

F.5. Urinary Pathophysiology

Introduction:

<p>1. As in previous chapters, we will not discuss here the pathophysiology of the urinary system caused by diseases such as cancer, infections etc.</p>	<p>2. Instead, we will concentrate on pathophysiological issues that are related to normal and abnormal physiology of the urinary tract.</p>
<p>3. We will discuss the following topics:</p> <ul style="list-style-type: none"> a. kidney stones b. hangover (yes!!) c. urethra obstruction d. incontinence e. dialysis 	

A. Kidney Stones:

<p>1. Kidney stones can develop and accumulate in the kidney pelvis when the urine becomes more concentrated ('darker'). This is called nephrolithiasis or urolithiasis. (<i>link</i>)</p>	<p>2. This can be caused for example by dehydration, when less water is available to the body and the kidneys.</p>
<p>3. Then the solutes such as uric acid may 'precipitate' (= this is when a compound is deposited as a solid form in a fluid).</p>	<p>4. Once a small pebble is formed, it can act as a depository for more solutes to precipitate, making the stone larger.</p>
<p>5. If the stones remain small, below 0.5 mm, then they will be easily discharged through the ureters and the bladder to the outside world.</p>	<p>6. But if they become bigger, then they can get stuck in the system, either in the kidney pelvis, or along the ureters or in the urethra.</p>
<p>7. If they are stuck, the muscle layers will make every effort to expel these stones and this is extremely painful. In addition, these stones may damage the muscle layer, thereby causing bleeding (haematuria = 'blood in the urine').</p>	<p>8. In fact, these patients often have bouts of sudden and violent pain, called (renal) colic, in which they move restlessly, possibly with vomiting, nausea, sweating etc.</p>
<p>9. If these stones are stuck, they can be removed by surgery, either by an incision or through a catheter or a scope.</p>	<p>10. A new treatment is the application of shock waves (= lithotripsy), which will disintegrate the stones into fragments that can then be removed through micturition.</p>

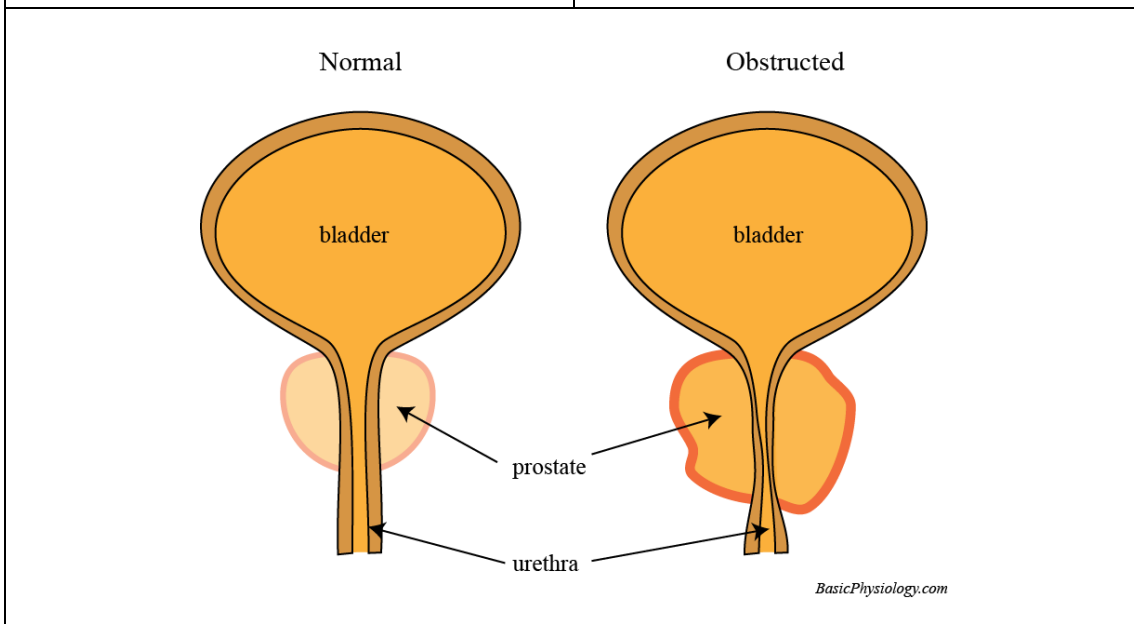
Link: Lithiasis = formation of stones (=calculi) in the body, such as in the kidneys.

