of pure water as a diluent drink; recreation in the form of physical exercise or physical rest, commensurate with the mental activity or physical tire of the individual; the correction of irregular habits of sleep, of time of taking food and of exercise; the withdrawal of tobacco, tea, coffee and alcoholic drinks, which is usually necessary, and especially in the patients who suffer from the neurosis. Lavage the stomach when necessary and overcome the constipation by hygienic measures, if possible without drugs. In the conditions of malnutrition and anemia, give restorative tonics and an abundant simple diet. In short, a sensible hygienic life will not only prevent the headache, but will usually remove the gastrointestinal disease or cause.

100 State Street.

QUANTITATIVE ESTIMATION OF ALBUMIN IN THE URINE.*

BY CHAS. W. PURDY, M.D., LL.D.
CHICAGO.

Our present lack of a uniform method of expressing quantities of albumin in the urine detracts much from the value of all our methods; indeed, it renders the subject very confusing. As commonly employed, the term "percentage of albumin" is applied indifferently to gravimetric and volumetric measurements, as though they were synonymous, when, as a matter of fact, the two possess the most widely different significations. Thus, we commonly hear and read of percentages of albumin in the urine ranging from 20 to 40, etc., without further qualification. Such amounts expressed by actual weight would be a physical impossibility, since the proportion of albumin in the blood-serum itself never exceeds 9 per cent., and it would therefore be clearly impossible for the proteid contents of a fluid derived directly from the blood—such as the urine—to exceed that in the blood itself. As a matter of fact, the albumin in the urine expressed gravimetrically, rarely rises above 2 per cent., and perhaps never exceeds 3 per cent. It would therefore seem beyond question that at present we greatly need for clinical purposes some rapid, accurate, and ready method for estimating albumin in the urine, coupled with a more definite and exact method of expressing results obtained.

The author of this paper claims to have recently supplied this want, but before entering into a description of his method a brief survey will be taken of the more prominent methods heretofore employed.

THE GRAVIMETRIC METHOD.

The process consists in coagulation of the albumin, which may be accomplished either by boiling, or by means of a chemical agent; the succeeding steps being filtering out the albumin, collecting, drying and weighing.

Coagulation by Heat.—In this process a certain quantity of urine is taken—say 100 c.c.—a few drops of acetic acid added until the urine is distinctly acid, and then it is filtered. The urine is then put into a flask and gradually heated to boiling. The boiling should be continued for a half minute, and the urine then passed through a filter, the weight of the latter having been first ascertained and noted. The flask is next washed with distilled water, to secure all the adherent particles of albumin, and the contents of the flask are then again thrown on the filter. Next, the albumin is washed with boiling distilled water, by means of a pipette, the jet

being directed so as to wash the albumin toward the center of the filter. The washing should be continued until the albumin becomes perfectly clean and white. Sometimes it is necessary to use hot alcohol to cleanse the albumin. The filter is next placed in an oven, the temperature of which is 100 C. (212 F.), and then left until desiccation is complete. Drying is known to be complete when two weighings at an interval of an hour are identical. From the whole weight that of the filter is deducted, and the difference represents the weight of albumin in 100 c.c. of urine, from which the whole amount may be readily calculated. The tediousness of the process is its chief drawback for clinical purposes, since it can not be carried out in less than five or six hours.

TITRATION METHOD OF TANRET.

This method consists in precipitating the albumin by means of double iodid of mercury and potassium solution, and estimating the amount of albumin by the amount of mercuric solution required to precipitate all the albumin. Thus, one drop of the precipitating solution delivered from a pipette of standard size precipitates exactly 0.005 gm. of albumin. Therefore as many drops as it takes to precipitate all the albumin in a given quantity of urine represents that number of times 0.005 gm. of albumin present.

The formula for the precipitating solution is: Potassium iodid 3.22 gm., hyd. bichlorid 1.35 gm., aqua destil. to 100 c. c. The formula for the confirmatory solution is hyd. bichlorid 1 gm., aqua destil. to 100 c.c.

