The patient was ordered to bed and stayed there until his admission to hospital some six weeks later. During the whole of this time until June 9th he had no definite symptoms or signs beyond feeling ill and becoming progressively weaker. From June 9th to June 16th, approximately five weeks after the onset of his illness, he had a rigor every day. There was nothing in his family or past history of importance relating to his present condition, and he had never been abroad.

On admission he looked very toxic and ill; he had a muddy complexion and a drawn anxious expression, and there was great emaciation. Temperature 99.8° F., pulse 120, respirations 30. He was not jaundiced, the tongue was dry and furred, and the breath was offensive. There was a slight fullness in the right lower chest extending downwards to the right hypochondrium; the respiratory movement of the right side was restricted. Vocal fremitus was absent in the right axilla and right base, the percussion note being much impaired and the breath sounds weak over this area. There were no added sounds in the lungs, and the left lung was normal. The heart was normal. The abdomen moved well on respiration; there was a slight fullness in the right hypochondriac region continuous with that in the right lower chest. The liver dullness was increased to the fourth rib above in the mid-clavicular line, but it did not extend downwards beyond the costal margin. There was no tenderness or rigidity even on deep palpation over the liver, spleen, or right iliac fossa. The spleen and kidneys were not felt. The urine was normal. A white blood count showed 27,000 cells per c.mm.

On June 17th the right chest was explored in the seventh intercostal space in the post-axillary line, with negative results. Next day, under α rays, it was seen that the right dome of the diaphragm was abnormally high and that its movements were limited. The diagnosis of right subphrenic abscess was suggested. On June 19th the right subphrenic space was explored, with negative results. During these few days his temperature rose to 103° F. each evening, and fell to 99° each morning. The pulse varied from 130 to 120, the respirations were 25. There were no rigors.

During the next few days his general condition became worse and the physical signs changed. The conjunctivae became slightly jaundiced, his spleen became palpable, and there was epigastric tenderness. In addition there was now a definite outward bulging of the right hypochondrium, and the liver was palpable below the level of the costal margin. A white blood count showed 27,000 cells per c.mm.; a differential count revealed a polymorphonuclear leucocytosis. Blood culture was negative.

On June 25th the patient was extremely ill; he was seen for the first time by Mr. T. P. Dunhill, who made a diagnosis of right subphrenic abscess or hepatic abscess, and advised an exploratory laparotomy. This was performed on the same day by Mr. Dunhill, nitrous oxide gas and oxygen being the anaesthetic, together with local anaesthetic (1 per cent. solution of novocain) for infiltration of the anterior abdominal wall. The abdomen was opened through a right paramedian incision. On opening the peritoneal cavity the liver was found to be much enlarged, a deep purple colour, and intensely congested; it blanched on pressure and was oedematous; there was no perihepatitis. There were some areas paler than normal, and on palpation they felt firmer than the intervening liver tissue, suggesting induration underlying them deep in the liver. The largest of these areas, about three inches in diameter, was situated in the left lobe of the liver, and smaller ones were in the right lobe. It was then decided to explore the indurated area in the left lobe with a syringe. Pus was discovered and about 1 c.cm. withdrawn. The gall-bladder was normal; the portal vein was palpated and appeared to be thickened. The appendix was next examined and found to be surrounded by recent adhesions, the last two inches of it being buried in a loop of mesentery. On peeling it out this two inches was distended with fluid, which afterwards proved to be mucus. It was lying in a mass of material which was obviously the remains of an abscess. Appendicectomy was then performed; the peritoneal cavity was packed off and the left lobe of the liver was next opened up with Spencer Wells forceps at the point at which pus had been found; the haemorrhage was considerable, but no more pus escaped. A rubber drainage tube was inserted deeply into the liver and held in position by a catgut suture, two other sutures controlling the haemorrhage. The abdomen was then closed.

The pus from the liver was examined pathologically and proved to be Gram-negative coliform bacilli.

After History.—Pus was discharged in large amounts through the drainage tube for the first few days, and then the quantity gradually diminished. The temperature varied from 100° to 98.4° F., pulse from 130 to 110, respirations 26. The patient felt better, the appetite rapidly improved, and he slept well. On the fourth day after the operation the white blood count showed 22,800 cells per c.mm. On the eighth day the drainage tube came away with the dressing; the temperature dropped to normal, and remained so; the pulse was 100. On the tenth day the white blood count was 7,200 cells per c.mm. He made an uninterrupted recovery and was discharged on the twentieth day. He was seen again on November 23rd, when he was in the best of health and had regained his normal weight.

