

# Blood tests in kidney disease

This page describes some blood tests that are commonly used in patients with kidney diseases, or to measure kidney function in people who may have kidney disease.

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## **Tests for *how well are my kidneys working?***

**Creatinine** - Creatinine is the best routine blood test for measuring how well kidneys are working. It is a waste product produced by muscles and put out through the kidneys. This means that 'normal' levels depend on how much muscle you have, and this can cause some problems in spotting kidney disease.

**Creatinine comes from muscle.** The little girl has normal kidney function and a creatinine level less than 60. The body-builder has normal kidney function and a

creatinine of 110. For the girl, a creatinine of 110 would be very poor kidney function. *Cartoon by Beth Shortt, copyright EdREN.*

Because of the problem of differing amounts of muscle in different people, most labs now also report an [estimated GFR \(eGFR\)](#) with creatinine measurements, and this can be very useful - [see below](#).

Big changes in creatinine are likely to be important, whatever the creatinine level. However different labs may give significantly different results for the same creatinine sample, because there are different ways of doing the test.

Normal blood **creatinine** is 60-120 micromol/litre (0.7-1.4mg/dl) - but see the cartoon above for a caution about this that applies particularly to small, disabled, or elderly people. In many people, 'normal' creatinine can sometimes conceal 50% loss of kidney function.

**Urea** - Urea is a small molecule that is produced in the liver from protein that you have eaten. It is normally put out by the kidneys, so blood levels rise as kidneys fail. However other things change the level of urea in your blood too, so that it is not a simple guide to kidney function. Here are some of the things:

- Blood loss into your gut - e.g. a bleeding ulcer - raises urea
- Fluid - if you are short of fluid (e.g. drinking very little), your kidneys keep more urea in the blood
- How much protein you have eaten - high protein intake raises urea
- Liver disease can stop urea being produced normally

Urea is still a very useful test when used together with creatinine. It can also be used to measure how well dialysis is working to clear waste products (see [Is my dialysis good enough?](#)).

Normal blood **urea** is 3.5-6.5 mmol/litre (20-30mg/dl)

**Creatinine clearance** - You can get round many of the problems of blood creatinine measurements by collecting urine for 24 hours and measuring how much creatinine is in the urine at the same time as finding out how much is in the blood. This is called **creatinine clearance**. If any urine produced during the 24 hours is not collected the result will not be accurate.

Normal **creatinine clearance** is about 100ml/minute

## Glomerular filtration rate (GFR) and estimated GFR (eGFR)

GFR is a test of how much the kidneys are filtering. It is normally about 100 mls/minute. This means that the kidneys are removing all the creatinine found in 100mls of blood every minute - almost [150 litres per day](#)! Most of this 150 litres is absorbed back into the body, so that only 1-2% of the filtrate appears as urine. Creatinine clearance (see above) gives quite a good measure of GFR, but requires a 24 hour urine collection for measurement. Two other ways of measuring GFR are:

- **eGFR** - Using blood tests, age, sex, and sometimes other information to *estimate* the GFR. This isn't as good as measuring GFR, but is much simpler as it requires just one blood test. It is being used increasingly to spot kidney disease earlier than previously, earlier than would be possible using just creatinine measurements ([see above](#))
- **Measured GFR** - Injecting a tiny amount of a radioactive or other substance and measuring how quickly it disappears from the blood, or appears in the urine, is used to calculate GFR.

**GFR** - Normal is about 100ml/minute/1.73m<sup>2</sup>. eGFR provides a rough estimate of the percentage function of your kidneys

Knowing your GFR is very useful. It can give you an approximate % kidney function, and be used to show your CKD stage - [more info about low GFR and CKD stages](#).

If you are interested in calculating your own eGFR, you can try these links. You need to know your creatinine.

- [MDRD from the Renal Association](#) - links to information about CKD stages.
- [CKD-EPI eGFR](#) (Kidney Health Australia - this is more accurate than MDRD and better graphs).