B. Alcohol Hangover:

<p>1. Ever had a hangover? (Of course, you have!). Did you then notice that, the next day, your mouth felt very dry?</p>	<p>2. Why is that? Well, drinking to much alcohol inhibits the production of ADH by the pituitary gland (in the brain).</p>
<p>3. Remember that ADH = (anti-diuretic hormone) keeps the water 'inside' the body. When there is not enough ADH, then more water will be excreted and removed in the urine. (<i>link</i>)</p>	<p>4. This will cause a decrease in the amount of water in your blood, decreased blood pressure, which then causes dizziness, headache, dry mouth etc. In other words, a perfect hangover! But in fact, you are actually, and seriously, dehydrated.</p>
<p>5. The solution? Stop drinking alcohol and start drinking a lot of water!</p>	


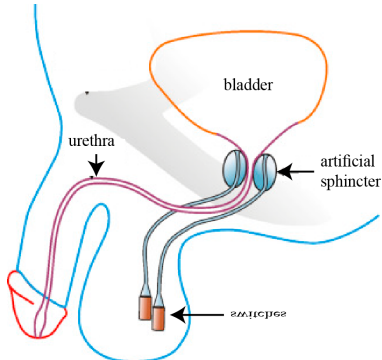
C. Urethra obstruction:

<p>1. Obstruction in a 'tubular' system such as the urinary system is of course always dangerous (and painful).</p>	<p>2. We already discussed above the problems with an obstruction such as by a kidney stone in the kidney pelvis (= nephrolithiasis) or in the ureters (= urolithiasis).</p>
<p>3. Another problem could be an obstruction in the urethra. This is often the case in older males. But not by a (kidney) stone!</p>	<p>4. In these (older) males, the prostate has become too big. Remember that the prostate is located below the bladder and that the urethra 'runs' through the gland.</p>



<p>5. If the prostate hypertrophies, this may squeeze the urethra, making it more difficult to urinate.</p>	<p>6. This can cause pain (=dysuria), increase the frequency to urinate, maybe causing swelling of the bladder etc.</p>
<p>7. In those cases, the (surgical) therapy is to ‘scrape the prostate tissue with a catheter knife running through the urethra; a TURP (= Trans Urethral Resection Prostate).</p>	

D. Incontinence:

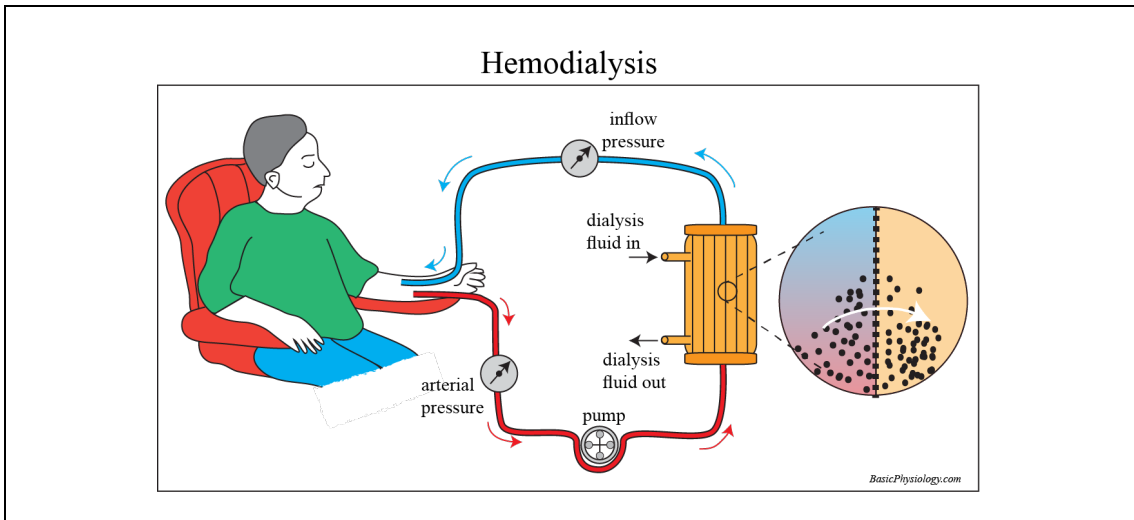
<p>1. Urinary incontinence occurs when you ‘accidently’ lose urine. This can occur in woman and in males.</p>	
<p>2. In woman, accidental loss of (little) urine may occur after giving birth (vagally). During that procedure (birth!), the muscles in the pelvis and the sphincter may have been overstretched.</p>	
<p>3. In both genders, an overactive bladder can also cause incontinence, possibly due to an infection, cancer, or whatever.</p>	<p>4. In older males, if they develop prostate cancer, then their prostate may have to be removed. This also removes the external and/or the internal urinary sphincter.</p>
<p>5. Fortunately, there is an increasing number of therapeutic options to treat such incontinence, ranging from physiotherapy (developing your pelvic muscles) to the implantation of an artificial sphincter!</p>	