The interesting features of the case are: (1) The mildness of the signs and symptoms from the beginning of the illness, including the attack of appendicitis, up till the onset of the rigors some five weeks later. (2) The interval which elapsed between the attack of appendicitis and the onset of suppurative pylephlebitis and hepatic abscess, as indicated by the rigors. (3) The slight jaundice, profound

toxaemia, rapid prostration, enlarging liver and spleen associated with the onset of portal pyaemia, and leucocytosis.

The whole story is typical of this condition, except for the fact that the patient recovered. The significance of the case lies in the importance of draining the liver and in the proof it affords that the condition, although one of extreme gravity, is not necessarily fatal.

While in St. Bartholomew's Hospital the patient was under the care of Dr. C. M. Hinds Howell and the Surgical Professorial Unit, to whom we wish to express our thanks for permission to publish the case notes.

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THE EXAMINATION OF URINE FOR PUS.

BY

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THE presence of pus in the urine can only be established certainly by microscopical examination. Other methods of testing for it, such as the guaiac and caustic potash tests, or simple turbidity estimations, only give positive results when much pus is present; they are open to many fallacies because they are not in any way specific. Microscopical examination requires some preliminary preparation of the urine; this has been hitherto effected by centrifuging or sedimentation. A method which obviated preliminary preparation would be an advantage, because the apparatus necessary for centrifuging is not always available, and it may be inconvenient to wait while the cells of the urine settle in a conical vessel. Moreover, each of these methods has certain inherent disadvantages too often overlooked. In the case of the centrifuge the faster the revolutions and the longer the time revolved the more numerous are the formed elements swung to the bottom of the tube, so that a diagnosis of pus is more likely to be made by the owner of a powerful centrifuge than by one who relies on simpler apparatus. The disadvantages and fallacies of sedimentation are so obvious that it is surprising to see such methods still trusted. The rate of sedimentation depends on so many variable factors, and the cells are often unrecognizably deformed consequent on the increased alkalinity accompanying bacterial fermentation.

The following method of microscopic examination of urine for pus can be performed immediately the urine is voided. The test is completed in two or three minutes, and the only apparatus required is a microscope, a pipette, a ruled slide, and cover-glass. The method has the great advantage also of expressing the amount of pus quantitatively as cells per cubic millimetre, a procedure of special value in those doubtful cases in which one observer reports "excess of leucocytes" and another "small quantities of pus." It allows also a record to be kept of the progress of the disease, the increase or decrease of pus being registered as easily as the temperature and pulse.

Method of Counting Leucocytes in Urine.

The formed elements of the urine (casts, red blood corpuscles, and leucocytes) are enumerated in a counting chamber by a method similar in principle to that employed for blood counts. The chamber differs in that the glass cell is 0.2 mm. in depth and not 0.1 mm. as in the ordinary haemocytometer, and the area of the ruled lines is 16 sq. mm. The Fuchs-Rosenthal slide for enumeration of cells in the cerebro-spinal fluid is very suitable for this urine test and the one now recommended, but other cerebro-spinal fluid chambers providing a depth of 0.2 mm. may be easily adapted. The ordinary haemocytometer cell is unsuitable because the volume enclosed in it is too small. The ruled area of the Fuchs-Rosenthal slide encloses a square, each side of which is 4 mm. in length, the enclosed space therefore being 16 sq. mm. (See Fig. 1.) This large square is divided into sixteen smaller squares, distinguished by being bordered by three lines, each of which encloses one square millimetre. Each of these is again divided into sixteen squares, bounded by sides 1/4 mm. in length. Since the cell is 0.2 mm. in depth (this being the distance between platform and cover-glass) the volume enclosed in the whole cell is $16 \times 0.2 = 3.2$ c.mm.

The urine to be tested is shaken thoroughly to distribute the cells evenly; a sample is then taken with a clean rubber teat pipette, and a drop of the urine is transferred to the platform of

the slide and allowed to run between the platform and cover-glass. A minute or two having been allowed for the formed elements to settle, the cells are counted by moving the ruled slide to and fro across the microscope stage until the whole ruled area has been surveyed.