Process.—It will be more convenient to always conduct the test with a certain quantity of urine—say 10 c. c.—as in such cases the number of drops of the solution it takes to precipitate all the albumin in 10 c. c. of urine will represent so many half grams of albumin per liter. Thus, if it takes 10 drops of the precipitating solution to precipitate all the albumin in 10 c. c. of urine, then we have 0.05 gm. of albumin in the 10 c.c. of urine, which gives us 5 gm. albumin per liter. We proceed by then taking 10 c.c. of the albuminous urine and adding to it 2 c. c. of acetic acid, and stirring well with a glass rod. Next the precipitating solution is added, drop by drop, stirring thoroughly each time. After the addition of each drop of the precipitating reagent, a drop of the urine is placed on a porcelain dish or tile and a drop of the confirmatory solution is brought into contact therewith. As soon as a yellowish-red color appears all the albumin is precipitated, and the process is completed. The amount of albumin may at once be determined by taking the number of drops of the precipitating reagent employed, subtracting 3 as having been used in excess to make the color development perfectly apparent, and considering the remainder as so many half grams of albumin per liter, or so many 0.005 grams in the 10 c. c. of urine.

So long as any albumin remains in solution in the urine, the precipitating reagent will not form red iodid of mercury when the bichlorid solution is added, but it immediately does so when all the albumin is precipitated, therefore the bichlorid solution constitutes a perfect and beautiful indicator.

The above test is a fairly ready and rapid method which might be made available for practical clinical work were it not for the fact that it can not be depended upon in point of accuracy. As is well known, Tanret's reagent precipitates all known proteids in the urine, and unless corrected by means of heat, many of these would often be estimated for albumin. All alkaloids likewise are thrown out by this reagent. In short, if this test

*Abstract of paper presented to the Section on Practice of Medicine, at the Fiftieth Annual Meeting of the American Medical Association, held at Columbus, Ohio, June 6-9, 1899.

be employed cold, as directed by its author, it can not but prove entirely untrustworthy and misleading.

DIFFERENTIAL DENSITY METHOD OF LANG, HOEBLER AND BORNHARDT.

This method is based upon the difference in the specific gravity of the urine before and after coagulation and removal of the albumin. According to Haebler, the difference must be multiplied by 210; and according to Bornhardt, it must be multiplied by 415 in order to find the percentage of albumin in the urine. Neubauer states that his observations show that Haebler's quotient is absolutely false, and, moreover, that Bornhardt's number with careful manipulation yields only tolerable results when the amount of albumin in the urine is not too small; but in small amounts the limit of error is very great. Halliburton says of this process: "The supposed constant factor is from its very nature a variable one, and a simple algebraic demonstration of this will be found in a paper by Huppert and Lahor¹"

THE OPTICAL METHOD.

The principle of this method, proposed by Vogel, consists in gauging the amount of albumin by the degree of transparency of the urine after precipitation of the albumin. Various modifications of this method have been proposed, among the most simple of which is that of George Oliver. Thus, standard lines have been adopted by Oliver, of different thickness or width; corresponding to the different percentages of albumin, according to their degrees of visibility through a certain stratum of urine.

CIRCUMPOLARIZATION.

If the amount of albumin in the urine is not very small, and the urine is not too dark in color, and if it is rendered perfectly clear on filtering, the albumin may be estimated by means of the polarizing apparatus of Soliel-Ventizke. An observing-tube 200 mm. long is employed, and after filling and placing in the apparatus, by turning the compensator, the two halves of the field of the double plate are made exactly isochromatic. The zero point of the nonius now lies on the left side of the zero point of the scale, and each division, with a tube 200 mm. long corresponds to 1 gram of albumin in 100 c.c. of urine; and each division of the nonius to 0.1 gm.

ESBACH'S VOLUMETRIC METHOD.

For clinical purposes this method has attained very great popularity, chiefly on account of its simplicity, rather than from its accuracy. The process is simple in the extreme, although it takes twenty-four hours to complete the process. This method is based upon the fact that picric acid precipitates all the albumin in the urine at ordinary temperatures, and the assumption that the precipitate deposits in a uniform state and degree of density through gravitation, permitting volumetric measurement which corresponds with gravimetric measurement. The fact is incontestable, but the assumption is far from accurate.