E. Kidney dialysis:

<p>1. As you have seen from the previous pages, your two kidneys play a crucial role in the continuous filtering of the blood and removal of all toxic material. Without them, you would quickly accumulate toxins in your body and ultimately die!</p>	<p>2. Unfortunately, there are conditions in which the kidneys will no longer work properly. These can be infections, trauma or, most often, cancer.</p>
<p>3. If you are lucky (as happened to me), only one kidney may have to be removed. Then, the other kidney will continue to filter your blood without any problem. This is a nice example in which some of our organs are able to compensate for the loss of their counterpart.</p>	<p>4. However, in some patients, both kidneys may become damaged, perfuse less, and this may lead to irreversible damage. What can be done? Three things: <ul style="list-style-type: none"> a) kidney transplantation b) haemodialysis c) peritoneal dialysis </p>
<p>5. Kidney transplantation is only possible if a suitable donor is available. This is often the case in your own family but must be tested before the transplantation is performed. As stated in 3, the donor can easily live with a single kidney.</p>	<p>6. Quite often, a donor is not available and another method must be used to filter and 'clean' your blood; this is called dialysis. ('dia'= through, and "lysis=" loosening or splitting).</p>
<p>7. There are currently two types of dialysis; haemodialysis and peritoneal dialysis.</p>	

F. Haemodialysis:

<p>1. In haemodialysis, blood (= 'haemo') is pumped through a 'kidney' machine to filter out all the accumulated toxins in the blood.</p>	<p>2. This kidney machine was first developed in 1943 (<i>during WW2!</i>), is quite large and needs proper attention and cleaning. Therefore, this machine can only be used in hospitals or specialized centres.</p>
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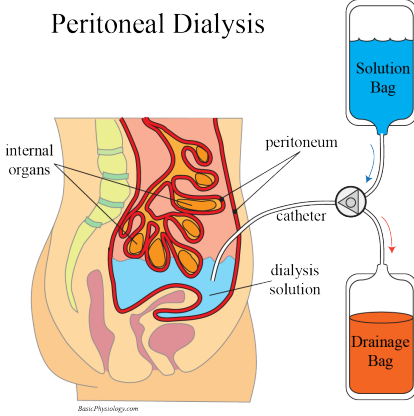
<p>3. Therefore, patients who don't have functioning kidneys have to go regularly to such a dialysis centre. There, two tubes are inserted in their circulation, usually in the lower arm, one to the venous system and one to the arterial system.</p>	<p>4. The blood from the arteries is pumped into a 'filter' where the toxins are removed through a semi-permeable membrane, very much like what happens at the capillary level (link).</p>
<p>5. However, this takes some time and the patients often have to sit for about 4 hours, in a chair, while a total amount of 70-80 litres of blood is 'cleaned'.</p>	<p>6. After such a dialysis, the patient can go home. This procedure must be repeated approx. 3-4 times every week!</p>

Link:

<http://www.basicphysiology.com/A.%20Basic%20Human%20Physiology/A.2.%20The%20Cell/A.2.3.%20Passive%20Transport%20Systems/A.2.3.%20Passive%20Transport%20Systems.html>

G. Peritoneal dialysis:

<p>1. In peritoneal dialysis, use is made of your own peritoneum. What is the peritoneum?</p>	<p>2. The peritoneum is the lining of all the organs in your abdomen. This thin membrane covers the inside of the abdominal cavity and all its organs (stomach, intestines, liver etc).</p>
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<p>3. This thin peritoneum is filled with blood vessels, arteries, veins and capillaries, which makes it an excellent (semipermeable) membrane.</p>	<p style="text-align: center;">Peritoneal Dialysis</p>  <p>The diagram illustrates the peritoneal dialysis process. On the left, a human torso is shown with internal organs and the peritoneum highlighted in red. A catheter is inserted into the peritoneal cavity. On the right, a blue 'Solution Bag' is connected to the catheter, with an arrow indicating the flow of dialysis solution into the peritoneum. Below it, an orange 'Drainage Bag' is connected to the catheter, with an arrow indicating the flow of used dialysis solution out of the peritoneum. Labels include 'internal organs', 'peritoneum', 'catheter', 'dialysis solution', 'Solution Bag', and 'Drainage Bag'.</p>
<p>4. How do we use this membrane for dialysis? Well, a permanent catheter is inserted and placed inside the peritoneal cavity.</p>	
<p>5. Then, a sterile solution is pumped into the peritoneal cavity and left there for a few hours.</p>	<p>6. During this time, the solution will interact, through the semipermeable membrane, with the blood streaming through the peritoneal capillaries, thereby absorbing waste products such as urea and creatinine from the blood.</p>
<p>7. So, gradually, all the toxins in the blood diffuse into the solution in your peritoneum. After several hours, the fluid is pumped out of the peritoneal cavity and replaced with a fresh solution, and the whole process starts again.</p>	<p>8. This can be done at home (after proper training), some 3-4 times a day. Nowadays, the system can even be automated and then can be used during your sleep!</p>