The most convenient objective to use for this purpose is an 8 mm. or 1/3 in. dry lens providing an initial magnification of about 20. This objective with a $\times 10$ eyepiece includes comfortably in its field of view four of the smallest squares (see Fig. 1, A), and this permits the whole field of 16 sq. mm. to be surveyed in eight journeys—four from left to right and four from right to left. At this magnification (about 200 diameters) leucocytes and red blood cells can be distinguished easily.

Most microscopes in common use are provided with only two dry lenses, a 16 mm. or 2/3 in., and 4 mm. or 1/6 in. The 8 mm.

FIG. 1.—Ruling of Fuchs-Rosenthal slide magnified nine times. A=field of view with 8 mm. objective and $\times 10$ eyepiece; B=field of view with 4 mm. objective and $\times 5$ eyepiece; C=field of view with 16 mm. objective and $\times 10$ eyepiece.

cytes and bodies which closely resemble them in size and shape. It may be used for the rapid examination of a urine almost free from cells, but if formed elements are present in the urine it will usually be necessary to re-examine the field with a higher objective to determine what should or should not be counted. A mechanical stage is almost indispensable. In an emergency the count can be made without a movable stage if the observer has acquired sufficient dexterity to move the slide by hand, but a mechanical stage saves time and energy and ensures much greater accuracy. Unless pus is present in large quantities all the sixteen large squares must be counted—that is, the whole ruled area. The volume thus surveyed is 16 sq. mm. by 0.2 mm. = 3.2 cubic millimetres. The number of cells observed in the whole ruled area divided by 3.2 gives the number of cells per cubic millimetre. It is sufficiently accurate for practical purposes to count all the cells in the sixteen squares and divide by 3. If pus is present in such large quantities that each microscope field shows several cells, then the survey of all the 16 sq. mm. may mean counting several thousand cells. For such specimens a shorter method is sufficient. Only the first four of the sixteen 1 mm. squares need be counted, and the figure obtained is multiplied by 4 and divided by 3 to give the cells per cubic millimetre.

Leucocyte Content of the Urine in Health.

A few leucocytes are often found in the urine of healthy men and women who give no history of any disease of the genito-urinary organs. Whether or not such cells are physiological, or represent the after-effects of some morbid lesion too slight to evoke symptoms, is a question on which urologists have held different views. For practical purposes it is generally admitted that if only an occasional leucocyte or two is found in a centrifuged urine after searching several fields of the microscope, the urine may be regarded as normal; but the fact that a few leucocytes may be present in the urine of healthy people necessitates a definition of the normal limits before a numerical definition of pyuria is possible.

The cell count method of examining urine for pus has been applied to more than 700 samples of urine; of these examinations 411 were of men and women free from genito-urinary disease and 291 were of cases of urinary sepsis. The summary of results obtained with normal men and women is recorded in the following table.

	No. of Counts.	No. of Individuals.	Maximum Count.	Minimum Count.	Average Count.
Healthy men ...	288	157	50	0	2.1
Healthy women ...	123	85	50	0	7.1

A Numerical Definition of Pus.

A total of 291 counts has been made on patients suffering from various diseases of the genito-urinary tract, including nephritis, pyelitis, cystitis, prostatic abscess, urethritis, stone in the ureter, and many undetermined inflammations. Insufficient data have been collected to permit any sort of classification of the pus counts of different pathological conditions; for the present purpose they are grouped together as individuals suffering from some disease of the genito-urinary tract in whom the diagnosis of pyuria was justified. The counts ranged from 100 to 5,000 leucocytes per c.mm. In most cases of acute inflammation a leucocyte count higher than 500 cells per c.mm. was obtained; in more quiescent or chronic cases the figure was less than 500. Experience has shown that a count of more than 100 leucocytes per c.mm. points to disease of the genito-urinary tract, and justifies the designation pyuria. Urine should be described as containing pus when more than 100 leucocytes are present per c.mm. This allows of a very generous margin above the average count of 2.1 cells per c.mm. for men and 7.1 for women, but such a wide margin is advisable because of the normal range of variation. What significance, if any, should be attached to counts between 50 and 100 will probably have to be decided separately for each individual case when other sources of information have been explored.