**Normal kidneys filter 150 litres per day.** That's 100 mls per minute. It also adds up to 33 Imperial gallons, 40 US gallons per day. *Cartoon by Beth Shortt.*

### **Tests of other things the kidney puts out**

**Sodium (Na)** Sodium comes from salt, which is sodium chloride. Although there is often too much of it in your body when your kidneys don't work properly, its level in the blood does not change much. This is probably because sodium makes you thirsty, so you drink more until the level is normal again. Having too much sodium in the body causes high blood pressure, oedema (swelling), and eventually severe problems such as heart failure and fluid on the lungs (pulmonary oedema). Removing sodium is an important part of dialysis treatment. Diuretic drugs (e.g. furosemide) increase the sodium put out by the kidney. Most people with kidney disease need to keep down the amount of salt in their food. In the western world we add too much salt to food and in preparation of food. Too much salt is said to increase blood pressure by as much as 10/5, for example 140/85 to 130/80, but the effects get worse if kidney function is reduced.

Normal blood **sodium** levels are 135 - 145 mmol/litre

**Potassium (K)** - Potassium comes from food, especially fruit, vegetables and nuts. Extra potassium you eat is normally put out in urine, so its levels in blood may rise in kidney failure. Blood potassium is normally precisely controlled and important. High levels can be very dangerous as they can cause serious heart rhythm abnormalities, including cardiac arrest, even before you have any other symptoms from it.

Normal blood **potassium** levels are 3.5 - 5.0 mmol/litre

### *How high is dangerous?*

There isn't a simple danger level, but levels above 6.0 causes concern, and levels much above 6.5 are dangerous. Levels above 7.0 are certainly dangerous.

- Diet is the most important way of controlling potassium levels in renal failure. [More info](#).
- Potassium is lowered by dialysis, but in patients treated by haemodialysis it rises between treatments, so it is important to be careful what you eat.
- Some medicines make blood potassium higher. This is more of a problem when kidneys don't work properly.
- Sometimes high potassium levels may not be accurate, for instance because of delays in getting the sample to the lab.

Treatments for dangerously high potassium may include giving sugar (glucose) and insulin, and some other measures. If it is very high and kidney function is poor, dialysis may be necessary.

**Calcium (Ca)** - The body's calcium is mostly in bones, but in kidney failure there are problems with calcium and bones. Low levels of calcium may lead to thinning of bones, very low levels lead to weakness, tingling, and other problems. High levels cause sickness. It is measured regularly in patients with kidney diseases because:

- Blood calcium may be low in renal failure, without treatment.
- Special types of vitamin D (calcitriol, alfacalcidol) are given to prevent renal bone disease and to raise blood calcium.
- Medicines (phosphate binders) given to keep blood phosphate low may also raise blood calcium.
- After years of kidney failure, **parathyroid hormone** levels often rise, causing high blood calcium levels - see [parathyroid hormone \(PTH\)](#).

### [More information about renal bone disease](#)

- Normal blood **calcium** levels are 2.3 - 2.5 mmol/litre (8.4-10.4 mg/dl).
- Changes in blood proteins (albumin) may change these normal ranges though.

**Phosphate (PO<sub>4</sub>)** - Phosphate levels are high in kidney failure. If not controlled, this causes

- Bone disease to be worse
- Itching
- Calcium deposits to form in blood vessels and in other parts of the body - these may cause serious disease.

[More information about renal bone disease](#)

- Normal blood **phosphate** levels are 0.9 - 1.3 mmol/litre (2.5-4.3mg/dl).
- In renal failure the aim is to keep levels at or below 1.8 by controlling the amount of phosphate in diet and by using phosphate binding drugs.