The apparatus consists of a tube not unlike an ordinary test-tube in shape and size, but much thicker and graduated on the side so as to indicate the amounts of deposits, representing in grams and fractions thereof the albumin per liter of urine. The standard reagent is composed of 10 grams pure picric acid, 20 grams citric acid, distilled water to 1000 c.c.—1 liter.

Process.—The urine is poured into the albuminometer to the mark U, and the reagent is added to the letter R; the tube is then closed with a stopper and in-

verted a number of times until the urine and the reagent are thoroughly mingled. The tube is then stood in a rack for twenty-four hours, when the amount of albumin may be read off as indicated by the scale in grams per liter of urine. If it be desired to know the percentage of albumin in the urine, instead of the number of grams per liter, remove the decimal point one figure to the left—thus 5 grams per liter would be 0.5 per cent.

This method is simple and convenient; but, unfortunately, the results are only approximately accurate for the following reasons: In the first place, the reagent—picric acid—throws out and measures peptones, albumoses, nucleo-albumin, and practically all proteids met with in the urine in addition to alkaloids if present. In the second place, the force of gravitation, which is depended on for securing uniform packing of the albumin, is inadequate to overcome the lesser forces which often arise from varying conditions in the test itself and its physical surroundings, thus the slow chemical changes in progress between the reagents, or between the latter and the urine, or even in the latter alone, are often sufficient to liberate sufficient gases to completely overcome the force of gravitation, and the albumin often arises *en masse* to the surface. In a less degree the quantity of albumin itself, the specific gravity of the urine, and the surrounding temperature furnish opposing forces to that of gravitation, which disturbs uniformity of results and defeats the accuracy of the process. Observations in the writer's laboratory have shown conclusively that Esbach's method, with every precaution, is subject to constant and sometimes very wide errors.

THE AUTHOR'S CENTRIFUGAL METHOD.

It will be seen from the brief glance at the various quantitative methods just considered that the clinician demands something more accurate and ready for practical work than at present is available. The method herewith brought forward and recommended for practical clinical work is the result of five years' experimentation, with the details of which I will not take your time: The process in brief consists of the following steps: Precipitation of the albumin in carefully graduated percentage-tubes of 10 c.c. of the urine by means of 2 c.c. of 50 per cent. acetic acid and 3 c.c. of 1 to 10 aqueous solution of potassium ferrocyanid; after mingling the urine and reagents, the tubes should stand for ten minutes to ensure entire precipitation of the albumin. At the end of ten minutes the percentage-tubes are placed in a centrifuge, the radius of which with tubes in position must be exactly $6\frac{3}{4}$ inches. The tubes are revolved for exactly three minutes, at a uniform speed of 1500 revolutions per minute. The tubes are next removed and the amount of albumin is read off in bulk percentage, which, by the aid of accompanying table, is converted into percentage by weight and grams per fluid ounce. It will be observed that the time necessary to carry out this test need not exceed fifteen minutes, and as a result of many observations in the writer's laboratory in which the results were compared with the gravimetric method it has been found that the errors arising by this method need never amount to more than 0.01 per cent. Such minimal errors are of no practical import, being in fact no greater than ordinarily claimed for the gravimetric method itself.

To insure the most accurate results the following details should be observed: The urine should first be filtered and its chemical secretions ascertained, and if found to be neutral or alkaline it should be rendered frankly acid by the careful addition of a few drops of

¹ Ziet. f. Physiol. Chem., xii, 467.

acetic acid, great excess being avoided. Next, if the quantity of albumin be excessive the urine should be diluted with one or more volumes of water until the volumetric percentage does not exceed 10 or at most 15 per cent. Observations conducted in the writer's laboratory have determined the fact that accurate and uniform volumetric measurements of albumin in the urine are only possible when the volumetric percentage does not exceed 10 per cent., and this applies both to gravitation and centrifugal force.

