LABORATORY INVESTIGATIONS IN UROLOGY.

By CUTHBERT DUKES, M.D.

(Pathologist, St. Peter's Hospital for Stone, and St. Mark's Hospital, London.)

This paper will answer the question when and how laboratory investigations are useful in urology. It will not describe the technique of performing the tests, which is the province of the pathologist, but it will give a list of the different ways in which the laboratory may be useful to a urological surgeon and will discuss the interpretation of the results of the different tests.

The three chief ways in which laboratory investigations are useful in urology are 1. In the performance of renal function tests. 2. In the chemical and bacteriological examination of urine. 3. In the examination of operation specimens. There are, of course, other laboratory investigations which may be useful in special cases, such as blood counts, Wassermann tests, estimations of blood sugar, etc., but this paper is concerned only with those laboratory investigations which are of special interest to urology.

1. RENAL FUNCTION TESTS.

Renal function tests are intended to show whether or not the kidneys are functioning well. In interpreting the results of such tests it is of course necessary to remember that extra-renal factors, such as the state of the circulatory system, influence greatly the performance of the kidneys. It is obvious also that in pathological conditions which may improve or deteriorate from day to day the response to renal function tests will express similar ups and downs. However, these limitations do not detract seriously from the usefulness of the tests. We possess in the renal function tests very sensitive methods of assessing the essential activities of the kidneys and they have become an indispensable procedure in the investigation of urinary diseases.

There are several different ways in which the functions of the kidneys may be observed and several different types of renal function tests. Some of these are very simple, others intricate. Each does not measure the activity of the kidney in the same terms so that the results of renal function tests do not always correspond exactly. That is to say, the response to one test might be classed as poor whereas to another test the response might be regarded as satisfactory. This is often due to the fact that slightly different functions are being measured by the different tests.

A brief description will be given of the tests in most common use in this country at present, proceeding from those for which no special laboratory apparatus or training is necessary, to the more elaborate investigations which should be left to the clinical pathologist. For descriptive purposes they may be grouped as follows:

1. Simple estimations of the concentrating power of the kidneys.
2. Measurements of the rate of elimination in the urine of foreign substances such as dyes.
3. Measurements of the rate of elimination in the urine of natural substances such as urea, chlorides, creatinin, etc.
4. Chemical analysis of the blood to determine whether or not there is any retention of substances which the kidneys are due to excrete.
1. Simple Estimation of the Concentrating Power of the Kidney. One of the first signs of renal failure is the loss of the concentrating power of the kidney. The existence of such a defect may be shown by the specific gravity test, a procedure which requires no apparatus except an accurate hydrometer and measure.

The principle of the test is the restriction of fluids for 24 hours to see to what extent the urine can be concentrated. The patient is forbidden all fluids from 8 a.m. one day to 8 a.m. next day. All urine is collected, but that which is passed in the first twelve hours is not required for examination. The patient is instructed to empty his bladder at 8 p.m. and this sample and anything passed in the first twelve hours are discarded. All urine voided between 8 p.m. and 8 a.m. is kept. The specific gravity of the urine passed in this second period is measured and should be about 1,030. The concentration of urea should be over 2%. During the test the patient is not allowed any fluid, soup, milk, milk-puddings or fruit. Vegetables, meat, bread and butter are allowed. The advantage of this test is its simplicity, but this is perhaps more apparent than real when one reflects on the inconvenience of the performance and its unsuitability to many urinary diseases.

Another similar test measures the renal function in the opposite way, namely by forced fluids. Here the patient is given as much fluid as possible in the form of barley water, Vichy water, etc., and the intake and output measured. When the kidneys are functioning without impairment the excretion of urine closely follows the amount of fluid administered and can be forced up to about 100 ounces a day.

2. Measurement of the Rate of Elimination in the Urine of Foreign Substances such as Dyes. The Indigo-carmine test is used chiefly to contrast one kidney with the other. It is usually employed whilst the patient is being cystoscopically examined and the time of appearance of the blue at each orifice noted. "If after intravenous injection of 10 c.c. of a 0.4% solution of indigo-carmine the drug fails to appear in the urine from one kidney within fifteen minutes, whilst the kidney on the opposite side is excreting dense blue clouds within a period of seven minutes, it is practically certain that that kidney is deficient." (Thomson-Walker.)