Comparison with Previous Standards for Pus.

In deciding whether or not a urine shall be said to contain pus reliance is sometimes placed upon the number of leucocytes seen per field of the microscope after the urine has been allowed to settle or been centrifuged. Obviously no comparison is possible between the standard now recommended of 100 leucocytes per c.mm. and the number of cells per field of the microscope, because the thickness of the drops adds yet another variable factor to those already mentioned inherent in the process of centrifuging and sedimentation. Comparison was made with other methods by adding leucocytes to normal urine until the tests became positive and then counting the cells, and by diluting pus-containing urine with normal urine until the tests became negative and again counting the cells. These comparisons, repeated on many occasions, only served to emphasize how crude and full of pitfalls are all methods for the detection of pus other than by the microscope. These comparisons may be summarized in a sentence by saying that urine which is clear from every other possible cause of turbidity must contain more than 400 leucocytes per c.mm. before the pus causes sufficient opacity to be detected by the naked eye, and the guaiac test and liquor potassae test are often negative with urine containing more than 500 cells per c.mm.

The Examination of Urine for Blood.

The cell count method of estimating pus is applicable also to the study of haematuria. An occasional red blood corpuscle may be found in the urine of healthy people, but except after injury or disease of the genito-urinary tract, or during menstruation in women, there are always far fewer red blood corpuscles than leucocytes. The discovery in the urine of more than 2 or 3 blood cells per c.mm. is an important observation, but the counting of the cells has no practical value except when both red blood cells and leucocytes are found, and the question is raised whether the condition is one of uncomplicated haematuria or whether blood and pus are both present. When both red and white corpuscles are enumerated the cell count method will decide this question, thereby showing whether or not the relationship existing in the blood of one leucocyte to 500 red blood cells is maintained or exceeded in the urine.

First count the red cells per cubic millimetre of the urine (after suitable dilution if necessary) and divide by 500 to give the number of leucocytes expected to accompany this quantity of blood. Then count the number of leucocytes per cubic millimetre actually present in the urine (after laking the red cells with acetic acid if necessary), and if this figure per cubic millimetre exceeds the estimated figure by more than 100 pus is present in addition to blood.

The delicacy of the cell count method for detection of blood is proved in a convincing way when a comparison is made between this and other methods. It was noticed during routine testing, and has been frequently verified by

the simple experiment of adding blood to urine and then counting the cells, that all methods of testing for blood other than microscopic are not only valueless, but a positive source of deception. The guaiac test for blood is hardly ever positive unless the urine is red in colour, and experiment has shown that more than 10,000 red blood corpuscles must be present per c.mm. before this point is reached. The pyramidon and benzidine and spectroscopic tests are only positive when the urine is either obviously red or has a "smoky" tint, "smokiness" being reached only when the urine contains at least 1,000 red blood corpuscles per c.mm. When less than 1,000 red blood cells are present per c.mm. no test other than the microscope will show the presence of blood. On the other hand, the cell count method may be relied on when such small quantities of blood as 10 red blood cells or even less are present per c.mm. The delicacy of the cell count method is revealed when these facts are presented in an example. A specimen of urine containing about 800 to 900 red blood corpuscles per c.mm. would show no smokiness and no trace of blood to the naked eye, and the guaiac, benzidine, and spectroscopic tests might all be negative, and yet the presence of blood would be indisputably demonstrated by the cell count method *after the urine had been diluted more than one hundred times.*

Practical Points.

The specimen of urine to be examined should be the first passed in the morning, and the patient should be instructed to pass the urine direct into a wide-mouthed bottle, or into a clean receptacle from which it is to be transferred at once to a clean bottle. The figures given above are based on early morning specimens; lower counts are obtained if a specimen is collected only an hour or two after the bladder has been emptied and the patient has taken a lot of fluid. Specimens may be accepted if an interval of more than four hours has passed since the last micturition, but in all doubtful cases the early morning specimen must be insisted on. The urine should be examined on the day on which it is passed.

Turbid Urines.

Urines need not be clear from crystalline or amorphous deposit of inorganic salts, but if these are dense accurate counting becomes impossible. A cloud of phosphates may be quickly dispelled by a drop of acetic acid. A deposit of urates and oxalates cannot be easily removed by any chemicals, but urine turbid from this cause usually becomes quite clear by dilution with an equal volume of warm water.