With regard to the reagents: the 2 c.c. of 50 per cent. acetic acid should be added to 10 c.c. of the urine, the tubes should be inverted a number of times to insure thorough mingling of the acid with the urine; then 3 c.c. of the 1 to 10 ferrocyanid of potassium should be added, the tubes again inverted till all are well mingled, and lastly the tubes *should be stood aside for ten minutes* to insure entire precipitation of the albumin. Lastly, with regard to packing and measurement: The first and most important essential is an efficient centrifuge. The Purdy electric centrifuge possesses all the essentials for exact work. If this is at hand very few additional suggestions are necessary. If not, then a centrifuge must be employed that possesses certain essential features or is capable of such modification as will include these essentials, which are as follows: *a.* The percentage-tubes must be accurately graduated in tenths of a c.c. up to .15 c.c. *b.* The arm of the centrifuge should possess a radius of exactly $6\frac{3}{4}$ inches, that is to say, the linear distance from the center of the axle to the tip of either tube must be just $6\frac{3}{4}$ inches. *c.* The motor must be capable of an even and sustained speed of 1500 revolutions per minute, with the required radius, and carrying one ounce of urine. *d.* Lastly, some reliable method of gauging the exact speed of the motor must be employed. Any centrifuge that fulfils the above named requirements will give accurate results, as indicated by this method and the accompanying table.

PURDY'S QUANTITATIVE METHOD FOR ALBUMIN IN URINE.
(CENTRIFUGAL.)

Showing the relation between the volumetric and gravimetric percentage of albumin obtained by means of the centrifuge with radius of $6\frac{3}{4}$ inches; rate of speed 1500 revolutions per minute; time three minutes.

Volumetric percentage by centrifuge.	Percentage by weight of dry albumin.	Grains per fluid ounce dry albumin.	Volumetric percentage by centrifuge.	Percentage by weight of dry albumin.	Grains per fluid ounce dry albumin.	Volumetric percentage by centrifuge.	Percentage by weight of dry albumin.	Grains per fluid ounce dry albumin.
$\frac{1}{4}$	0.005	0.025	$13\frac{1}{2}$	0.281	1.35	$31\frac{1}{2}$	0.656	3.15
$\frac{1}{2}$	0.01	0.05	14	0.292	1.4	32	0.667	3.2
$\frac{3}{4}$	0.016	0.075	$14\frac{1}{2}$	0.302	1.45	$32\frac{1}{2}$	0.677	3.25
1	0.021	0.1	15	0.313	1.5	33	0.687	3.3
$1\frac{1}{4}$	0.026	0.125	$15\frac{1}{2}$	0.323	1.55	$33\frac{1}{2}$	0.698	3.35
$1\frac{1}{2}$	0.031	0.15	16	0.333	1.6	34	0.708	3.4
$1\frac{3}{4}$	0.036	0.175	$16\frac{1}{2}$	0.344	1.65	$34\frac{1}{2}$	0.719	3.45
2	0.042	0.2	17	0.354	1.7	35	0.729	3.5
$2\frac{1}{4}$	0.047	0.225	$17\frac{1}{2}$	0.365	1.75	$35\frac{1}{2}$	0.74	3.55
$2\frac{1}{2}$	0.052	0.25	18	0.375	1.8	36	0.75	3.6
$2\frac{3}{4}$	0.057	0.275	$18\frac{1}{2}$	0.385	1.85	$36\frac{1}{2}$	0.76	3.65
3	0.063	0.3	19	0.396	1.9	37	0.771	3.7
$3\frac{1}{4}$	0.068	0.325	$19\frac{1}{2}$	0.406	1.95	$37\frac{1}{2}$	0.781	3.75
$3\frac{1}{2}$	0.073	0.35	20	0.417	2.	38	0.792	3.8
$3\frac{3}{4}$	0.078	0.375	$20\frac{1}{2}$	0.427	2.05	$38\frac{1}{2}$	0.801	3.85
4	0.083	0.4	21	0.438	2.1	39	0.813	3.9
$4\frac{1}{4}$	0.089	0.425	$21\frac{1}{2}$	0.448	2.15	$39\frac{1}{2}$	0.823	3.95
$4\frac{1}{2}$	0.094	0.450	22	0.458	2.2	40	0.833	4.
$4\frac{3}{4}$	0.099	0.475	$22\frac{1}{2}$	0.469	2.25	$40\frac{1}{2}$	0.844	4.05

