteinemia (reduction in plasma protein concentration) and increased venous pressure. Hypoproteinemia for example, may arise from liver disease that causes a number of problems, for example glomerulonephritis (kidney disease) which harms glomerular capillaries and starvation as the consumption of amino acids is inadequate to support synthesis of plasma proteins. However, they all link to the reduction of plasma protein concentration, which reduces the plasma osmotic pressure and this decreases the usual return of tissue fluid to the venule ends of capillaries.

Likewise, the osmotic pressure of the fluid increases because the proteins that the lymphatic circulation normally removes, build-ups in the body. Another example where the osmotic pressure increases is the abdominal fluid and this can only happen if the portal blood vessels and venous pressure within the liver increases due to the blockage of the inferior vena cava. Consequently, the fluid with great concentration of protein is eliminated from the exteriors of the intestine and liver into the peritoneal cavity. Last of all, oedema which can be caused by increased capillary

permeability is also linked to inflammation. This is therefore a response to tissue damage; thus it normally releases histamine from harmed cells.

For this reason, it causes increased capillary permeability and vasodilation (the dilation of blood vessels, which decreases blood pressure) which means that excess fluid emerges the capillary and arrives in the interstitial spaces. In conclusion, I have outlined the psychological overview of the kidneys and explained the renal system and kidneys in detail. Also I have explained and discussed the dysfunctions that relate to the balance between water intake and the disturbance of water output. Finally, I have analysed the influence of water balance dysfunctions on the body.

## References

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