Recognition of Leucocytes.

Only round cells of the size and shape of leucocytes must be counted. Until the eye has become trained to

FIG. 2.—Field of view obtained with 8 mm. objective and $\times 10$ eyepiece, enclosing four $\frac{1}{4}$ mm. squares, reduced for reproduction to one-fifth of the size actually seen. Red blood corpuscles in upper left-hand square and leucocytes in lower right-hand square.

red blood cells have been drawn to scale, and in the lower right-hand square leucocytes. An impression of the relative size of things can be obtained by recollecting that each of these smallest squares is bounded by lines 250 microns in length. Red blood cells in urine usually measure 8 to 9 microns in diameter, a little less than $\frac{1}{25}$ of the boundary

line, and leucocytes usually measure 10 to 12 microns, a little more than $\frac{1}{25}$ of the boundary line.

Epithelial cells must not be included in the count. These are usually larger, often irregular in outline, with a relatively small conspicuous nucleus. Squamous cells are easily distinguished and disregarded; caudate cells with a tail-like prolongation of the body, and pear-shaped cells, usually attributed to the renal pelvis or neck of the bladder, must not be included in the count. In judging whether or not a cell should be counted as a leucocyte special attention should be paid to the size, the definite rounded outline, and the presence of a nucleus. The recognition of a leucocyte is an accomplishment that becomes progressively easier with experience. No advantage is gained by trying to stain the cells, and the so-called differential stains purporting to distinguish epithelium from blood cells are unreliable. Acidifying with acetic acid makes the cell nuclei more conspicuous, but with experience in the counting of leucocytes even this simple step is usually unnecessary.

Recognition of Red Blood Cells.

Red blood corpuscles are more difficult to distinguish than leucocytes, and it is well before attempting to count erythrocytes to become familiar with the shapes they may assume, whether the disc is viewed through the centre or periphery. Accurate measurements are necessary in doubtful cases.

Storing of Apparatus.

After use the slide and cover-glass are conveniently disinfected and stored in methylated spirit. The glass pipette should be well rinsed out with water and stored standing in a test tube containing 1 per cent. formalin. After use for a urine containing much pus the pipette should be boiled or thrown away. The pipettes are made by drawing out glass tubing in the blowpipe flame, and it is useful to have about a dozen at hand.

Summary.

The most accurate method of determining whether or not pus is present in urine is to count the leucocytes in a chamber similar to that used for counting the cells in cerebro-spinal fluid. The sample to be tested must be the first urine passed in the morning or after an interval of four hours. The test can be completed in two or three minutes, and provides a quantitative record comparable from day to day. It is suggested that no urine should be said to contain pus unless it contains more than 100 leucocytes per c.mm.

SARCOMA OF THE STOMACH.

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THE following case presents so many features of interest, apart from the extreme rarity of the condition, that it seems worthy of record. Most of the surgical authorities consulted either make no reference to the incidence of this type of growth or else quote it as a "rare pathological curiosity." In this instance the only practitioner to diagnose the case as one of malignancy was the anaesthetist, who was not acquainted with the physical signs or the clinical history.

A man, aged 40, was first admitted to the Victoria Hospital, Deal, on April 14th, 1927, under my colleague the late Dr. F. M. S. Hulke. The diagnosis made on admission was chronic duodenal ulcer. The history was typical: pain an hour or two after food, slightly relieved by food, melaena, some wasting. A skiagram after a barium meal confirmed this diagnosis. There was a rapidly acting stomach with considerable deformity of the duodenal cap, no filling defects, no sign of crater in the lesser curvature, and, to complete the picture, an apparent duodenal ileus.

Dr. Hulke commenced medical treatment, and the results were excellent. The patient put on weight, a stone or more, regained his healthy appearance, and was discharged fit a month later. After three months of rather strenuous work he came to consult me with a view to operative treatment of his condition. His previous good health had disappeared, he was emaciated, had frequent vomiting, and melaena with a good deal of pain and discomfort. He was therefore readmitted to hospital on August 15th for a preliminary course of rest and dieting, as his condition was too poor to risk immediate operation. During the following