5	0.104	0.5	23	0.479	2.3	41	0.854	4.1
$5\frac{1}{2}$	0.111	0.55	$23\frac{1}{2}$	0.49	2.35	$41\frac{1}{2}$	0.865	4.15
6	0.125	0.6	24	0.5	2.4	42	0.875	4.2
$6\frac{1}{2}$	0.135	0.65	$24\frac{1}{2}$	0.51	2.45	$42\frac{1}{2}$	0.885	4.25
7	0.146	0.7	25	0.521	2.5	43	0.896	4.3
$7\frac{1}{2}$	0.156	0.75	$25\frac{1}{2}$	0.531	2.55	$43\frac{1}{2}$	0.906	4.35
8	0.167	0.8	26	0.542	2.6	44	0.917	4.4
$8\frac{1}{2}$	0.177	0.85	$26\frac{1}{2}$	0.552	2.65	$44\frac{1}{2}$	0.927	4.45
9	0.187	0.9	27	0.563	2.7	45	0.938	4.5
$9\frac{1}{2}$	0.198	0.95	$27\frac{1}{2}$	0.573	2.75	$45\frac{1}{2}$	0.948	4.55
10	0.208	1.	28	0.583	2.8	46	0.958	4.6
$10\frac{1}{2}$	0.219	1.05	$28\frac{1}{2}$	0.594	2.85	$46\frac{1}{2}$	0.969	4.65
11	0.229	1.1	29	0.604	2.9	47	0.979	4.7
$11\frac{1}{2}$	0.24	1.15	$29\frac{1}{2}$	0.615	2.95	$47\frac{1}{2}$	0.99	4.75
12	0.25	1.2	30	0.625	3.	48	1.	4.8
$12\frac{1}{2}$	0.26	1.25	$30\frac{1}{2}$	0.635	3.05			
13	0.271	1.3	31	0.646	3.1			

Test—2 c.c. of 50 per cent. acetic acid and 3 c.c. of 10 per cent. solution of ferrocyanid of potassium are added to 10 c.c. of the urine in the percentage-tube and stood aside for ten minutes, then placed in the centrifuge and revolved; rate of speed and time as stated at head of the table. If albumin is excessive dilute the urine with water till volume of albumin falls below 10 per cent. Multiply result by the number of dilutions employed before using the table.

This method has now been in daily use in the writer's laboratory for the past six months, where it has afforded the greatest possible satisfaction. The advantages claimed for this method over all others are its rapidity, simplicity, accuracy and comprehensiveness in expressing results, the volumetric percentage, the gravimetric percentage, the number of grains per ounce and the total amount by weight in twenty-four hours all being apparent by a single glance at the table.

57 East Twentieth Street.

ACCIDENTAL OR SPURIOUS ALBUMINURIA.*

BY CHARLES G. STOCKTON, M.D.

BUFFALO, N. Y.

The term accidental albuminuria as here used relates not only to the presence of albumin in the urine exclusive of disease of the kidney, but also of the various conditions aside from recognized kidney disease, which permit of the passage of serum albumin through the renal parenchyma into the urinary tubules. In other words, the term is employed to include those cases of albuminuria in which albumin finds its way into the urine from the pelvis of the kidneys, from the ureters, the bladder and the genitalia.

Albumin thus appearing possesses indirect interest to the student of internal medicine, because he must be able to exclude albumin arising from the sources above mentioned before he can affirm that he has to deal with albumin coming from the kidneys. As a matter of exclusion, therefore, the question must be made a familiar one.

Accidental albuminuria is of direct interest to the physician, because it is one of the diagnostic data for the recognition of pelvic renal diseases, ureteritis, and cystitis. The occurrence of albumin in pyelitis is almost constant while, in quantity, it varies with the character of the inflammation. It seems to bear direct ratio to the extent of pus formation in the pelvis of the kidney. When there is an inflammatory edema of the pelvis of the kidney, the exudation of albumin may be considerable. Occasionally in tubercular disease of the pelvis albumin may appear in small amount, but as the disease advances the albumin is more abundant, though this may be frequently explained by the fact that the parenchyma of the organ is at the same time involved. In

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