[More information about control of phosphate by diet and drugs](#)

**Parathyroid hormone (PTH)** - Parathyroid hormone is measured from time to time in patients with kidney diseases to prevent renal bone disease (renal osteodystrophy; [read more information about renal bone disease](#)). After years of kidney failure, PTH levels often rise, causing calcium to be removed from bone and blood calcium levels to be high. Normal levels of PTH are different when measured in different labs. In kidney disease it may not be best to keep PTH levels completely normal - some guidelines suggest just keeping it less than 2 or 3 times the normal level at 150-300 mg/L. This is best done by controlling blood phosphate levels (see above) or by taking vitamin D supplements such as alfacalcidol. If PTH levels cannot be controlled by these measures alone then parathyroid glands may need to be removed in an operation called parathyroidectomy. There are 4 parathyroid glands, all located in the neck, behind the thyroid gland.

## Other blood tests

**Haemoglobin (Hb)** - The stuff in red blood cells that carries oxygen. Too little is anaemia. Most patients with severe kidney failure are anaemic.

- Normal **haemoglobin** levels are approximately 110-180 grams/litre in men and 115-165 g/l in women. (Many labs use grams/decilitre, g/dl, for which normal values are 11-18 rather than 110-180)
- Erythropoietin (EPO) and other treatments aim to keep Hb levels near the normal range in patients with renal anaemia.

**White blood cell count (wbc)** White blood cells fight infection. Levels are often high during infections, but may be made low by some drugs, such as those used to lower the immune system (e.g., azathioprine, mycophenolate, cyclophosphamide) and sometimes also by infections. If the numbers are very low there is an increased risk of serious infection. Different kinds of white blood cell are added together to get the wbc. Neutrophils are the type that is most important for fighting common infections, and they are particularly likely to be affected by drugs.

- Normal **wbc** is approximately 4-11 thousand million per litre

**Platelets (plats)** - Platelets are needed to form blood clots. If the numbers are very low (below 50) the risk of serious bleeding increases. Patients with kidney disease quite often have slightly low platelet counts, but other diseases, and drugs, may also cause low platelet counts.

- Normal **platelet count** is approximately 150-350 thousand million per litre.

**Albumin (Alb)** - Albumin is a blood protein. It usually makes up more than half of the protein in blood. Low levels can contribute to ankle swelling. Some things that may cause low levels include:

- Leakage into urine - heavy leakage is called [nephrotic syndrome](#)
- Poor diet and starvation
- Infections or other causes of inflammation
- Liver disease

Normal **albumin** levels are 35-45g/litre.

In dialysis patients it has been found that low albumin levels can be a marker for not doing well on dialysis. Unfortunately different methods used to measure albumin mean that different labs can get quite different results for the same samples from patients with kidney diseases.

## Is my dialysis good enough?

Either of two tests may be used to measure how much haemodialysis you get. These tests aren't the only things that are important though. It is also important to have long enough dialysis to get fluid balance right, and to correct some other chemicals, such as Phosphate.

**Urea Reduction Ratio (URR)** - This is a measure of how much waste products such as urea have been reduced by one haemodialysis treatment. It is used to check that enough haemodialysis is being given. If it is too low more than once, you should find out why.

- URR should usually be over 70% if you are dialysed three times each week and have little or no remaining kidney function.

**Kt/V** - This is a more complicated test of how good dialysis is. URR is a simpler test. Kt/V includes more than just the change in urea. If it is too low more than once, you should find out why.

- Kt/V should be over 1.2 for each dialysis if you are dialysed three times each week and have little or no remaining kidney function.

## Drug levels

**Ciclosporin, Tacrolimus and Sirolimus** are drugs that are used to prevent your immune system from rejecting your transplant. They all need blood tests to make sure that you are taking enough, but not too much. Too much may cause serious side effects, while too little may not prevent rejection. The exact levels you are aiming for depend on a number of things, for instance:

- How long ago your transplant was
- The other medicines you are taking
- The risk of rejection for you

- so we have not given a target range here. If you want to know, you should ask your transplant team what your target levels are.

Tacrolimus and ciclosporin are sometimes used to reduce urinary protein leak in patients with [nephrotic syndrome](#).

## Further information

[PatientView](#) has links to detailed information about all the tests it shows.

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