In the Phenol-sulphone-phthalein test the patient is given intravenously six mgm. of phenol-sulphone-phthalein dissolved in 1--2 c.c. of sterile water. The urine is collected by catheter and the time of the appearance of the pink colour noted. Once the drug has begun to appear the catheter is plugged and the urine allowed to collect in the bladder for one hour. This is released and a second hour sample collected. The two specimens are then sent to the laboratory for colorimetric estimation of the amount of phenol-sulphone-phthalein they contain. In normal individuals with active kidneys about 60% of phenol-sulphine-phthalein is eliminated during the first hour and about 80 to 90% by the end of the second.

3. Measurement of the Rate of Elimination in the Urine of Natural Substances such as Urea, Chlorides, Creatinin, etc. One of the main functions of the kidney is to excrete from the blood end-products of protein metabolism such as urea. A quick and natural method of assessing renal function is to measure the excretion of urea in the urine. The most popular way of carrying this out is by Maclean's Urea Concentration test. The patient is given 15 grm. of urea by the mouth and then the urine passed in each of the three succeeding hour periods is collected.
and the urea content measured. If the percentage of urea is over 2 the renal function may be regarded as normal: if between 1 and 2, impaired: and if under 1 badly damaged.

One advantage of the urea concentration test lies in the fact that we measure the elimination of a natural constituent of the blood and not artificial products such as indigo-carmine and phenol-sulphone-phthalein. The test appears a very simple one but it is often carelessly carried out leading to fallacious conclusions. It is best to carry out the test first thing in the morning before breakfast. No fluids should be allowed from 10 p.m. the previous evening. The test dose of urea is given in only half a glass of water. The bladder must be emptied completely after the first, second and third hours and all the urine passed sent to the laboratory for examination. It is not fair to use the figures for comparison if the volume passed in any one hour is over 120 c.c.

The chlorides test and creatinin test also measure the rate of excretion of natural substances from the blood, but these substances are not so easily estimated in the urine as is urea so that they are not so much in use as the urea concentration test.

4. Chemical Analysis of the Blood. One of the chief functions of the kidney is to excrete urea from the blood. If therefore the urea in the blood rises above the normal level of 20—40 mgms., it is an indication of defective renal excretion. This may not necessarily be the result of kidney disease because it is well known that the level of the urea in the blood will rise in any condition accompanied by dehydration, and in intestinal obstruction. Under such conditions as this, however, it will be found that although the blood urea is high there is also a good percentage of urea in the urine, perhaps even more than 4%. When the blood urea is raised as the result of renal failure it will be found that the percentage of urea in the urine is low.

For estimating the level of the blood urea about 5—10 c.c. of blood should be taken from the vein into a tube containing a few grains of oxalate or citrate to prevent coagulation. Blood serum from clotted blood may also be used, but plasma is more convenient. The sample may be taken at any time of the day. There is no immediate hurry in sending the sample to the pathologist because no appreciable deterioration occurs for several hours.

The estimation of the blood urea is one of the most useful of the renal function tests for the urological surgeon. It can be carried out without any preliminary preparations and without any interference with the day's routine. It does not, of course, reveal the existence of kidney disease in its early stages, nor does it show minor defects in renal function. However, experience has shown that defects in renal function unaccompanied by a rise in the blood urea are usually of insufficient importance to modify surgical procedure. On the other hand when the blood urea is raised above 50 mgms. this must be taken into serious consideration when deciding on surgical treatment and a rise above 100 mgms. makes it advisable in many cases to delay operations necessitating general anaesthesia.

In making use of the blood urea test for assessing the operability of a patient it is necessary that the test should be carried out as near to the operation day as possible. The level of the blood urea may rise rapidly when renal function is declining. It also falls rapidly when retention of urine has been relieved by surgical treatment.
Apart from the simple estimation of blood urea, there are other more complicated renal function tests dependant on blood chemistry or on the correlation of the level of the urea in the blood and urine and rate of excretion of urine. One of the most interesting of these is the urea clearance test which measures the rate of clearance of urea from the blood. This will reveal defects in renal function before urea, uric acid or creatinin are increased in the circulating blood, but these minor derangements of renal function are of more interest to the physician than the surgeon.

**General value of Renal Function Tests.**

The results of renal function tests must always be correlated to information obtained from clinical examination of the patient. One cannot say that any one of the recognized tests supplies all the information that it is possible to obtain and the safest plan is to carry out two or three and correlate the results. Which set of tests should be employed in any given case is partly a matter of personal preference and partly depends on the type of renal disease which exists.

Amongst most urologists in this country reliance is placed on a combination of the blood urea and urea concentration tests. The figure for the blood urea alone only shows whether or not there is nitrogen retention, whilst the urea concentration test measures the capacity of the kidney to rise to a special occasion and increase the concentration of urea in the urine. These tests miss some of the lesser defects in renal function but they provide standards which experience has shown to be reliable as a guide to surgical treatment.

**II. CHEMICAL AND BACTERIOLOGICAL EXAMINATION OF URINE.**

Urine analysis is of course an indispensable part of the proper examination of a urological case but the tests which are useful are few and simple. The urine must be examined for its reaction, and for the presence of albumin and sugar. The centrifuged deposit should be examined for pus, blood, casts and crystals and films made and stained for bacteria. Cultures are prepared either from the fresh urine or centrifuged deposit according to the nature of the case and manner of collection of the specimen. Further than this it is not necessary to go in most cases.

The chief fact revealed by this examination is whether the urine is infected or not and if so by what types of bacteria. We need not discuss further the significance of the finding in urine of such bacteria as the tubercle bacillus or the gonococcus, but a word or two of comment may not be out of place with regard to streptococci, staphylococci and B.coli. Streptococci are often present in urine which has been passed naturally and allowed to stand before examination. They are very often numerous in the urine after instrumentation such as catheterisation, having been carried into the bladder from the urethra. The most important observation for the pathologist to make with regard to these is whether the culture belongs to the haemolytic, the viridans or the faecalis type. Staphylococci are often present in the urine in association with calculus disease and are almost invariably of the albus strain. Other similar Gram positive cocci resembling staphylococci may be found in heavily infected urine but the cultural characteristics are different and they do not have the same significance as a genuine staphylococcus albus. Many different strains of B.coli and coliform bacilli may cause urinary infections but it is not of any surgical interest to catalogue the different varieties. They are all of the same pathological significance.
The presence or absence of pus is another point of importance to establish by urine analysis, and it is of value to express this quantitatively by such terms as "present in large quantity," "in small quantity" or "a few pus cells only." Pus may be detected by microscopic examination when other tests would be negative and the same is true for blood. It is often possible to show the presence of red blood cells in urine that is clear and untinted. The presence and variety of crystals in the urine is often of surgical interest particularly in the case of cystinuria.

Before leaving the subject of urine analysis something should be said about the examination of ureteric catheter specimens. A comparison of the urine from each kidney is often of great value to the urologist. It helps very much in the chemical analysis if prior to the catheterisation of the ureters the patient is given 15 grms. of urea. This results in a more concentrated urine permitting a more accurate estimation and comparison of the urea and specific gravity on each side. The other tests of value in ureteric catheter specimens are the estimation of pus, and the films and cultures for bacteria.

A surgeon is often uncertain as to how much urine he should send to the laboratory. About 30 c.c. (1 ounce) is adequate for ordinary chemical and bacteriological analysis, but for the examination for tubercle bacilli it is better to send the deposit from the 24 hours' excretion. In specimens obtained by catheterisation of ureters the surgeon is often only able to collect a few drops but he should send it along as it will probably be enough. A clinical pathologist who has had special experience of this work is able to do the following tests on about 1 c.c. (20 drops) of urine—estimation of reaction, specific gravity, percentage of urea; presence of albumin, blood, pus casts and crystals: films and cultures for bacteria.

III. THE EXAMINATION OF OPERATION SPECIMENS.

Laboratory investigations are often of great value in the examination of operation specimens. The presence or absence of carcinoma in an excised prostate and the question of malignancy in a villous papilloma are important issues that can only be decided by section. Apart from those urgent problems there are many instances in which a pathologist's report on an operation specimen is of interest to the surgeon and valuable in relation to after-treatment. It is generally possible to make this report much more complete if the specimen is sent intact to the laboratory without having been opened up to satisfy the immediate curiosity of the surgeon. If organs such as kidneys, or pieces of tissue such as tumours, are cut or dissected before fixation, they lose their natural shape and relationship which can never be restored. If therefore a surgeon has removed an organ or piece of tissue which he regards as of particular interest or beauty, he will be well advised to put aside his knife and scissors and wrap the precious object in gauze soaked in dilute formalin and hand it over intact to the pathologist for dissection after it has been properly fixed.
Laboratory Investigations in Urology

Cuthbert Dukes

*Postgrad Med J* 1935 11: 390-394
doi: 10.1136/pgmj.11.121.390

Updated information and services can be found at:
http://pmj.bmj.com/content/11/121/390.citation

**Email alerting service**

Receive free email alerts when new articles cite this article. Sign up in the box at the top right corner of the online article.

**Notes**

To request permissions go to:
http://group.bmj.com/group/rights-licensing/permissions

To order reprints go to:
http://journals.bmj.com/cgi/reprintform

To subscribe to BMJ go to:
http://group.bmj.com/subscribe/